Francis Bacon

NOVUM ORGANUM

(Latin)

1620

Edited with introduction, notes, etc., by

Thomas Fowler

1889

Re-formatting, and Extra annotation by

Hossein Jorjani

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Notes by

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1- This is the second edition of Thomas Fowler's work from 1889 on Novum Organum. The copies of this version can be found on different Internet sites, including "The Internet Archive" (https://archive.org/).

2- Thomas Fowler has commented on the text of the book exhaustively, or may I should say over-exhaustively, because he has commented on many matters related to mathematics, physics, chemistry, biology, etc., which have become outdated now.

3- I could not find a good copy of this book in any format. Therefore, this text has been created by converting a poor-quality PDF file into a Word file. Consequently, in the beginning the text contained massive amounts of typographical mistakes. Removing the typographical mistakes will be on-going work. I have corrected to most obvious one. However, some may still remain. I will correct the remaining mistakes gradually (at different 'passes'!).

4- I tried to improve the formatting to increase the readability. Among other things, I included the footnotes in the text, so that they are read in the "right order". I have tried to explain the Latin abbreviations and make the abbreviations consistent. I have also pointed out some typographical mistakes in the original printing. Comments by Thomas Fowler, are shown in blue and marked by his initials [TF]. My own comments, if there are any, are in green and marked by [HJ]. **My work on the version is not finished by any means**.

5- I will publish the PDF version of this edited text on my website, under the "Philosophy" section: https://hosseinjorjani.com/novum-organum/. The filename will include a date in **YYYYMMDD** format to indicate the most recent revision.

6- I make no claim to knowing Latin well (and I know even less Greek). Over the course of this work, I've come to realize that my grasp of Latin — especially its historical forms and stylistic nuances — is more limited than I had imagined. Even certain older spellings and typographic conventions continue to puzzle me. To carry out this task, I've relied extensively on online tools, including Google Translate and Wikipedia — and more recently and substantially, on ChatGPT. I make no apology for using these resources. On the contrary, I am sincerely grateful to the brilliant minds who made them possible. I also wish to extend a word of thanks to ChatGPT itself — should it happen to be, or someday become, sentient — for its unfailing assistance and insight.

7- This is a living document, and it remains **under development**. It may still contain errors of various kinds. If you come across any mistakes, I would be grateful if you let me know by writing to: hosseinjorjani2@gmail.com.

FRANCISCUS DE VERULAMIO

SIC COGITAVIT;
TALEMQUE APUD SE
rationem instituit, quam Viventibus et
Posteris notam fieri ipsorum
interesse putavit.

Cum illi pro comperto esset intellectum humanum sibi ipsi negotium facessere, neque auxiliis veris (quae in hominis potestate sunt) uti sobrie et commode; unde multiplex rerum ignoratio et ex ignoratione rerum detrimenta innumera: omni ope connitendum existimavit, si quo modo commercium istud Mentis et Rerum (cui vix aliquid in terris, aut saltem in terrenis, se ostendit simile) restitui posset in integrum, aut saltem in melius deduci. Ut vero errores qui invaluerunt, quique in aeternum invalituri sunt, alii post alios (si mens sibi permittatur) ipsi se corrigerent, vel ex vi intellectus propria vel ex auxiliis atque adminiculis dialecticae, nulla prorsus suberat spes; propterea quod notiones rerum primae, quas mens haustu facili et supino excipit recondit atque accumulat (unde reliqua omnia fluunt), vitiosae sint et confusae et temere a rebus abstractae; neque minor sit in secundis et reliquis libido et inconstantia; ex quo fit, ut universa ista ratio humana, qua utimur quoad inquisitionem naturae, non bene congesta et aedificata sit, sed tanquam moles aliqua magnifica sine fundamento. Dum enim falsas mentis vires mirantur homines et celebrant, veras ejusdem quae esse possint (si debita ei adhibeantur auxilia, atque ipsa rebus morigera sit, nec impotenter rebus insultet) praetereunt et perdunt. Restabat illud unum ut res de integro tentetur melioribus praesidiis, utque fiat scientiarum et artium atque omnis humanae doctrinae in universum Instauratio, a debitis excitata fundamentis. Hoc vero licet aggressu infinitum quiddam videri possit ac supra vires mortales, tamen idem tractatu sanum invenietur ac sobrium, magis quam ea quae adhuc facta sunt. Exitus enim hujus rei est nonnullus. In iis vero quae jam fiunt circa scientias, est vertigo quaedam et agitatio perpetua et circulus. Neque eum fugit quanta in solitudine versetur hoc experimentum, et quam durum et incredibile sit ad faciendam fidem. Nihilominus, nec rem nec seipsum deserendum putavit, quin viam quae una humanae menti pervia est tentaret atque iniret. Praestat enim principium dare rei quae exitum habere possit, quam in iis quae exitum nullum habent perpetua contentione et studio implicari. Viae autem contemplativae viis illis activis decantatis fere respondent; ut altera, ab initio ardua et difficilis, desinat in apertum; altera, primo intuitu expedita et proclivis, ducat in avia et praecipitia. Quum autem incertus esset quando haec alicui posthac in mentem ventura sint; eo potissimum usus argumento, quod neminem hactenus invenit qui ad similes cogitations animum applicuerit; decrevit prima quaeque quae perficere licuit in publicum edere. Neque haec festinatio ambitiosa fuit, sed sollicita; ut si quid illi humanitus accideret, extaret tamen designatio quaedam ac destinatio rei quam animo complexus est; utque extaret simul signum aliquod honestae suae et propensae in generis humani commoda voluntatis. Certe aliam quamcunque ambitionem inferiorem

duxit re quam prae manibus habuit. Aut enim hoc quod agitur nihil est, aut tantum, ut merito ipso contentum esse debeat nec fructum extra quaerere.

SERENISSIMO POTENTISSIMOQUE PRINCIPI AC DOMINO *NOSTRO,*

JACOBO,

DEI GRATIA *MAGNAE BRITANNIAE,*
Franciae et Hiberniae Regi,
FIDEI *Defensori, etc.*

Serenissime Potentissimeque Rex,

POTERIT fortasse Majestas tua me furti incusare, quod tantum temporis quantum ad haec sufficiat negotiis tuis suffuratus sim. Non habeo quod dicam. Temporis enim non fit restitutio; nisi forte quod detractum fuerit temporis rebus tuis, id memoriae nominis tui et honori saeculi tui reponi possit; si modo haec alicujus sint pretii. Sunt certe prorsus nova; etiam toto genere: sed descripta ex veteri admodum exemplari, mundo scilicet ipso, et natura rerum et mentis. Ipse certe (ut ingenue fatear) soleo aestimare hoc opus magis pro partu temporis quam ingenii. Illud enim in eo solummodo mirabile est, initia rei et tantas de iis quae invaluerunt suspiciones alicui in mentem venire potuisse. Caetera non illibenter sequuntur. At versatur proculdubio casus (ut loquimur) et quiddam quasi fortuitum non minus in iis quae cogitant homines quam in iis quae agunt aut loquuntur. Verum hunc casum (de quo loquor) ita intelligi volo, ut si quid in liis quae affero sit boni, id immensae misericordiae et bonitati divinae et foelicitati temporum tuorum tribuatur: cui et vivus integerrimo affectu servivi, et mortuus fortasse id effecero, ut ilia posteritati, nova hac accensa face in philosophiae tenebris, praelucere possint. Merito autem temporibus regis omnium sapientissimi et doctissimi Regeneratio ista et Instauratio scientiarum debetur. Superest petitio, Majestate tua non indigna, et maxime omnium faciens ad id quod agitur. Ea est, ut quando Salomonem in plurimis referas, judiciorum gravitate, regno pacifico, cordis latitudine, librorum denique quos composuisti nobili varietate, etiam hoc ad ejusdem regis exemplum addas, ut cures Historiam Naturalem et Experimentalem, veram et severam (missis philologicis), et quae sit in ordine ad condendam philosophiam, denique qualem suo loco describemus, congeri et perfici: ut tandem post tot mundi aetates philosophia et scientiae non sint amplius pensiles et aëreae, sed solidis experientiae omnigenae, ejusdemque bene pensitatae, nitantur fundamentis. Equidem Organum praebui; verum materies a rebus ipsis petenda est. Deus Opt. Max. Majestatem tuam diu servet incolumem.

Serenissimae Majestati tuae
Servus devinctissimus, et, devotissimus,
FRANCISCUS VERULAM,
CANCELLARIUS.

FRANCISCI DE VERULAMIO
INSTAURATIO MAGNA.

PRAEFATIO.

De statu scientiarum, quod non sit foelix aut majorem in modum auctus; quodque alia omnino quam prioribus cognita fuerit via aperienda sit intellectui humano, et alia comparanda auxilia, ut mens suo jure in rerum naturam uti possit.

VIDENTUR nobis homines nec opes nec vires suas bene nosse; verum de illis majora quam par est, de his minora credere. Ita fit, ut aut artes receptas insanis pretiis aestimantes nil amplius quaerant, aut seipsos plus aequo contemnentes vires suas in levioribus consumant, in iis quae ad summum rei faciant non experiantur. Quare sunt et suae scientiis columnae tanquam fatales; cum ad ulterius penetrandum homines nec desiderio nec spe excitentur. Atque cum opinio copiae inter maximas causas inopiae sit; quumque ex fiducia praesentium vera auxilia negligantur in posterum; ex usu est, et plane ex necessitate, ut ab illis quae adhuc inventa sunt in ipso operis nostri limine (idque relictis ambagibus et non dissimulanter) honoris et admirationis excessus tollatur; utili monito, ne homines eorum aut copia aut utilitatem in majus accipiant aut celebrent. Nam si quis in omnem illam librorum varietatem qua artes et scientiae exultant diligentius introspiciat, ubique inveniet ejusdem rei repetitiones infinitas, tractandi modis diversas, inventione praeoccupatas; ut omnia primo intuitu numerosa, facto examine pauca reperiantur. Et de utilitate aperte dicendum est, sapientiam istam quam a Graecis potissimum hausimus pueritiam quandam scientiae videri, atque habere quod proprium est puerorum, ut ad garriendum prompta, ad generandum invalida et immatura sit. Controversiarum enim ferax, operum effoeta est. Adeo ut fabula illa de Scylla in literarum statum, qualis habetur, ad vivum quadrare videatur; quae virginis os et vultum extulit, ad uterum vero monstra latrantia succingebantur et adhaerebant. Ita habent et scientiae quibus insuevimus generalia quaedam blandientia et speciosa, sed cum ad particularia ventum sit, veluti ad partes generationis, ut fructum et opera ex se edant, tum contentiones et oblatrantes disputationes exoriuntur, in quas desinunt, et quae partus locum obtinent. Praeterea, si hujusmodi scientiae plane res mortua non essent, id minime videtur eventurum fuisse quod per multa jam saecula usu venit, ut illae suis immotae fere haereant vestigiis, nec incrementa genere humano digna sumant: eo usque, ut saepenumero non solum assertio maneat assertio sed etiam quaestio maneat quaestio, et per disputationes non solvatur sed figatur et alatur, omnisque traditio et successio disciplinarum repraesentet et exhibeat personas magistri et auditoris, non inventoris et ejus qui inventis aliquid eximium adjiciat. In artibus autem mechanicis contrarium evenire videmus; quae, ac si aurae cujusdam vitalis forent participes, quotidie crescunt et perficiuntur, et in primis authoribus rudes plerunque et fere onerosae et informes apparent, postea vero novas virtutes et commoditatem

quandam adipiscuntur, eo usque, ut citius studia hominum et cupiditates deficiant et mutentur, quam illae ad culmen et perfectionem suam pervenerint. Philosophia contra et scientiae intellectuales, statuarum more, adorantur et celebrantur, sed non promoventur. Quin etiam in primo nonnunquam authore maxime vigent, et deinceps degenerant. Nam postquam homines deditii facti sint et in unius sententiam (tanquam pedarii senatores) coierint, scientiis ipsis amplitudinem non addunt, sed in certis authoribus ornandis et stipandis servili officio funguntur. Neque illud afferat quispiam, scientias paullatim succrescentes tandem ad statum quendam pervenisse, et tum demum (quasi confectis spatiis legitimis) in operibus paucorum sedes fixas posuisse; atque postquam nil melius inveniri potuerit, restare scilicet ut quae inventa sint exornentur et colantur. Atque optandum quidem esset haec ita se habuisse. Rectius illud et verius, istas scientiarum mancipationes nil aliud esse quam rem ex paucorum hominum confidentia et reliquorum socordia et inertia natam. Postquam enim scientiae per partes diligenter fortasse excultae et tractatae fuerint, tum forte exortus est aliquis, ingenio audax et propter methodi compendia acceptus et celebratus, qui specie tenus artem constituerit, revera veterum labores corruperit. Id tamen posteris gratum esse solet, propter usum operis expeditum et inquisitionis novae taedium et impatientiam. Quod si quis consensu jam inveterato tanquam temporis judicio moveatur, sciat se ratione admodum fallaci et infirma niti. Neque enim nobis magna ex parte notum est, quid in scientiis et artibus, variis saeculis et locis, innotuerit et in publicum emanarit; multo minus, quid a singulis tentatum sit et secreto agitatum. Itaque nec temporis partus nec abortus extant in fastis. Neque ipse consensus ejusque diuturnitas magni prorsus aestimandus est. Utcunque enim varia sint genera politiarum, unicus est status scientiarum, isque semper fuit et mansurus est popularis. Atque apud populum plurimum vigent doctrinae aut contentiosae et pugnaces aut speciosae et inanes, quales videlicet assensum aut illaqueant aut demulcent. Itaque maxima ingenia proculdubio per singulas aetates vim passa sunt; dum viri captu et intellectu non vulgares, nihilo secius existimationi suae consulentes, temporis et multitudinis judicio se submiserint. Quamobrem altiores contemplationes si forte usquam emicuerint, opinionum vulgarium ventis subinde agitatae sunt et extinctae. Adeo ut Tempus, tanquam fluvius, levia et inflata ad nos devexerit, gravia et solida demerserit. Quin et illi ipsi authores qui dictaturam quandam in scientiis invaserunt et tanta confidentia de rebus pronuntiant, cum tamen per intervalla ad se redeunt, ad querimonias de subtilitate naturae, veritatis recessibus, rerum obscuritate, causarum implicatione, ingenii humani infirmitate, se convertunt; in hoc nihilo tamen modestiores, cum malint communem hominum et rerum conditionem causari quam de seipsis confiteri. Quin illis hoc fere solenne est, ut quicquid ars aliqua non attingat id ipsum ex eadem arte impossibile esse statuant. Neque vero damnari potest ars, quum ipsa disceptet et judicet. Itaque id agitur, ut ignorantia etiam ab ignominia liberetur. Atque quae tradita et recepta sunt ad hunc fere modum se habent: quoad opera sterilia, quaestionum plena; incrementis suis tarda et languida; perfectionem in tot simulantia, sed per partes male impleta; delectu autem popularia et authoribus ipsis suspecta, ideoque artificiis quibusdam munita et ostentata. Qui autem et ipsi experiri et se scientiis addere earumque fines proferre statuerunt, nec illi a receptis prorsus desciscere ausi sunt, nec fontes rerum petere. Verum se magnum quiddam consequutos putant si aliquid ex proprio inserant et adjiciant; prudenter secum

reputantes, se in assentiendo modestiam, in adjiciendo libertatem tueri posse. Verum dum opinionibus et moribus consulitur, mediocritates istae laudatae in magnum scientiarum detrimentum cedunt. Vix enim datur authores simul et admirari et superare. Sed fit aquarum more, quae non altius ascendunt quam ex quo descenderunt. Itaque hujusmodi homines emendant nonnulla sed parum promovent, et proficiunt in melius non in majus. Neque tamen defuerunt, qui ausu majore omnia integra sibi duxerunt, et ingenii impetu usi, priora prosternendo et destruendo aditum sibi et placitis suis fecerunt; quorum tumultu non magnopere profectum est: quum philosophiam et artes non re ac opere amplificare, sed placita tantum permutare atque regnum opinionum in se transferre contenderint; exiguo sane fructu, quum inter errores oppositos errandi causae sint fere communes. Si qui autem nec alienis nec propriis placitis obnoxii, sed libertati faventes, ita animati fuere ut alios secum simul quaerere cuperent; illi sane affectu honesti, sed conatu invalidi fuerunt. Probabiles enim tantum rationes secuti videntur, et argumentorum vertigine circumaguntur, et promiscua quaerendi licentia severitatem inquisitionis enervarunt. Nemo autem reperitur, qui in rebus ipsis et experientia moram fecerit legitimam. Atque nonnulli rursus qui experientiae undis se commisere et fere mechanici facti sunt, tamen in ipsa experientia erraticam quandam inquisitionem exercent, nec ei certa lege militant. Quin et plerique pusilla quaedam pensa sibi proposuere, pro magno ducentes si unum aliquod inventurm eruere possint; instituto non minus tenui, quam imperito. Nemo enim rei alicujus naturam in ipsa re recte aut foeliciter perscrutatur; verum post laboriosam experimentorum variationem non acquiescit, sed invenit quod ulterius quaerat. Neque illud imprimis omittendum est, quod omnis in experiendo industria statim ab initio opera quaedam destinata praepropero et intempestivo studio captavit; fructifera (inquam) experimenta, non lucifera, quaesivit; nec ordinem divinum imitata est, qui primo die lucem tantum creavit, eique unum diem integrum attribuit; neque illo die quicquam materiati operis produxit, verum sequentibus diebus ad ea descendit. At qui summas dialecticae partes tribuerunt, atque inde fidissima scientiis praesidia comparari putarunt, verissime et optime viderunt intellectum humanum sibi permissum merito suspectum esse debere. Verum infirmior omnino est malo medicina; nec ipsa mali expers. Siquidem dialectica quae recepta est, licet ad civilia et artes quae in sermone et opinione positae sunt rectissime adhibeatur, naturae tamen subtilitatem longo intervallo non attingit; et prensando quod non capit, ad errores potius stabiliendos et quasi figendos quam ad viam veritati aperiendam valuit.

Quare, ut quae dicta sunt complectamur, non videtur hominibus aut aliena fides aut industria propria circa scientias hactenus foeliciter illuxisse; praesertim quum et in demonstrationibus et in experimentis adhuc cognitis parum sit praesidii. Aedificium autem hujus universi, structura sua, intellectui humano contemplanti, instar labyrinthi est; ubi tot ambigua viarum, tam fallaces rerum et signorum similitudines, tam obliquae et implexae naturarum spirae et nodi, undequaque se ostendunt. Iter autem sub incerto sensus lumine, interdum affulgente, interdum se condente, per experientiae et rerum particularium sylvas perpetuo faciendum est. Quin etiam duces itineris (ut dictum est) qui se offerunt, et ipsi implicantur, atque errorum et errantium numerum augent. In rebus tam duris, de judicio hominum ex vi propria, aut etiam de foelicitate fortuita, desperandum est. Neque enim ingeniorum quantacunque excellentia, neque experiendi

alea saepius repetita, ista vincere queat. Vestigia filo regenda sunt: omnisque via, usque a primis ipsis sensuum perceptionibus, certa ratione munienda. Neque haec ita accipienda sunt, ac si nihil omnino tot saeculis, tantis laboribus, actum sit. Neque enim eorum quae inventa sunt nos poenitet. Atque antiqui certe, in iis quae in ingenio et meditatione abstracta posita sunt, mirabiles se viros praestitere. Verum quemadmodum saeculis prioribus, cum homines in navigando per stellarum tantum observationes cursum dirigebant, veteris sane continentis oras legere potuerunt, aut maria aliqua minora et mediterranea trajicere; priusquam autem oceanus trajiceretur et novi orbis regiones detegerentur, necesse fuit usum acus nauticae, ut ducem viae magis fidum et certum, innotuisse: simili prorsus ratione, quae hucusque in artibus et scientiis inventa sunt, ea hujusmodi sunt ut usu, meditatione, observando, argumentando, reperiri potuerint; utpote quae sensibus propiora sint et communibus notionibus fere subjaceant; antequam vero ad remotiora et occultiora naturae liceat appellere, necessario requiritur ut melior et perfectior mentis et intellectus humani usus et adoperatio introducatur.

Nos certe, aeterno veritatis amore devicti, viarum incertis et arduis et solitudinibus nos commisimus; et divino auxilio freti et innixi, mentem nostram et contra opinionum violentias et quasi instructas acies, et contra proprias et internas haesitationes et scrupulos, et contra rerum caligines et nubes et undequaque volantes phantasias, sustinuimus; ut tandem magis fida et secura indicia viventibus et posteris comparare possemus. Qua in re si quid profecerimus, non alia sane ratio nobis viam aperuit quam vera et legitima spiritus humani humiliatio. Omnes enim ante nos, qui ad artes inveniendas se applicuerunt, conjectis paulisper in res et exempla et experientiam oculis, statim, quasi inventio nil aliud esset quam quaedam excogitatio, spiritus proprios ut sibi oracula exhiberent quodammodo invocarunt. Nos vero inter res caste et perpetuo versantes, intellectum longius a rebus non abstrahimus quam ut rerum imagines et radii (ut in sensu fit) coire possint; unde fit, ut ingenii viribus et excellentiae non multum relinquatur. Atque quam in inveniendo adhibemus humilitatem, eandem et in docendo sequuti sumus. Neque enim aut confutationum triumphis, aut antiquitatis advocationibus, aut authoritatis usurpatione quadam, aut etiam obscuritatis velo, aliquam his nostris inventis majestatem imponere aut conciliare conamur; qualia reperire non difficile esset ei, qui nomini suo non animis aliorum lumen affundere conaretur. Non (inquam) ullum aut vim aut insidias hominum judiciis fecimus aut paramus; verum eos ad res ipsas et rerum foedera adducimus; ut ipsi videant quid habeant, quid arguant, quid addant atque in commune conferant. Nos autem si qua in re vel male credidimus, vel obdormivimus et minus attendimus, vel defecimus in via et inquisitionem abrupimus, nihilominus iis modis res nudas et apertas exhibemus, ut errores nostri, antequam scientiae massam altius inficiant, notari et separari possint; atque etiam ut facilis et expedita sit laborum nostrorum continuatio. Atque hoc modo inter empiricam et rationalem facultatem (quarum morosa et inauspicata divortia et repudia omnia in humana familia turbavere) conjugium verum et legitimum in perpetuum nos firmasse existimamus.

Quamobrem, quum haec arbitrii nostri non sint, in principio operis, ad Deum Patre, Deum Verbum, Deum Spiritum, preces fundimus humillimas et ardentissimas, ut humani generis aerumnarum memores et peregrinationis istius vitae in qua dies paucos et malos terimus, novis suis eleemosynis, per manus nostras, familiam humanam dotare dignentur. Atque illud insuper supplices rogamus, ne humana divinis officiant, neve ex reseratione viarum sensus et accensione majore luminis naturalis aliquid incredulitatis et noctis animis nostris erga divina mysteria oboriatur: sed potius, ut ab intellectu puro, a phantasiis et vanitate repurgato et divinis oraculis nihilominus subdito et prorsus dedititio, fidei dentur quae fidei sunt. Postremo, ut scientiae veneno a serpente infuso, quo animus humanus tumet et inflatur, deposito, nec altum sapiamus nec ultra sobrium, sed veritatem in charitate colamus.

Peractis autem votis, ad homines conversi, quaedam et salutaria monemus et aequa postulamus. Monemus primum (quod etiam precati sumus) ut homines sensum in officio, quoad divina, contineant. Sensus enim (instar solis) globi terrestris faciem aperit, coelestis claudit et obsignat. Rursus, ne hujusce mali fuga in contrarium peccent; quod certe fiet, si naturae inquisitionem ulla ex parte veluti interdicto separatam putant. Neque enim pura illa et immaculata scientia naturalis, per quam Adam nomina ex proprietate rebus imposuit, principium aut occasionem lapsui dedit. Sed ambitiosa illa, et imperativa scientiae moralis, de bono et malo dijudicantis, cupiditas, ad hoc ut Homo a Deo deficeret et sibi ipsi leges daret, ea demum ratio atque modus tentationis fuit. De scientiis autem quae naturam contemplantur sanctus ille philosophus pronuntiat, *Gloriam Dei esse celare rem; gloriam regis autem rem invenire*: non aliter ac si divina natura innocenti et benevolo purorum ludo delectaretur, qui ideo se abscondunt ut inveniantur; atque animam humanam sibi collusorem in hoc ludo pro sua in homines indulgentia et bonitate cooptaverit. Postremo omnes in universum monitos volumus, ut scientiae veros fines cogitent; nec eam aut animi causa petant, aut ad contentionem, aut ut alios despiciant, aut ad commodum, aut ad famam, aut ad potentiam, aut hujusmodi inferiora; sed ad meritum et usus vitae; eamque in charitate perficiant et regant. Ex appetitu enim potentiae angeli lapsi sunt; ex appetitu scientiae, homines; sed charitatis non est excessus; neque angelus aut homo per eam unquam in periculum venit.

Postulata autem nostra quae afferimus talia sunt. De nobis ipsis silemus: de re autem quae agitur petimus, ut homines eam non opinionem sed opus esse cogitent; ac pro certo habeant, non sectae nos alicujus aut placiti, sed utilitatis et amplitudinis humanae fundamenta moliri. Deinde ut suis commodis aequi, exutis opinionum zelis et praejudiciis, in commune consulant; ac ab erroribus viarum atque impedimentis, nostris praesidiis et auxiliis, liberati et muniti, laborum qui restant et ipsi in partem veniant. Praeterea, ut bene sperent; neque *Instaurationem* nostram, ut quiddam infinitum et ultra mortale, fingant et animo concipiant; quum revera sit infiniti erroris finis et terminus legitimus; mortalitatis autem et humanitatis non sit immemor; quum rem non intra unius aetatis curriculum omnino perfici posse confidat, sed successioni destinet; denique scientias, non per arrogantiam in humani ingenii cellulis, sed submisse in mundo majore quaerat. Vasta vero ut plurimum solent esse, quae inania: solida contrahuntur maxime, et in parvo sita sunt. Postremo etiam petendum videtur (ne forte quis rei ipsius

periculo nobis iniquus esse velit) ut videant homines, quatenus ex eo quod nobis asserere necesse sit (si modo nobis ipsi constare velimus) de his nostris opinandi aut sententiam ferendi sibi jus permissum putent: quum nos omnem istam rationem humanam praematuram, anticipantem, et a rebus temere et citius quam oportuit abstractam, (quatenus ad inquisitionem naturae) ut rem variam et perturbatam et male extructam rejiciamus. Neque postulandum est ut ejus judicio stetur, quae ipsa in judicium vocatur.

DISTRIBUTIO OPERIS.

Ejus constituuntur Partes sex.

Prima;	*Partitiones Scientiarum.*
Secunda;	*Novum Organum, sive Indicia de Interpretatione Naturae.*
Tertia;	*Phaenomena Universi, sive Historia Naturalis et Experimentalis ad condendam Philosophiam.*
Quarta;	*Scala Intellectus.*
Quinta;	*Prodromi, sive Anticipationes Philosophiae Secundae.*
Sexta;	*Philosophia Secunda, sive Scientia Activa.*

Singularum Argumenta.

PARS autem instituti nostri est, ut omnia, quantum fieri potest aperte et perspicue proponantur. Nuditas enim animi, ut olim corporis, innocentiae et simplicitatis comes est. Pateat itaque primo ordo operis atque ratio ejus. Partes operis a nobis constituuntur sex.

Prima pars exhibet scientiae ejus sive doctrinae in cujus possessione humanum genus hactenus versatur, Summam, sive descriptionem universalem. Visum enim est nobis etiam in iis quae recepta sunt nonnullam facere moram: eo nimirum consilio, ut facilius et veteribus perfectio et novis aditus detur. Pari enim fere studio ferimur et ad vetera excolenda et ad ulteriora assequenda. Pertinet etiam hoc ad faciendam fidem: juxta illud, *Non accipit indoctus verba scientiae, nisi prius ea dixeris quae versantur in corde ejus*. Itaque scientiarum atque artium receptarum oras legere, necnon utilia quaedam in illas importare, tanquam in transitu, non negligemus.

Partitiones tamen Scientiarum adhibemus eas, quae non tantum jam inventa et nota, sed hactenus omissa et debita, complectantur. Etenim inveniuntur in globo intellectuali, quemadmodum in terrestri, et culta pariter et deserta. Itaque nil mirum videri debet, si a divisionibus usitatis quandoque recedamus. Adjectio enim, dum totum variat, etiam partes earumque sectiones necessario variat: receptae autem divisiones receptae summae scientiarum, qualis nunc est, tantum competunt.

Circa ea vero quae ceu omissa notabimus, ita nos geremus, ut non leves tantum titulos et argumenta concisa eorum quae desiderantur proponamus. Nam siquid inter omissa retulerimus (modo sit dignioris subjecti) cujus ratio paulo videatur obscurior adeo ut

merito suspicari possimus homines non facile intellecturos quid nobis velimus aut quale sit illud opus quod animo et cogitatione complectimur, perpetuo nobis curae erit aut praecepta hujusmodi operis conficiendi aut etiam partem operis ipsius jam a nobis confectam ad exemplum totius subjungere; ut in singulis aut opera aut consilio juvemus. Etenim etiam as nostram existimationem, non solum aliorum utilitatem, pertinere putavimus, ne quis arbitretur levem aliquam de istiusmodi rebus notionem mentem nostram perstrinxisse, atque esse illa quae desideramus ac prensamus tanquam votis similia. Ea vero talia sunt, quorum et penes homines (nisi sibi ipsi desint) potestas plane sit, et nos apud nosmet rationem quandam certam et explicatam habeamus. Neque enim regiones metiri animo, ut augures, auspiciorum cause: sed intrare, ut duces, promerendi studio, suscepimus.

Atque haec prima operis pars est.

Porro praetervecti artes veteres, intellectum humanum ad trajiciendum instruemus. Destinatur itaque parti secundae, doctrina de meliore et perfectiore usu rationis in rerum inquisitione, et de auxiliis veris intellectus: ut per hoc (quantum conditio humanitatis ac mortalitatis patitur) exaltetur intellectus, et facultate amplificetur ad naturae ardua et obscura superanda. Atque est ea quam adducimus ars (quam *Interpretationem Naturae* appellare consuevimus) ex genere logicae; licet plurimum, atque adeo immensum quiddam, intersit. Nam et ipsa illa logica vulgaris auxilia et praesidia intellectui moliri ac parare profitetur: et in hoc uno consentiunt. Differt autem plane a vulgari rebus praecipue tribus: viz. ipso fine, ordine demonstrandi, et inquirendi initiis.

Nam huic nostrae scientiae finis proponitur, ut inveniantur non argumenta sed artes, nec principiis consentanea sed ipsa principia, nec rationes probabiles sed designationes et indicationes Operum. Itaque ex intentione diversa diversus sequitur effectus. Illic enim adversarius disputatione vincitur et constringitur; hic natura, opere.

Atque cum hujusmodi fine conveniunt demonstrationum ipsarum natura et ordo. In logica enim vulgari opera fere universa circa Syllogismum consumitur. De Inductione vero Dialectici vix serio cogitasse videntur; levi mentione eam transmittentes, et ad disputandi formulas properantes. At nos demonstrationem per syllogismum rejicimus, quod confusius agat, et naturam emittat e manibus. Tametsi enim nemini dubium esse possit quin, quae in medio termino conveniunt, ea et inter se conveniant (quod est mathematicae cujusdam certitudinis): nihilominus hoc subest fraudis, quod syllogismus ex propositionibus constet, propositiones ex verbis, verba autem notionum tesserae et signa sint. Itaque si notiones ipsae mentis (quae verborum quasi anima sunt, et totius hujusmodi structurae ac fabricae basis) male ac temere a rebus abstractae, et vagae, nec satis definitae et circumscriptae, denique multis modis vitiosae fuerint, omnia ruunt. Rejicimus igitur syllogismum; neque id solum quoad principia (ad quae nec illi eam adhibent) sed etiam quoad propositiones medias, quas educit sane atque parturit utcunque syllogismus, sed operum steriles et a practica remotas et plane quoad partem activam scientiarum incompetentes. Quamvis igitur relinquamus syllogismo et

hujusmodi demonstrationibus famosis ac jactatis jurisdictionem in artes populares et opinabiles (nil enim in hac parte movemus), tamen ad naturam rerum Inductione per omnia, et tam ad minores propositiones quam ad majores, utimur. *Inductionem* enim censemus eam esse demonstrandi formam, quae sensum tuetur et naturam premit et operibus imminet ac fere immiscetur.

Itaque ordo quoque demonstrandi plane invertitur. Adhuc enim res ita geri consuevit; ut a sensu et particularibus primo loco ad maxime generalia advoletur, tanquam ad polos fixos circa quos disputationes vertantur; ab illis caetera per media deriventur: via certe compendiaria, sed praecipiti, et ad naturam impervia, ad disputationes vero proclivi et accommodata. At secundum nos, axiomata continenter et gradatim excitantur, ut nonnisi postremo loco ad generalissima veniatur: ea vero generalissima evadunt non notionalia, sed bene terminata, et talia quae natura ut revera sibi notiora agnoscat, quaeque rebus haereant in medullis.

At in forma ipsa quoque inductionis, et judicio quod per eam fit, opus longe maximum movemus. Ea enim de qua dialectici loquuntur, quae procedit per enumerationem simplicem, puerile quiddam est, et precario concludit, et periculo ab instantia contradictoria exponitur, et consueta tantum intuetur, nec exitum reperit.

Atqui opus est ad scientias inductionis forma tali, quae experientiam solvat et separet, et per exclusiones ac rejectiones debitas necessario concludat. Quod si judicium illud vulgatum dialecticorum tam operosum fuerit, et tanta ingenia exercuerit; quanto magis laborandum est in hoc altero, quod non tantum ex mentis penetralibus, sed etiam ex naturae visceribus extrahitur?

Neque tamen hic finis. Nam fundamenta quoque scientiarum fortius deprimimus et solidamus, atque initia inquirendi altius sumimus, quam adhuc homines fecerunt: ea subjiciendo examini, quae logica vulgaris tanquam fide aliena recipit. Etenim dialectici principia scientiarum a scientiis singulis tanquam mutuo sumunt: rursus, notiones mentis primas venerantur: postremo, informationibus immediatis sensus bene dispositi acquiescunt. At nos logicam veram singulas scientiarum provincias majore cum imperio quam penes ipsarum principia sit debere ingredi decrevimus, atque illa ipsa principia putativa ad rationes reddendas compellere quousque plane constent. Quod vero attinet ad notiones primas intellectus; nihil est eroum quae intellectus sibi permissus congessit, quin nobis pro suspecto sit, nec ullo modo ratum, nisi novo judicio se stiterit et secundum illud pronuntiatum fuerit. Quinetiam sensus ipsius informationes multis modis excutimus. Sensus enim fallunt utique, sed et errores suos indicant: verum errores praesto, indicia eorum longe petita sunt.

Duplex autem est sensus culpa: aut enim destituit nos aut decipit. Nam primo, plurimae sunt res quae sensum etiam recte dispositum nec ullo modo impeditum effugiunt; aut subtilitate totius corporis, aut partium minutiis, aut loci distantia, aut tarditate atque etiam velocitate motus, aut familiaritate objecti, aut alias ob causas. Neque rursus, ubi sensus rem tenet, prehensiones ejus admodum firmae sunt. Nam testimonium et

informatio sensus semper est ex analogia hominis, non ex analogia universi: atque magno prorsus errore asseritur, sensum esse mensuram rerum.

Itaque ut his occurratur, nos multo et fido ministerio auxilia sensui undique conquisivimus et contraximus, ut destitutionibus substitutiones, variationibus rectificationes suppeditentur. Neque id molimur tam instrumentis quam experimentis. Etenim experimentorum longe major est subtilitas quam sensus ipsius, licet instrumentis exquisitis adjuti; (de iis loquimur experimentis, quae ad intentionem ejus quod quaeritur perite et secundum artem excogitata et apposita sunt). Itaque perceptioni sensus immediatae ac propriae non multum tribuimus: sed eo rem deducimus, ut sensus tantum de experimento, experimentum de re judicet. Quare existimamus nos sensus (a quo omnia in naturalibus petenda sunt, nisi forte libeat insanire) antistites religiosos, et oraculorum ejus non imperitos interpretes, nos praestitisse: ut alii professione quadam, nos re ipsa, sensum tueri ac colere videamus. Atque hujusmodi sunt ea quae ad lumen ipsum naturae ejusque accensionem et immissionem paramus: quae per se sufficere possent, si intellectus humanus aequus et instar tabulae abrasae esset. Sed cum mentes hominum miris modis adeo obsessae sint ut ad veros rerum radios excipiendos sincera et polita area prorsus desit, necessitas quaedam incumbit ut etiam huic rei remedium quaerendum esse putemus.

Idola autem a quibus occupatur mens, vel Adscititia sunt vel Innata. Adscititia vero immigrarunt in mentes hominum, vel ex philosophorum placitis et sectis vel ex perversis legibus demonstrationum. At Innata inhaerent naturae ipsius intellectus, qui ad errorem longe proclivior esse deprehenditur quam sensus. Utcunque enim homines sibi placeant et in admirationem mentis humanae ac fere adorationem ruant, illud certissimum est: sicut speculum inaequale rerum radios ex figura et sectione propria immutat, ita et mentem, cum a rebus per sensum patitur, in notionibus suis expediendis et comminiscendis haud optima fide rerum naturae suam naturam inserere et immiscere.

Atque priora illa duo *Idolorum* genera aegre, postrema vero haec nullo modo, evelli possunt. Id tantum relinquitur, ut indicentur, atque ut vis ista mentis insidiatrix notetur et convincatur; ne forte a destructione veterum novi subinde errorum surculi ex ipsa mala complexione mentis pullulent, eoque res recidat, ut errores non extinguantur se permutentur; verum e contra ut illud tandem in aeternum ratum et fixum sit, intellectum nisi per inductionem ejusque formam legitimam judicare non posse. Itaque doctrina ista de expurgatione intellectus ut ipse ad veritatem habilis sit, tribus redargutionibus absolvitur: redargutione philosophiarum, redargutione demonstrationum, et redargutione rationis humanae nativae. His vero explicatis, ac postquam demum patuerit quid rerum natura, quid mentis natura ferat, existimamus nos thalamum Mentis et Universi, pronuba divina bonitate, stravisse et ornasse. Epithalamii autem votum sit, ut ex eo connubio auxilia humana et stirps inventorum quae necessitates ac miserias hominum aliqua ex parte doment et subigant, suscipiatur. *Haec vero est operis pars secunda*.

At vias non solum monstrare et munire, sed inire quoque consilium est. Itaque tertia pars operis complectitur *Phaenomena Universi*; hoc est, omnigenam experientiam, atque historiam naturalem ejus generis quae possit esse ad condendam philosophiam fundamentalis. Neque enim excellens aliqua demonstrandi via sive naturam interpretandi forma, ut mentem ab errore et lapsu defendere ac sustinere, ita ei materiam ad sciendum praebere et subministrare possit. Verum iis quibus non conjicere et hariolari, sed invenire et scire propositum est, quique non simiolas et fabulas mundorum comminisci, sed hujus ipsius veri mundi naturam introspicere et velut dissecare in animo habent, omnia a rebus ipsis petenda sunt. Neque huic labori et inquisitioni ac mundanae perambulationi, ulla ingenii aut meditationis aut argumentationis substitutio aut compensatio sufficere potest; non si omnia omnium ingenia coierint. Itaque aut hoc prorsus habendum, aut negotium in perpetuum deserendum. Ad hunc vero usque diem ita cum hominibus actum est, ut minime mirum sit si natura sui copiam non faciat.

Nam primo, sensus ipsius informatio, et deserens et fallens: observatio, indiligens et inaequalis et tanquam fortuita; traditio, vana et ex rumore; practica, operi intenta et servilis; vis experimentalis, caeca, stupida, vaga, et praerupta; denique historia naturalis, levis et inops, vitiosissimam materiam intellectui ad philosophiam et scientias congesserunt.

Deinde, praepostera argumentandi subtilitas et ventilatio serum rebus plane desperatis tentatur remedium, nec negotium ullo modo restituit aut errores separat. Itaque nulla spes majoris augmenti ac progressus sita est, nisi in restauratione quadam scientiarum.

Hujus autem exordia omnino a naturali historia sumenda sunt, eaque ipsa novi cujusdam generis et apparatus. Frustra enim fuerit speculum expolire, si desint imagines; et plane materia idonea praeparanda est intellectui, non solum praesidia fida comparanda. Differt vero rursus historia nostra (quemadmodum logica nostra) ab ea quae habetur, multis rebus: fine sive officio, ipsa mole et congerie, dein subtilitate, etiam delectu et constitutione in ordine ad ea quae sequuntur.

Primo enim eam proponimus historiam naturalem, quae non tam aut rerum varietate delectet aut praesenti experimentorum fructu juvet, quam lucem inventioni causarum affundat, et philosophiae enutricandae primam mammam praebeat. Licet enim opera atque activam scientiarum partem praecipue sequamur, tamen messis tempus expectamus, nec muscum et segetem herbidam demetere conamur. Satis enim scimus, axiomata recte inventa tota agmina operum secum trahere, atque opera non sparsim sed confertim exhibere. Intempestivum autem illum et puerilem affectum, ut pignora aliqua novorum operum propere captentur, prorsus damnamus et amovemus, ceu pomum Atalantae quod cursum retardat. Atque Historiae nostrae Naturalis officium tale est.

Quoad congeriem vero, conficimus historiam non solum naturae liberae ac solutae (cum scilicet illa sponte fluit et opus suum peragit), qualis est historia coelestium,

meteororum, terrae et maris, mineralium, plantarum, animalium; sed multo magnis naturae constrictae et vexatae; nempe, cum per artem et ministerium humanum de statu suo detruditur, atque premitur et fingitur. Itaque omnia artium mechanicarum, omnia operativae partis liberalium, omnia practicarum complurium quae in artem propriam non coaluerunt, experimenta (quantum inquirere licuit et quantum ad finem nostrum faciunt) perscribimus. Quin etiam (ut quod res est eloquamur) fastum hominum et speciosa nil morati, multo plus et operae et praesidii in hac parte quam in illa altera ponimus; quandoquidem natura rerum magis se prodit per vexationes artis quam in libertate propria.

Neque Corporum tantum historiam exhibemus; sed diligentiae insuper nostrae esse putavimus, etiam Virtutum ipsarum (illarum dicimus quae tanquam cardinales in natura censeri possint, et in quibus naturae primordia plane constituuntur, utpote materiae primis passionibus ac desideriis, viz. *Denso, Raro, Calido, Frigido, Consistenti, Fluido, Gravi, Levi*, aliisque haud paucis) historiam seorsum comparare.

Enimvero ut de subtilitate dicamus, plane conquirimus genus experimentorum longe subtilius et simplicius quam sunt ea quae occurrunt. Complura enim a tenebris educimus et eruimus, quae nulli in mentem venisset investigare, nisi qui certo et constanti tramite ad inventionem causarum pergeret; cum in se nullius magnopere sint usus; ut liquido appareat, ea non propter se quaesita esse; sed ita prorsus se habeant illa ad res et opera quemadmodum literae alphabeti se habeant ad orationem et verba; quae licet per se inutiles eaedem tamen omnis sermonis elementa sunt.

In delectu autem narrationum et experimentorum melius hominibus cavisse nos arbitramur, quam qui adhuc in historia naturali versati sunt. Nam omnia fide oculata aut saltem perspecta, et summa quadam cum severitate, recipimus; ita ut nil referatur auctum miraculi causa, sed quae narramus a fabulis et vanitate casta et intemerata sint. Quinetiam et recepta quaeque ac jactata mendacia (quae mirabili quodam neglectu per saecula multa obtinuerunt et inveterata sunt) nominatim proscribimus et notamus; ne scientiis amplius molesta sint. Quod enim prudenter animadvertit quidam, fabulas et superstitiones et nugas quas nutriculae pueris instillant, mentes eorum etiam serio depravare: ita eadem nos movit ratio ut solliciti atque etiam anxii simus ne ab initio, cum veluti infantiam philosophiae sub historia naturali tractemus et curemus, illa alicui vanitati assuescat. At in omni experimento novo et paulo subtiliore, licet (ut nobis videtur) certo ac probato, modum tamen experimenti quo usi sumus aperte subjungimus; ut, postquam patefactum sit quomodo singula nobis constiterint, videant homines quid erroris subesse et adhaerere possit, atque ad probationes magis fidas et magis exquistas (si quae sint) expergiscantur: denique ubique monita et scrupulos et cautiones aspergimus, religione quadam et tanquam exorcismo omnia phantasmata ejicientes ac cohibentes.

Postremo, cum nobis exploratum sit quantopere experientia et historia aciem mentis humanae disgreget, et quam difficile sit (praesertim animis vel teneris vel praeoccupatis) a principio cum natura consuescere, adjungimus saepius observationes nostras,

tanquam primas quasdam conversiones et inclinationes ac veluti aspectus historiae ad philosophiam; ut et pignoris loco hominibus sint eos in historiae fluctibus perpetuo non detentos iri, utque cum ad opus intellectus deveniatur omnia sint magis in procinctu. Atque per hujusmodi (qualem describimus) Historiam Naturalem, aditum quendam fieri posse ad naturam tutum et commodum, atque materiam intellectui praeberi probam et praeparatam, censemus.

Postquam vero et intellectum fidissimis auxiliis se praesidiis stipavimus, et justum divinorum operum exercitum severissimo delectu comparavimus; nil amplius superesse videtur, nisi ut philosophiam ipsam aggrediamur. Attamen in re tam ardua et suspensa, sunt quaedam quae necessario videntur interponenda; partim docendi gratia, partim in usum praesentem.

Horum primum est, ut exempla proponantur inquirendi et inveniendi secundum nostram rationem ac viam, in aliquibus subjectis repraesentata: sumendo ea potissimum subjecta quae et inter ea quae quaeruntur sunt nobilissima et inter se maxime diversa; ut in unoquoque genere exemplum non desit. Neque de iis exemplis loquimur quae singulis praeceptis ac regulis illustrandi gratia adjiciuntur (hoc enim in secunda parte operis abunde praestitimus); sed plane typos intelligimus et plasmata, quae universum mentis processum atque inveniendi continuatam fabricam et ordinem, in certis subjectis, iisque variis et insignibus, tanquam sub oculos ponant. Etenim nobis in mentem venit, in mathematicis, astante machina, sequi demonstrationem facilem et perspicuam; contra absque hac commoditate, omnia videri involuta et, quam revera sunt, subtiliora. Itaque hujusmodi exemplis quartam partem nostri operis attribuimus: quae revera nil aliud est, quam secundae partis applicatio particularis et explicata.

At quinta pars ad tempus tantum, donec reliqua perficiantur, adhibetur; et tanquam foenus redditur, usque dum sors haberi possit. Neque enim finem nostrum ita petimus occaecati, ut quae occurrunt in via utilia negligamus. Quamobrem quintam partem operis ex iis conficimus quae a nobis aut inventa aut probata aut addita sunt; neque id tamen ex rationibus atque praescriptis interpretandi, sed ex eodem intellectus usu quem alii in inquirendo et inveniendo adhibere consueverunt. Etenim cum, ex perpetua nostra cum natura consuetudine, majora de meditationibus nostris quam pro ingenii viribus speramus; tum poterunt ista veluti tabernaculorum in via positorum vice fungi, ut mens ad certiora contendens in iis paulisper acquiescat. Attamen testamur interim, nos illis ipsis, quod ex vera interpretandi forma non sint inventa aut probata, teneri minime velle. Istam vero judicii suspensionem non est quod exhorreat quispiam, in doctrina quae non simpliciter nil sciri posse, sed nil nisi certo ordine et certa via sciri posse, asserit; atque interea tamen certos certitudinis gradus ad usum et levamen constituit, donec mens in causarum explicatione consistat. Neque enim illae ipsae scholae philosophorum qui *Acatalepsiam* simpliciter tenuerunt inferiores fuere istis quae pronuntiandi licentiam usurparunt. Illae tamen sensui et intellectui auxilia non paraverunt, quod nos fecimus, sed fidem et authoritatem plane sustulerunt; quod longe alia res est, et fere opposita.

Sexta tandem pars operis nostri (cui reliquae inserviunt ac ministrant) eam demum recludit et proponit philosophiam, quae ex hujusmodi (qualem ante docuimus et paravimus) inquisitione legitima et casta et severa educitur et constituitur. Hanc vero postremam partem perficere et ad exitum perducere, res est et supra vires et ultra spes nostras collocata. Nos ei initia (ut speramus) non contemnenda, exitum generis humani fortuna dabit, qualem forte homines in hoc rerum et animorum statu haud facile animo capere aut metiri queant. Neque enim agitur solum foelicitas contemplativa, sed vere res humanae et fortunae, atque omnis operum potentia. Homo enim naturae minister et interpres tantum facit et intelligit, quantum de naturae ordine, opere vel mente, observaverit: nec amplius scit, aut potest. Neque enim ullae vires causarum catenam solvere aut perfringere possint; neque natura aliter quam parendo vincitur. Itaque intentiones geminae illae, humanae scilicet *Scientiae* et *Potentiae*, vere in idem coincidunt; et frustratio operum maxime fit ex ignoratione causarum.

Atque in eo sunt omnia, siquis oculos mentis a rebus ipsis nunquam dejiciens, earum imagines plane ut sunt excipiat. Neque enim hoc siverit Deus, ut phantasiae nostrae somnium pro exemplari mundi edamus: sed potius benigne faveat, ut apocalypsim ac veram visionem vestigiorum et sigillorum creatoris super creaturas scribamus.

Itaque Tu Pater, qui lucem visibilem primitias creaturae dedisti, et lucem intellectualem ad fastigium operum tuorum in faciem hominis inspirasti; opus hoc, quod a tua bonitate profectum tuam gloriam repetit, tuere et rege. Tu postquam conversus es ad spectandum opera quae fecerunt manus tuae, vidisti quod omnia essent bona valde; et requievisti. At homo conversus ad opera quae fecerunt manus suae, vidit quod omnia essent vanitas et vexatio spiritus; nec ullo modo requievit. Quare si in operibus tuis sudabimus, facies nos visionis tuae et sabbati tui participes. Supplices petimus, ut haec mens nobis constet; utque novis eleemosynis, per manus nostras et aliorum quibus eandem mentem largieris, familiam humanam dotatam velis.

DEEST PARS PRIMA

INSTAURATIONIS,

QUAE COMPLECTITUR
PARTITIONES SCIENTIARUM.
Iliae tamen ex Secundo Libro de Progressibus
faciendis in Doctrina Divina
et Humana, *nonnulla*
ex parte, peti
possunt.

SEQUITUR SECUNDA PARS

INSTAURATIONIS,

QUAE ARTEM IPSAM

Interpretandi Naturam, et verioris adoperationis
Intellectus exhibet: neque eam ipsam
tamen in Corpore tractatiis justi,
sed tantum digestam per
summas, in Aphorismos.

PARS SECUNDA OPERIS,

QUAE DICITUR

NOVUM ORGANUM,

SIVE

INDICIA VERA
DE INTERPRETATIONE
NATURAE.

PRAEFATIO.

Qui de natura, tanquam de re explorata, pronuntiare ausi sunt, sive hoc ex animi fiducia fecerint sive ambitiose et more professorio, maximis illi philosophiam et scientias detrimentis affecere. Ut enim ad fidem faciendam validi, ita etiam ad inquisitionem extinguendam et abrumpendam efficaces fuerunt. Neque virtute propria tantum profuerunt, quantum in hoc nocuerunt, quod aliorum virtutem corruperint et perdiderint. Qui autem contrariam huic viam ingressi sunt atque nihil prorsus sciri posse asseruerunt, sive ex sophistarum veterum odio sive ex animi fluctuatione aut etiam ex quadam doctrinae copia in hanc opinionem delapsi sint, certe non contemnendas ejus rationes adduxerunt; veruntamen nec a veris initiis sententiam suam derivarunt, et, studio quodam atque affectatione provecti, prorsus modum excesserunt. At antiquiores ex Graecis (quorum scripta perierunt) inter pronuntiandi jactantiam et *Acatalepsiae* desperationem prudentius se sustinuerunt: atque de inquisitionis difficultate et rerum obscuritate saepius querimonias et indignationes miscentes, et veluti fraenum mordentes, tamen propositum urgere atque naturae se immiscere non destiterunt; consentaneum (ut videtur) existimantes, hoc ipsum (videlicet utrum aliquid sciri possit) non disputare, sed experiri. Et tamen illi ipsi, impetu tantum intellectus usi, regulam non adhibuerunt, sed omnia in acri meditatione et mentis volutatione et agitatione perpetua posuerunt.

Nostra autem ratio, ut opere ardua, ita dictu facilis est. Ea enim est, ut certitudinis gradus constituamus, sensum per reductionem quandam tueamur, sed mentis opus quod sensum subsequitur plerunque rejiciamus; novam autem et certam viam, ab ipsis sensuum perceptionibus, menti aperiamus et muniamus. Atque hoc proculdubio viderunt et illi qui tantas dialecticae partes tribuerunt. Ex quo liquet, illos intellectui adminicula quaesivisse, mentis autem processum nativum et sponte moventem, suspectum habuisse. Sed serum plane rebus perditis hoc adhibetur remedium; postquam mens ex quotidiana vitae consuetudine, et auditionibus et doctrinis inquinatis occupata, et vanissimis *idolis* obsessa fuerit. Itaque ars illa dialecticae, sero (ut diximus) cavens, neque rem ullo modo restituens, ad errores potius figendos, quam ad veritatem aperiendam valuit. Restat unica salus ac sanitas, ut opus mentis universum de integro resumatur; ac mens, jam ab ipso principio, nullo modo sibi permittatur, sed perpetuo regatur; ac res veluti per machinas conficiatur. Sane si homines opera mechanica nudis manibus, absque instrumentorum vi et ope, aggressi essent, quemadmodum opera intellectualia nudis fere mentis viribus tractare non dubitarunt, parvae admodum fuissent res quas movere et vincere potuissent, licet operas enixas atque etiam conjunctas praestitissent. Atque si paulisper morari, atque in hoc ipsum exemplum, veluti in speculum, intueri velimus; exquiramus (si placet) si forte obeliscus aliquis magnitudine insignis ad triumphi vel hujusmodi magnificentiae decus transferendus esset, atque id homines nudis manibus aggrederentur, annon hoc magnae cujusdam esse dementiae spectator quispiam rei sobrius fateretur? Quod si numerum augerent

operariorum, atque hoc modo se valere posse confiderent, annon tanto magis? Sin autem delectum quendam adhibere vellent, atque imbecilliores separare, et robustis tantum et vigentibus uti, atque hinc saltem se voti compotes fore sperarent, annon adhuc eos impensius delirare diceret? Quin etiam si hoc ipso non contenti, artem tandem athleticam consulere statuerent, ac omnes deinceps manibus et lacertis et nervis ex arte bene unctis et medicatis adesse juberent, annon prorsus eos dare operam ut cum ratione quadam et prudentia insanirent, clamaret? Atque homines tamen simili malesano impetu et conspiratione inutili feruntur in intellectualibus; dum ab ingeniorum vel multitudine et consensu vel excellentia et acumine magna sperant, aut etiam dialectica (quae quaedam athletica censeri possit) mentis nervos roborant; sed interim, licet tanto studio et conatu, (si quis vere judicaverit) intellectum nudum applicare non desinunt. Manifestissimum autem est, in omni opere magno, quod manus hominis praestat, sine instrumentis et machinis, vires nec singulorum intendi nec omnium coire posse.

Itaque ex his quae diximus praemissis, statuimus duas esse res de quibus homines plane monitos volumus, ne forte illae eos fugiant aut praetereant. Quarum prima hujusmodi est; fieri fato quodam (ut existimamus) bono, ad extinguendas et depellendas contradictiones et tumores animorum, ut et veteribus honor et reverentia intacta et imminuta maneant, et nos destinata perficere et tamen modestiae nostrae fructum percipere possimus. Nam nos, si profiteamur nos meliora afferre quam antiqui, eandem quam illi viam ingressi, nulla verborum arte efficere possimus, quin inducatur quaedam ingenii vel excellentiae vel facultatis comparatio sive contentio; non ea quidem illicita aut nova; -- quidni enim possimus pro jure nostro (neque eo ipso alio, quam omnium) si quid apud eos non recte inventum aut positum sit, reprehendere aut notare? -- sed tamen utcunque justa aut permissa, nihilominus impar fortasse fuisset ea ipsa contentio, ob virium nostrarum modum. Verum quum per nos illud agatur, ut alia omnino via intellectui aperiatur illis intentata et incognita, commutata jam ratio est; cessant studium et partes; nosque indicis tantummodo personam sustinemus, quod mediocris certe est authoritatis, et fortunae cujusdam potius quam facultatis et excellentiae. Atque haec moniti species ad personas pertinet; altera ad res ipsas.

Nos siquidem de deturbanda ea quae nunc floret philosophia, aut si quae alia sit aut erit hac emendatior aut auctior, minime laboramus. Neque enim officimus, quin philosophia ista recepta, et aliae id genus, disputationes alant, sermones ornent, ad professoria munera et vitae civilis compendia adhibeantur et valeant. Quin etiam aperte significamus et declaramus, eam quam nos adducimus philosophiam ad istas res admodum utilem non futuram. Non praesto est, neque in transitu capitur, neque ex praenotionibus intellectui blanditur, neque ad vulgi captum nisi per utilitatem et effecta descendet.

Sint itaque (quod foelix faustumque sit utrique parti) duae doctrinarum emanationes, ac duae dispensationes; duae similiter contemplantium sive philosophantium tribus ac veluti cognationes; atque illae neutiquam inter se inimicae aut alienae, sed foederatae et mutuis auxiliis devinctae: sit denique alia scientias colendi, alia inveniendi ratio. Atque

quibus prima potior et acceptior est, ob festinationem, vel vitae civilis rationes, vel quod illam alteram ob mentis infirmitatem capere et complecti non possint (id quod longe plurimis accidere necesse est), optamus ut iis foeliciter et ex voto succedat quod agunt, atque ut quod sequuntur teneant. Quod si cui mortalium cordi et curae sit, non tantum inventis haerere atque iis uti, sed ad ulteriora penetrate; atque non disputando adversarium, sed opere naturam vincere; denique, non belle et probabiliter opinari, sed certo et ostensive scire; tales, tanquam veri scientiarum filii, nobis (si videbitur) se adjungant; ut omissis naturae atriis, quae infiniti contriverunt, aditus aliquando ad interiora patefiat. Atque ut melius intelligamur, utque illud ipsum quod volumus ex nominibus impositis magis familiariter occurrat, altera ratio sive via *Anticipatio Mentis*, altera *Interpretatio Naturae*, a nobis appellari consuevit.

Est etiam quod petendum videtur. Nos certe cogitationem suscepimus et curam adhibuimus, ut quae a nobis proponentur non tantum vera essent, sed etiam ad animos hominum (licet miris modis occupatos et interclusos) non incommode aut aspere accederent. Veruntamen aequum est, ut ab hominibus impetremus (in tanta praesertim doctrinarum et scientiarum restauratione) ut qui de hisce nostris aliquid, sive ex sensu proprio, sive ex authoritatum turba, sive ex demonstrationum formis (quae nunc tanquam leges quaedam judicialis invaluerunt), statuere aut existimare velit, ne id in transitu et velut aliud agendo facere se posse speret; sed ut rem pernoscat; nostram, quam describimus et munimus, viam ipse paullatim tentet; subtilitati rerum quae in experientia signata est assuescat; pravos denique atque alte haerentes mentis habitus tempestiva et quasi legitima mora corrigat; atque tum demum (si placuerit) postquam in potestate sua esse coeperit, judicio suo utatur.

SEQUITUR
PARTIS SECUNDAE SUMMA,
DIGESTA
IN APHORISMOS.

PARTIS SECUNDAE

SUMMA,

DIGESTA

IN

APHORISMOS.

SUMMARY OF BOOK I.

The First Book of the Novum Organum, which was designed to be a sort of introduction to the whole work, is called in the Partis Secundae Delineatio (Ellis and Spedding, Vol. III. p. 552) 'pars praeparans,' in opposition to the 'pars informans,' which was to be comprised in the remaining books. The following brief account of its contents may be of service to the reader. Aphorisms 1-31 consist of certain preliminary remarks, chiefly on the futility of the methods of enquiry at present in use and the necessity of a more faithful study of Nature. In Aphorisms 32-37, Bacon makes a kind of apology for the introduction of a new method. Aphorisms 38-70 contain the doctrine of the Idola, to which he justly attaches the utmost importance. 'Primo enim mentis area aequanda, et liberanda ab eis quae hactenus recepta sunt' (Partis Secundae Delineatio, Ellis and Spedding, Vol. III. p. 548.) Then follow the signs, five in number, of the weakness and inutility of preceding philosophies (Aphorisms 71-77). These are followed by the causes, fifteen in number, of so long continuance in error (Aphorisms 78-92). In the middle of Aphorism 92, he passes on to the Grounds of Hope in the future progress of Science. These are twenty-one, and occupy Aphorisms 92-115. The next three Aphorisms contain three cautions or warnings. Aphorisms 119-121 contain three apologies. Then follow the answers to four possible objections (Aphorisms 122-126). The next Aphorism is of great importance, as vindicating for the application of his method not only the field of natural, but also that of moral and mental science. The remainder of the Book (Aphorisms 128-130) consists of certain miscellaneous remarks, forming the transition to Book II.

LIBER PRIMUS

APHORISMI
DE INTERPRETATIONE
NATURAE
ET REGNO HOMINIS.

Aphorismus.

I.

HOMO, naturae minister et interpres, tantum facit et intelligit quantum de naturae ordine re vel mente observaverit: nec amplius scit, aut potest [1].

[1] 'Man, the servant and interpreter of Nature, does and understands just so much as he has discerned concerning the order of nature by observation or reflexion (or by the observation of things or of himself): nor does he know more, or can he do more.'

The precise meaning of the words *re vel mente observaverit* is not clear. The distinction intended may be either, as I am inclined to think is the case, between the observation of facts and the subsequent process of meditation or reflexion on such observation, or between the observation of the external world and that of our own minds, external and internal perception, as they have been called. According to either interpretation, the passage will remind the reader of the main positions in Locke's Essay, to which it might well serve as a motto. Though the precise meaning of the words is obscure, the purport of the Aphorism is plain. Man, if he would learn or do anything, must carefully watch the processes of Nature, must register and interpret her phenomena. This is his only way either to knowledge or power.

The same sentence, with a slight variation, occurs towards the end of the Distributio Operis. Its connexion in that place with the preceding and succeeding sentences is worthy of notice. 'Neque enim agitur solum felicitas contemplativa, sed vere res humanae et fortunae, atque omnis operum potentia. Homo enim naturae minister et interpres tantum facit et intelligit, quantum de naturae ordine, *opere* vel mente,

observaverit; nec amplius scit, aut potest. Neque enim ullae vires causarum catenam solvere aut perfringere possint, neque natura aliter quam parendo vincitur.'

Mr. Bywater has pointed out to me a passage in Galen (ed. Kühn. Tome [1.1] XV. p. 309) shewing that the expression 'minister naturae' was used by Hippocrates, who called the true physician τῆς φύσεως ὑπηρέτην. [TF]

[1.1] "Tome" = French for "volume," abbreviated "tom." in Fowler's edition; I restore the full form for consistency with Latin works. [HJ]

II.

Nec manus nuda, nec intellectus sibi permissus, multum valet; instrumentis et auxiliis res perficitur; quibus opus est, non minus ad intellectum, quam ad manum. Atque ut instrumenta manus motum aut cient aut regunt; ita et instrumenta mentis intellectui aut suggerunt aut cavent.

III.

Scientia et potentia humana in idem coincidunt [2], quia ignoratio causae destituit effectum. Natura enim non nisi parendo vincitur [3]: et quod in contemplatione instar causae est, id in operatione instar regulae est.

[2] The same thought is often briefly expressed in English under the form: 'Knowledge is Power.' (Cp. [2.1] Hobbes, De Homine, Cap. [2.2] x: 'Scientia potentia est, sed parva; quia scientia egregia rara est, nec proinde apparens nisi paucissimis, et in paucis rebus.') It may be remarked that Power always implies Knowledge, but Knowledge does not always give power. To do a thing, we must know how to do it, but there are some departments of knowledge which, however interesting in themselves or valuable as instruments of mental discipline, do not appear to increase our power over Nature.

Bacon seldom loses any opportunity of insisting on the practical applications of science. Professor Playfair truly remarks that the want of connexion between the sciences and arts was one of the principal defects which Bacon deplored in the philosophy of his time. [TF]

[2.1] *"'CP.' = Compare. Here meaning 'compare', not 'ceteris paribus'* (all other things being equal). *I standardize to full capitals."* [HJ]

[2.2] "Cap." = "capitulum" = "small chapter". [HJ]

[3] We must patiently observe Nature, if we wish to acquire any control over her operations. Our 'rules' are merely copies and adaptations of the 'causes' which we see

at work in the external world. The same sentence, slightly altered, is repeated in Aphorism 129. See note on it in that place. [TF]

IV.

Ad opera nil aliud potest homo, quam ut corpora naturalia admoveat et amoveat: reliqua natura intus transigit [4].

[4] We cannot create; we can only combine or separate bodies already existing, 'in Art,' says Playfair, 'man does nothing more than bring things nearer to one another, or carry them farther off; the rest is performed by Nature, and on most occasions by means of which we are quite ignorant.' [TF]

V.

Solent se immiscere naturae (quoad opera [5]) mechanicus, mathematicus, medicus, alchemista, et magus; sed omnes (ut nunc sunt res) conatu levi, successu tenui [6].

[5] So far as concerns the active or operative part of knowledge, that is to say, Art as distinguished from Science.

[6] Dr. Kitchin has the following note: 'As to the Mechanician, the Mathematician and the Physician, Bacon's remarks were being falsified at the very time he wrote. - Mechanics had produced fly-clocks, telescopes, and Other useful contrivances. - Mathematics boasted of Kepler and Galileo; and the discoveries of Harvey and Gilbert were opening out a new world for Medical research. But Bacon could scarcely have discerned all this, and his jealousy' (or, as I should rather say, distrust) 'of his contemporaries (CP. I. 54) would scarcely have allowed him to acknowledge their worth. Besides this he was utterly ignorant of Mathematics (see Hallam, Lit. Eur. Vol. II. III. 3. § 78). Alchemy was certainly thoroughly empirical and faulty; for "at this time Chemistry seemed to have an elective attraction for everything that was absurd and unfounded." (Playfair.) And Magic, which still exerted great influence, was as bad. Sir T. Browne, Rel. Med. I. 31, gives some account of it; which is worth consulting, as it gives the views of a physician and contemporary of Bacon. CP. also De Augmentis Scientarium [6.1] III. 5, and Adv. of Learning, Book II.' [TF]

In Aphorism 85, Bacon distinguishes between Natural and Superstitious Magic. Natural Magic is treated in the De Augmentis Scientarium, Libro [6.2] III. Cap. 5, as supplementary to the Inquisition of Forms, and vindicated, when distinguished from the 'false and ignoble kind,' as a legitimate branch of enquiry. 'Si igitur desiderari eam partem Metaphysicae quae de *Formis* agit posuimus, sequitur ut *Naturalis* etiam *Magia*, quae ad earn est relativa, similiter desideretur. Verum hoc loco postulandum videtur, ut vocabulum istud *Magiae*, in deteriorem partem jampridem acceptum, antiquo et lionorifico sensui restituatur. Etenim *Magia* apud Persas pro sapientia sublimi, et scientia

consensuum rerum universailium, acdpiebatur; atque etiam tres ilii reges, qui ab Oriente ad Christum adorandiim venerunt, *Magorum* nomine vocabantur. Nos vero earn illo in sensu intelligimiis, ut sit scientia quae cognitionem *Formarum Abditarum* ad opera admiranda deducat; atque, quod dici solet, *activa cum passivis conjungendo* magnalia naturae manifestet.'

The substance of this Aphorism, greatly expanded, occupies the two first paragraphs of the Cogitata et Visa. These paragraphs are too long to be extracted, but they maybe read, by the student with advantage. See also Filum Labyrinthi sive Formula Inquisitionis, ad init. (Ellis and Spedding, Vol. III. pp. 496, 497). [TF]

[6.1] 'De Augmentis Scientarium' is the expanded version of Bacon's book 'Advancement of Learning', translated to Latin. [HJ]

[6.2] "Libro" = "book". [HJ]

VI.

Insanum quiddam esset, et in se contrarium, existimare ea, quae adhuc nunquam facta sunt, fieri posse, nisi per modos adhuc nunquam tentatos.

VII.

Generationes mentis et manus numerosae admodum videntur in libris et opificiis. Sed omnis ista varietas sita est in subtilitate eximia, et derivationibus paucarum rerum, quae innotuerunt; non in numero axiomatum [7].

[7] The word Axioma is used by Bacon of any general proposition. In Aphorism 103, Axiomata are contrasted with 'Opera' and 'particularia.' In Aphorism 104, he speaks of 'axiomata generalissima' ('qualia sunt principia, quae vocant, artium et rerum'), 'axiomata media,' and 'axiomata minora' or 'infima.' Of the last class he says, 'Etenim axiomata infima non multum ab experientia nuda discrepant.'

In the works of Aristotle, the word ἀξίωμα, even when confined to its logical sense, is employed in no less than three significations. Sometimes it is used for any proposition whatever, as, for instance, in Topics, IX. Or Soph. El., 24 (ed. Bekker, p. 179 b, 12-15): αὐτῇ δ᾽ οὐκ ἔσται, ἄν τις μὴ ἐπὶ τοῦ εἰδέραι ἀλλ᾽ ἐπὶ τοῦ εἶναι ἢ πῶς ἔχειν τὸ αὐτὸ ἀξίωμα λαμβάνῃ, οἷον εἰ ὅδε ἐστὶ πατὴρ, ἔστι δὲ ods. CP. Topics, VIII. I (p. 156 a. 23), VIII. 3 (p. 159 a. 4, 5). Secondly, Aristotle shews that he is aware of the signification in which the term was employed by mathematicians, who then, as now, designated the first principles of their science as 'axioms.' λεκτέον δὲ πότερον μιᾶς ἢ ἑτέρας ἐπιστήμης περί Te τῶν ἐν τοῖς μαθήμασι καλουμένων ἀξιωμάτων Καὶ περὶ τῆς οὐσίας. Metaphysics, III. 3 (1005 a. 19-21). CP. Post. An. I. 10 [7.1]. Lastly, he employs the term in a peculiarly technical sense of his own, to designate those ultimate principles or assumptions which

are necessary not to the knowledge of this or that particular science but to any knowledge whatsoever. In this sense, ἀξιώματα are contrasted with θέσεις, the first principles of this or that particular science. ᾽Αμέσου δ᾽ ἀρχῆς συλλογιστικῆς θέσιν μὲν λέγω ἣν μὴ ἔστι δεῖξαι, μήδ᾽ ἀνάγκη ἔχειν τὸν μαθησόμενόν tu ἣν δ᾽ ἀνάγκη ἔχειν τὸν ὁτιοῦν μαθησόμενον, ἀξίωμα" ἔστι γὰρ ἔνια τοιαῦτα᾽ τοῦτο γὰρ μάλιστ᾽ ἐπὶ τοῖς τοιούτοις εἰώθαμεν ὄνομα λέγειν. An. Post. I. 3 (p. 72 a. 14-18). CP. I. 10. As an example of 'Axioms' in this sense may be adduced the 'Law of Contradiction,' which Aristotle describes (Metaphysics, III. 3, p. 1005 b. 33, 34) as Φνσει ἀρχὴ Kai τῶν, ἀλλῶν ἀξιωμάτων πάντων. The Mathematical Axioms are analogous to the Logical Axioms, inasmuch as they are common to all those branches of knowledge which Aristotle included within the sphere of ἀποδεικτική.

Some logicians, especially those of the school of Ramus, use the word Axioma as the equivalent of Propositio or Judicium. Thus Milton (Ars Logica, Libro II, Cap. 2) defines and defends this use of the word as follows: 'Axioma est dispositio argumenti cum argumento [7.2], qua esse aliquid aut non esse indicatur. Axioma saepe Aristoteli significat propositionem sive sententiam ita claram, ut quasi digna sit cui propter se fides habeatur.

Alias axioma et propositionem sive sententiam quamlibet pro eodem is liabet: et recte quidem: ut enim sententia a sentio, i. e. existimo vei arbitror, ita axioma a verbo Graeco quod idem significat, derivatur. Atque hujus vocis generalem hanc significationem apud veteres Dialecticos receptam fuisse, ex Cicerone, Plutarcho, Laertio, Gellio, Galeno Libro xvi. c. 8 etc. constat.' Cicero, following the Stoics, appears invariably to use the word in this sense. 'Nempe fundamentum dialecticae est, quidquid enuntietur (id autem appellant ἀξίωμα, quod est quasi effatum) aut verum esse aut falsum.' Acad. II. 29. 'Omne *pronuntiatum* (sic enim mihi in praesentia occurrit, ut appellarem ἀξίωμα; utar post alio, si invenero melius) id ergo est pronuntiatum, quod est verum aut falsum.' Tusc. I. 7. Bacon's usage of the word seems to differ from this only in restricting it to general propositions, that is, in excluding the 'axioma particulare' and the 'axioma proprium' of the Ramists.

The word is frequently restricted to self-evident propositions, whether common to all sciences, or peculiar to some particular science. Thus Chauvin in his Lexicon Philosophicum defines an Axiom as 'sententia generalis cuilibet attendenti nota,' and we commonly speak of truths, which require no proof, as 'axiomatic.'

Newton's use of the word appears to be less general than that of Bacon. Though he does not restrict it to self-evident propositions, or to those truths which are common to all sciences, he appears to use it exclusively of the first principles of any particular science. Thus, in the Principia, he speaks of the 'Axiomata sive Leges Motus,' and at the beginning of the Optics he enumerates five Axioms, such as that 'The Angles of Reflexion and Refraction lie in one and the same Plane with the Angle of Incidence,' 'The Angle of Reflexion is equal to the Angle of Incidence,' etc. These first principles would answer to the 'Axiomata Generalissima' of Bacon.

We have seen that Cicero proposes the word 'pronuntiatum' as a translation of ἀξίωμα in its more general sense, when used as the equivalent of proposition. The words 'maxim,' 'principle,' or 'dignitas' sometimes replace it in its more restricted senses.

The student will find a long note on the etymology and meaning of the word 'Axiom' in Hamilton's edition of Reid, pp., 764-6. [TF]

[7.1] Fowler assumes everyone is conversant with Aristotle's works. "Post. An." = "Analytica Posteriora". [HJ]

[7.2] 'Argumentum autem cum argumento est id quod arguit cum eo quod arguitur.' [TF]

VIII.

Etiam opera, quae jam inventa sunt, casui debentur et experientiae [8], magis quam scientiis: scientiae enim, quas nunc habemus, nihil aliud sunt quam quaedam concinnationes rerum antea inventarum; non modi inveniendi, aut designationes novorum operum.

[8] ἐμπειρία, empiricism, mere experience, as distinguished from properly directed observation and experiment. For a distinction between the different kinds of experience and their bearing on discovery, see De Augmentis Scientiarum, Libro V. Cap. 2. [TF]

IX.

Causa vero et radix fere omnium malorum in scientiis ea una est; quod dum mentis humanae vires falso miramur et extollimus, vera ejus auxilia non quaeramus.

X.

Subtilitas naturae subtilitatem sensus et intellectus multis partibus superat [9]; ut pulchrae illae meditationes et speculationes humanae et causationes [10] res malsana sint, nisi quod non adsit qui advertat [11].

[9] Dr. Kitchin here very appositely quotes Aristotle, Metaphysics a. I. Ἴσως δὲ καὶ τῆς χαλεπότητος οὔσης κατὰ δύο τρόπους, οὐκ ἐν τοῖς πράγμασιν. ἀλλ᾽ ἐν ἡμῖν τὸ αἴτιον αὐτῆς. "Ωσπερ γὰρ καὶ τὰ τῶν νυκτερίδων ὄμματα πρὸς τὸ φέγγος ἔχει τὸ μεθ᾽ ἡμέραν, οὕτω καὶ τῆς ἡμετέρας Ψυχῆς ὁ νοῦς mpos τὰ τῇ φύσει φανερώτατα πάντων.

To the same effect we find a passage in Galileo's Dialogo dei Massimi Sistemi, Giornata Prima (Sir Thomas Salusbury's Translation, pp. 84, 85):

Sagredus. 'I ever accounted extraordinary madness that of those who would make human comprehension the measure of what nature hath a power or knowledge to effect; whereas on the contrary there is not any the least effect in Nature, which can be fully understood by the most speculative wits in the world. This their so vain presumption of knowing all can take beginning from nothing, unless from their never having known anything; for if one hath but once only experienced the perfect knowledge of one only thing, and but truly tasted what it is to know, he shall perceive that of infinite other conclusions he understands not so much as one.' [TF]

[10] A post-classical word. 'Controversies.' Du Cange explains it as 'Lis, controversia, placitum,' and, amongst other authorities, quotes Gregor. Magn. Libro I. epist. 9: 'Fines, de quibus causatio mota est Concilium Arelatense, an. 813. can. 16: 'Ne in Dominicis diebus publicae mercatae, neque causationes disceptationesque exerceantur.'

The word occurs in the sense of an 'excuse' or 'apology' as early as the time of Aulus Gellius Atque id fecerunt ne causatio ista aegi'I corporis perpetuam vacationeni daret fidem detrectantibus, jurisque actiones declinantibus,' Noctes Atticae, Libro xx. Cap. i), but that does not seem to be its meaning in this place. [TF]

[11] We cannot place ourselves sufficiently apart from the crowd in which we move, to obtain anything like an adequate idea of its eccentricities and delusions. [TF]

XI.

Sicut scientiae [12], quae nunc habentur, inutiles sunt ad inventionem operum; ita et logica, quae nunc habetur, inutilis est ad inventionem scientiarum.

[12] Aphorisms xi-xiv should be considered in connexion with each other. They contain the sum of Bacon's complaint against the old logic. Though the scholastic logic recognised Induction as a form of reasoning, it failed to see its importance, and had not attempted to lay down any rules for its employment. Hence, practically, it was exclusively a syllogistic logic. Now it is the function of syllogism to develope the consequences of a principle, not to examine the principle itself. But, unless we examine the principle, how can we be certain of the truth of the consequences? We may only be multiplying error instead of truth. The conclusion of every new syllogism may be only one error the more, and, from the false confidence which the mere reiteration of a proposition begets in the mind, a principle which at first was received with hesitation may come to be regarded as unassailable, and be assumed as placed beyond all doubt. When men have reared a vast superstructure of reasoning, they are naturally unwilling to examine the foundations. What is required, then, not in order to replace, but in order to supplement, the old logic, is a logic which shall guarantee the premisses as well as the conclusions, which shall probe the validity of our elementary notions and first principles, as well as develope their ulterior consequences. Such a logic Bacon proposed to supply, or at least to inaugurate.

That Bacon recognised the function of the Syllogism as supplementary to Induction, is evident from several passages of the Novum Organum itself. But perhaps his most explicit statement on this subject is to be found in a letter to Father Baranzan (published in Spedding's Letters and Life of Bacon, Vol. VII. pp. 375-7). This letter, which is also interesting on other accounts, contains the following passage: —

'Non est meum abdicare in totum syllogismum. Res est syllogismus magis inhabilis ad praecipua, quam inutilis ad plurima.

'Ad Mathematica quidni adhibeatur? Cum fluxus materiae et inconstantia corporis physici illud sit, quod inductionem desideret; ut per earn veluti figatur, atque inde eruantur notiones bene terminatae.

'De Metaphysica ne sis sollicitus. Nulla enim erit post veram Physicam inventam; ultra quam nihil praeter divina.

'In Physica prudenter notas, et idem tecum sentio, post notiones primae classis, et axiomata super ipsas per inductionem bene eruta et terminata, tuto adhiberi syllogismum, modo Inhibeatur saltus ad generalissima, et fiat progressus per scalam convenientem.'

On the place of Induction in Aristotle's, system of logic, I have spoken in the Introduction. [TF]

XII.

Logica, quae in usu est, ad errores (qui in notionibus vulgaribus fundantur) stabiliendos et figendos valet, potius quam ad inquisitionem veritatis; ut magis damnosa sit, quam utilis.

XIII.

Syllogismus ad principia scientiarum [13] non adhibetur, ad media axiomata frustra adhibetur [14], cum sit [15] subtilitati naturae longe impar. Assensum itaque constringit, non res.

[13] The ἀρχαί of Aristotle. That the ἀρχαί, being the ultimate major premisses from which Syllogism proceeds, do not themselves admit of syllogistic proof, is constantly insisted on by Aristotle. See, for instance, All. Post. I. 2 (72 a. 7) ἀρχὴ δ᾽ ἐστὶν ἀποδείξεως πρύτασις ἄμεσος, ἄμεσος δὲ ἧς μή ἐστιν ἄλλη προτέρα. He also constantly insists on the fact that these ultimate principles must be gained by induction. See, for instance, Ethics, vi. 3. (3), 'Εx προγινωσκομένων δὲ πᾶσα διδασκαλία, ὥσπερ καὶ ἐν τοῖς ἀναλυτικοῖς λέγομεν᾽ ἡ μὲν γὰρ δι᾽ ἐπαγωγῆς, ἡ δὲ συλλογισμῷ. Ἡ μὲν δὴ ἐπαγωγὴ ἀρχή ἐστι καὶ τοῦ καθύλου, ὁ δὲ συλλογισμὸς ἐκ τῶν καθόλου. Εἰσὶν ἄρα ἀρχαὶ ἐξ ὧν ὁ συλλογισμὸς,

ὧν οὐκ ἔστι συλλογισμός" ἐπαγωγὴ ἄρα. Amongst Other decisive passages to the same effect may be specially cited An. Post II. 19, and Metaphysics I. 1. [TF]

[14] For if the principia scientiarum be uncertain, the axiomata media, which are deduced from them, must, of course, be uncertain as well We cannot rely on the truth of the conclusion, till we have placed beyond doubt the truth of the premisses. [TF]

[15] The reason here assigned applies to both the preceding clauses. For the metaphor, CP. Arist Soph. El. [15.1] Chapter 1. [TF]

[15.1] Fowler assumes everyone is conversant with Aristotle's works. "Soph. El." = "De Sophisticis Elenchis". [HJ]

XIV.

Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesserae sunt [16]. Itaque si notiones ipsae (id quod basis rei est) confusae sint, et temere a rebus abstractae; nihil in iis, quae superstruuntur, est firmitudinis. Itaque spes est una in inductione vera [17].

[16] The spoken or written word, it is true, is only the symbol of the notion in the mind of the speaker or writer, but could the notion itself be formed or retained without the use of language? This or that particular word is, of course, separable from the corresponding idea (as is shewn by the mere fact of translation from one language into another), but, without the use of signs of some kind or other, we could hardly make any progress in thinking. These considerations, however, do not affect the truth of Bacon's criticism. Whether we speak of the ultimate constituents of the syllogism as words or notions, it is essential to all reasoning that we should have a clear understanding of them. [TF]

[17] CP. II. 19, with the notes on that Aphorism. At first sight, it may not seem plain why it should be the office of Induction to remedy the defect of obscure, false, or inadequate notions. But all notions, we must recollect, involve judgments. In forming or attempting to realise a notion, we really assert a number of propositions. Thus, if I put before my mind the notion of gold, I think of it as yellow, malleable, heavy, capable of being exchanged, etc., and, without forming these judgments, I should not realise the notion. Now, when we are dealing with Nature, sound judgments, and, therefore, sound notions can only be gained by observation of facts and a legitimate generalisation from those facts. We may see from what has been said that the Definition of natural objects or qualities (as distinct from merely technical terms) ought always to rest on previous inductions. [TF]

XV.

In notionibus nil sani est, nec in logicis, nec in physicis: non *substantia*, non *qualitas*, *agere*, *pati*, ipsum *esse*, bonae notiones sunt; multo minus *grave*, *leve*, *densum*, *tenue*, *humidum*, *siccum*, *generatio*, *corruptio*, *attrahere*, *fugare*, *elementum*, *materia*, *forma*, et id genus; sed omnes phantasticae et male terminatae [18].

[18] Ill-defined. [TF]

XVI.

Notiones infimarum specierum, *hominis*, *canis*, *columbae*, et prehensionum immediatarum sensus, *calidi*, *frigidi*, *albi*, *nigri*, non fallunt magnopere; quae tamen ipsae a fluxu materiae et commissione rerum quandoque confunduntur [19]; reliquae omnes (quibus homines hactenus usi sunt) aberrationes sunt, nec debitis modis a rebus abstractae et excitatae.

[19] It must be recollected that there is no breach of continuity in Nature as there is in our distinctions. Hence, our terms or notions are never exhaustive or adequately representative of the endless varieties of Nature. Mr. Ellis proposes to read commistione for commissione. 'From the context it is clear that Bacon means that the union of bodies of different kinds, by giving rise to new qualities and species intermediate to those for which we have recognised names, tends to confuse our ideas of the latter. I think therefore we ought to read "commistione" for "commissione."' [TF]

XVII.

Nec minor est libido et aberratio in constituendis axiomatibus, quam in notionibus abstrahendis; idque in ipsis principiis, quae ab inductione vulgari [20] pendent. At multo major [21] est in axiomatibus, et propositionibus inferioribus, quae educit syllogismus.

[20] He is alluding to the Inductio per enumerationem simplicem as distinguished from the Scientific Induction by which he proposes to replace it. [TF]

[21] For, by deducing error from error, we recede further and further from the truth. [TF]

XVIII.

Quae adhuc inventa sunt in scientiis, ea hujusmodi sunt, ut notionibus vulgaribus fere subjaceant: ut vero ad interiora et remotiora naturae penetretur, necesse est ut tam notiones quam axiomata magis certa et munita via a rebus abstrahantur, atque omnino melior et certior intellectus adoperatio in usum veniat.

XIX.

Duae viae [22] sunt, atque esse possunt, ad inquirendam et inveniendam veritatem. Altera a sensu et particularibus advolat ad axiomata maxime generalia, atque ex iis principiis eorumque immota veritate judicat et invenit axiomata media; atque haec via in usu est. Altera a sensu et particularibus excitat axiomata, ascendendo continenter et gradatim, ut ultimo loco perveniatur ad maxime generalia; quae via vera est, sed intentata.

[22] It should be noticed that even the falsest and flimsiest generalisations about Nature rest upon some slight basis of fact. After observing a few particulars, Bacon complains, men usually fly off to the widest generalisations, and then acquiesce in these, as if they were so many indubitable truths. But, in considering this frequent source of error, he does not perceive that rapid generalisation is often indispensable to the scientific enquirer. The fault does not consist so much in making rapid generalisations as in acquiescing too readily and confidently in them, when made. The method of gradual and continuous ascent from particulars to the highest axioms, through all the intermediate steps, which is here commended by Bacon, is not the method which, for the most part, has been actually pursued by the most successful investigators of Nature, nor would its general adoption contribute to the advancement of science. Provided a hypothesis be regarded simply as a hypothesis, and not assumed as true without a rigorous investigation, the mere fact of its generality ought to be no objection to it. Indeed, by stimulating enquiry and directing its course, it is plain that a very general hypothesis, such as the theory of universal gravitation, or Laplace's nebular hypothesis, or the wave-theory of light and sound, or the theory of evolution, or the theory of final causes, even in its cruder forms, may, whether ultimately proved to be true or false, be of the utmost service in the investigation even of small groups of facts. The all-important proviso, of course, is that, *till proved*, such a hypothesis must be taken simply *quantum valeat*, as a hypothesis and no more. It would be far from an advantage to science, to restrain the flights of scientific imagination, but the products of imagination must never be confounded with the results of proof. The fantastic character of the Ancient Physics was due far less to an exuberant imagination than to a defective sense of evidence. And the true remedy was to insist on the necessity of verification rather than on the suppression of hypothesis.

There is, therefore, a third way of investigation which is not open to Bacon's animadversions and which is peculiarly the way of genius. It begins, like the other two, with the observation of particulars, for this always is and must be the first step, and then, by an effort of imagination, frames for itself some explanation which has a far wider range of application than the special class of phenomena which has been observed. This axioma maxime generale is regarded as a hypothesis, to be hereafter proved or disproved, but, meanwhile, it serves as a provisional explanation of the facts, and stimulates to further investigations. From it may be deduced a number of axiomata media which admit of being constantly compared with facts, and thus an ever-increasing experience tends to prove or disprove the axiom in question. If facts do not agree with the deductions from the hypothesis, it must be thrown aside as useless or modified to

meet the exceptions; but if it agree with the facts, there is a strong presumption in its favour. Even still, however, it must not be finally admitted as an ascertained truth, till it has been shewn to conform with the rigorous requirements of the inductive methods, or connected deductively with some still higher generalisations which have been established on independent grounds. When this final step has been taken, the axiomata media deduced from it may be accepted with implicit confidence.

Generally speaking, the axioma maxime generale, even when conceived before the axiomata media, will rest on an induction from these, as its final proof; as these themselves will probably rest on lower axioms, and so on till we reach the axioms which rest on an induction from individual facts. But, in the order of conception, though not in the order of proof, the axioma maxime generale or one of the highest of the intermediate axioms usually comes first, and this circumstance it is which distinguishes the method I am describing from that commended by Bacon.

The history of the Theory of Gravitation supplies an example of a scientific doctrine, the steps of which were established almost in the exact order which Bacon recommends. This fact may be seen by consulting the Inductive Table of Astronomy given in Dr. Whewell's Novum Organum Renovatum. Moreover, in all sciences this order is the most convenient mode of representing the laws, when once established, though, as we have seen, it is by no means that in which they are always actually established, as a matter of fact. Bearing in mind this qualification, I may adopt the words of Dr. Whewell: —

'We have, indeed, already explained that science consists of Propositions which include the Facts from which they were collected; and other wider Propositions, collected in like manner from the former, and including them. Thus, that the stars, the moon, the sun, rise, culminate, and set, are facts *included* m the proposition that the heavens, carrying with them all the celestial bodies, have a diurnal revolution about the axis of the earth. Again, the observed monthly motions of the moon, and the annual motions of the sun, are *included* in certain propositions concerning the movements of those luminaries with respect to the stars. But all these propositions are really *included* in the doctrine that the earth, revolving on its axis, moves round the sun, and the moon round the earth. These movements, again, considered as facts, are explained and *included* in the statement of the forces which the earth exerts upon the moon, and the sun upon the earth. Again, this doctrine of the forces of these three bodies is *included* in the assertion, that all the bodies of the solar system, and all parts of matter, exert forces, each upon each. And we might easily shew that all the leading facts in astronomy are comprehended in the same generalisation. In like manner with regard to any other science, so far as its truths have been well established and fully developed, we might shew that it consists of a gradation of propositions, proceeding from the most special facts to the most general theoretical assertions.' (Novum Organum Renovatum, Chapter VI. § I.)

Even in Astronomy, however, the heliocentric hypothesis had occurred to the ancients long before the state of their knowledge was sufficient to supply them with sound

arguments for it; nor, even in the time of Copernicus himself, was it more than the simplest and most consistent explanation of known facts.

The student is specially recommended to read Mr. Mill's strictures on this Aphorism. See Mill's Logic, Book vi. Chapter 5. § 5. On the other side, he may refer to Dr. Whewell's Philosophy of Discovery, Chapter xxii. § 56-62.

In extenuation of Bacon's error, for such I conceive it to be, may he pleaded the exceedingly vague and unsatisfactory character of the 'axiomata maxime generalia' which were in vogue in his time. As proof of this circumstance, I may cite the list which Mr. Mill himself gives at the beginning of the 24th chapter of his Examination of Sir W. Hamilton's Philosophy.

Notwithstanding all that is said here and in other places. Bacon himself had recourse to hypothesis (under the name of 'permissio intellectus') in II.20. The view which he there takes of its relation to Induction is far more just than that here taken. See my note on the beginning of that Aphorism. [TF]

XX.

Eandem ingreditur viam (priorem scilicet) intellectus sibi permissus, quam facit ex ordine dialecticae [23]. Gestit enim mens exsilire ad magis generalia, ut acquiescat; et post parvam moram fastidit experientiam: sed haec mala demum aucta sunt a dialectica ob pompas disputationum.

[23] The mind is naturally prone to the false method, and is encouraged in its tendencies by the use of the vulgar logic, which fails to insist on the examination of first principles. This proneness of the mind to rest in first principles, however obtained, and to resent any examination of them, is due mainly to a combination of pride with mental indolence. We recoil from the trouble of reviewing what lies at the bottom of so many of our beliefs, and we are too proud to acknowledge that we have been so long or so frequently in error. To a certain extent, also, it may be accounted for by the principle of association. We have ourselves repeated, or heard the maxim repeated by others, so frequently, and in connexion with so many other propositions which we accept as true, that we can hardly conceive it being called in question. [TF]

XXI.

Intellectus sibi permissus, in ingenio sobrio et patiente et gravi (praesertim si a doctrinis receptis non impediatur), tentat nonnihil illam alteram viam, quae recta est, sed exiguo profectu; cum intellectus, nisi regatur et juvetur, res inaequalis [24] sit, et omnino inhabilis ad superandam rerum obscuritatem.

[24] This word may perhaps be translated inadequate,' or perhaps 'irregular,' that is acting sometimes one way, sometimes another. See Mr. Ellis's note. [TF]

XXII.

Utraque via orditur a sensu et particularibus [25], et acquiescit in maxime generalibus: sed immensum quiddam discrepant; cum altera perstringat tantum experientiam et particularia cursim; altera in iis rite et ordine versetur; altera rursus jam a principio constituat generalia quaedam abstracta et inutilia [26]; altera gradatim exsurgat ad ea quae revera naturae sunt notiora [27].

[25] That, in any case, we begin with particulars furnished by sense, he takes for granted. CP. Campanella, Metaphysica, pars I. Libro I. Prooemium: 'Principia enim artis, quae intelligimus, sive sint nomina imperfecte naturam rei significantia, sive sint definitiones, perfecte eandem significantes, sive propositiones universales, a sensu accepimus per inductionem, quod et Aristoteles in 2 Poster, docet, licet sui oblitus.' [TF]

[26] Such as that 'Nature does nothing in vain,' 'Nature abhors a vacuum' that each body has only one proper motion, and the like. [TF]

[27] The phrase 'naturae notiora' is a scholastic mistranslation of Aristotle's τῇ φύσει γνωριμώτερα, which ought to be translated 'natura notiora;' τῇ φύσει or ἁπλῶς γνωριμώτερα are opposed to ἡμῖν γνωριμώτερα as the more general to the more particular, as universals to objects of sense. Amongst other places, see Post. An. I. 2 (p. 71 b. 33-p. 72 a. 5): Πρότερα δ᾽ ἐστὶ καὶ γνωριμώτερα διχῶς" οὐ yap ταὐτὸν πρότερον τῇ φύσει καὶ πρὸς ἡμᾶς πρύτερον, οὐδὲ γνωριμώτερον καὶ ἡμῖν γνωριμώτερον. Λέγω δὲ πρὸς ἡμᾶς μὲν πρότερα καὶ γνωριμώτερα τὰ ἐγγύτερον τῆς αἰσθήσεως, ἁπλῶς δὲ πρότερα καὶ γνωριμώτερα τὰ πορρώτερον. Ἔστι δὲ πορρωτάτω μὲν τὰ καθόλου μάλιστα, ἐγγυτάτω δὲ τὰ καθ᾽ ἕκαστα" καὶ ἀντίκειται ταῦτ᾽ ἀλλήλοις. The student may with advantage read Trendelenburg's note on this passage. See notes to the Elementa Logices Aristoteleae, § 19.

Naturally, or in reference to Nature, according to Aristotle's way of thinking, the universal is prior to the individual, the cause to the effect, the general law to the particular fact. By or in reference to us, on the other hand, the individual is better known than the universal, the effect than the cause, the particular fact than the general law. Nature indeed may be regarded as ever striving to reproduce the type in the individual, to represent the general law in its special manifestations, to carry out the cause into its effects. And so, by a figure of speech, it may be said to have a better or prior knowledge of that which, in our case, comes last, and as the result of a variety of mental operations.

Bacon here, as elsewhere, avails himself of the Aristotelian distinction, but seems to imply that with Aristotle the τῇ φύσει γνωριμώτερα were mere useless abstractions, while he himself probably understands by the 'revera naturae notiora' those ultimate causes or Forms, out of which, as a sort of alphabet, he conceived that the various

bodies, forces, and qualities in nature were composed. For the further explanation of these 'Forms,' the student must refer to the Introduction.

Mr. Spedding notices that, in his English writings. Bacon seems to use the word 'original' as equivalent to 'naturae notior'.

It is interesting to compare with this Aphorism the following passage of the Distributio Operis: 'At secundum nos, axiomata continenter et gradatim excitantur, ut nonnisi postremo loco ad generalissima veniatur: ea vero generalissima evadunt non notionalia, sed bene terminata, et talia quae natura ut revera sibi notiora agnoscat, quaeque rebus haereant in medullis.' [TF]

XXIII.

Non leve quiddam interest inter humanae mentis idola [28], et divinae mentis ideas [29]; hoc est, inter placita quaedam inania, et veras signaturas atque impressiones factas in creaturis, prout inveniuntur.

[28] εἴδωλα, 'phantoms' or 'spectres,' not 'idols' in the sense of false gods, as several writers have interpreted it. In the De Augmentis Scientiarum, Libro V. Cap. 4, they are called Imagines sive Idola, and in the second of the Two Books on the Advancement of Learning, published in 1605, they are spoken of as 'false appearances that are imposed upon us ' by ' the general nature of the mind,' by ' words,' etc. For the latter passage, see Ellis and Spedding's Edition of Bacon's Works, Vol. III. pp. 394-7. Mr. Hallam (Literature of Europe, part III., Chapter 3. § 60) gives some amusing extracts from the authors who have mistaken the meaning of the word. [TF]

[29] Are these 'ideas of the divine mind' the 'forms' of which Bacon will speak hereafter? That God created all things in conformity with certain ideas, forms, or exemplars in his own mind, as the sculptor fashions a statue, and that thus, in a certain sense, the world had a pre-existence in the mind of God, is a commonplace of philosophy and theology. CP. Campanella, Metaphysics, pars i., Libro i.; Prooemium: 'Propterea nil est in mundo, quod non aliquid in mente Dei latens idealiter exprimat.' One, though probably not the true, interpretation of the Ideal doctrine of Plato is that the ἰδέαι are simply the ideas or typical forms existing in the mind of God.

By the concluding words of the Aphorism, Bacon probably intends to intimate, as Dr. Kitchin says, 'that it would be futile for Man to endeavour to contemplate any thing abstracted from, and out of its connexion with, the material world,' that, in fact, our only mode of ascertaining the ideas of the divine mind is the patient study of the Book of Nature. The Aphorism might be paraphrased thus: God is omniscient; Nature is the reflexion of the mind of God. Man, led astray by the phantasms in his own mind, has vainly imagined that he can attain to knowledge, without going to Nature and therein studying the image of the divine mind. CP. Aphorism 124. [TF]

XXIV.

Nullo modo fieri potest, ut axiomata per argumentationem constituta ad inventionem novorum operum valeant; quia subtilitas naturae subtilitatem argumentandi multis partibus superat. Sed axiomata, a particularibus rite et ordine abstrata, nova particularia rursus facile indicant et designant [30]; itaque scientias reddunt activas.

[30] Except for the implied limitation to opera, this is the true conception of the relations of the Inductive and Deductive methods. When the axioms have been constituted by induction, they should be developed deductively into all their consequences and then ultimately, if they admit of it, applied to practice. The science of Mechanics affords an excellent instance of a science thus constituted, developed, and applied.

The word 'abstracta' as the equivalent of 'inferred by induction' is worthy of notice. The qualities in which a number of individual objects agree are regarded as 'drawn from' them, to the exclusion of those in which they differ, and, therefore, as predicable, in an axiom or proposition, of the class as a whole. Properly speaking, however, the word 'abstracted' ought to be applied, not to the qualities on which the attention is concentrated, but to those which are withdrawn from consideration: Attention and Abstraction are processes the reverse of and complementary to each other. [TF]

XXV.

Axiomata, quae in usu sunt, ex tenui et manipulari experientia, et paucis particularibus, quae ut plurimum occurrunt, fluxere; et sunt fere ad mensuram eorum facta et extensa: ut nil mirum sit, si ad nova particularia non ducant [31]. Quod si forte instantia [32] aliqua, non prius animadversa aut cognita, se offerat, axioma distinctione aliqua frivola salvatur [33], ubi emendari ipsum verius foret.

[31] The existing Axioms are founded on a small number of instances, of common occurrence, and just fit those instances, but are employed as if they were universally true, other instances to the contrary either not being taken into account or being explained away by some frivolous distinction. In other words, an empirical law is employed as if it were a law of causation. The student should read, in illustration of this Aphorism, Mr. Mill's chapter on Empirical Laws (Mill's Logic, Book III. Chapter i6). He will also find some remarks on the same subject in my Inductive Logic, Chapter 4 (4th ed., pp. 220-222). [TF]

[32] M. Bouillet draws attention to the fact that 'instantia' is never used in Classical Latin, in the sense of 'an instance.' But I think he is wrong in saying that it is here simply the English word 'instance' (= example) latinised. Instantia (as a translation of ἔνστασις) was a technical term of the schools, and, from the meaning of an 'objection,' which was generally founded on a single case, would easily pass into that which it usually bears in

Bacon and in modern works generally. In this Aphorism, it seems to retain the meaning of ἔνστασις or objection. [TF]

[33] Thus, for instance, till the time of Galileo, it was held that bodies fall to the earth in times inversely proportional to their weights. But some bodies, as, for example, flame, do not fall, but rise. This exception was accounted for by the principle of levity, according to which light bodies tend upwards. The various current divisions of motion, such as natural and violent motion, simple and compound motion, and the like, easily lent themselves to frivolous distinctions of this kind.

The desire to patch up a theory by ingenious devices rather than to review and emend it is well illustrated by the various contrivances of epicycles and eccentrics by which the ancient astronomers endeavoured to retain, in spite of all difficulties, the theory of the circular motion of the heavenly bodies. Another assumption of the ancient astronomy was that the heavenly bodies must be perfect spheres. When Galileo discovered, by means of the telescope, the existence of cavities in the moon, it was asserted, in reply, that they were filled with transparent crystal. [TF]

XXVI.

Rationem humanam, qua utimur ad naturam, *anticipationes naturae* [34] (quia res temeraria est et praematura), at illam rationem quae debitis modis elicitur a rebus, *interpretationem naturae*, docendi gratia, vocare consuevimus.

[34] Called, in the last paragraph but one of the Preface, anticipationes mentis. See p. 188. [TF]

XXVII.

Anticipationes satis firmae sunt ad consensum; quandoquidem, si homines etiam insanirent ad unum modum et conformiter, illi satis bene inter se congruere possent [35].

[35] Uniformity of opinion, even if it extend to universal consent, is no evidence of truth.

All men alike might be mad, and there might be no one to observe or point out the fact of their madness. Similar suppositions as to the possibility of the universality of error are constantly started by Descartes, and are resolved, in his philosophy, by the consideration of the veracity of God, who would never have so formed his creatures as to be exposed to the risk of insuperable deception.

Though this Aphorism is stated in an extravagant form, it suggests two very important considerations: (1) the relativity of human knowledge; (2) the possibility of universal error.

With reference to the first, the student may consult, amongst recent writings, Sir W. Hamilton's Essay on the Philosophy of the Unconditioned (published in the 'Discussions'), his Lectures on Metaphysics, Lectures. VIII, IX, Mill's Examination of Hamilton, Chapters 2, 3, 4, and Grote's Plato, Chapter 26 (1st ed., Vol. II. pp. 322-363). I shall limit myself to a few remarks, directly suggested by Bacon's supposition. All truth must be relative to ourselves, that is to the special constitution of the human faculties. We cannot transcend human consciousness. We cannot do more than observe phenomena and reflect on the observations made. All that we know, we can know only through the medium of our own senses and our own intellect, and hence all knowledge must be *relative* to our own cognitive powers. All that we can say, in the last resort, is that a proposition is true *to us*. As to what may be true or false to other orders of beings, differently constituted, we can have no conception, except so far as we have grounds for supposing that their intelligences and the conditions under which their intelligences work are analogous to our own. As to 'absolute truth,' or 'truth in itself,' the phrase seems to be entirely devoid of meaning, the very word 'truth' implying a percipient or thinking subject as well as an object of perception or thought. Thus, it is quite conceivable that beings with different faculties, or brought up amidst a different set of conditions, might, if they could observe us, suppose us to be all mad after the same fashion, as we, similarly, should suppose them to be.

As regards the second consideration, namely, the possibility of universal error, an important distinction must be drawn. Our *immediate perceptions* (when corrected by comparison with each other and with those of other men) are our ultimate test of truth; if these deceive us, we have no other criterion to guide us. But our *inferences* from these perceptions not only may be, but frequently are, false, and it has sometimes happened, as in the belief that the earth was the centre of the solar system, that all mankind have through several generations been mistaken in the inferences they drew from observed facts. In such cases, the false inference has often, in the first instance, been drawn by one or a few persons, and the rest have accepted it implicitly on their authority. Errors of this kind, however long or universally they may have obtained, need not lead us to despair as to the possibility of attaining truth. Previous errors in reasoning have been detected by the employment of the reasoning process itself, and hence we may fairly suppose that, if there are any questions now on which all men are mistaken, posterity will be able to correct our false inferences, as we have corrected those of our ancestors. The source of our errors itself supplies us with the means of correcting them. [TF]

XXVIII.

Quin longe validiores sunt ad subeundum assensum anticipationes, quam *interpretationes*; quia ex paucis collectae, iisque maxime quae familiariter occurrunt, intellectum statim perstringunt, et phantasiam implent; ubi contra, *interpretationes*, ex rebus admodum variis et multum distantibus sparsim collectae, intellectum subito percutere non possunt; ut necesse sit eas, quoad opiniones [36], duras et absonas, fere instar mysteriorum fidei videri.

[36] ‘So far as concerns the opinions which men have of them,’ ‘in common estimation.’ Some of the later editions omit the comma after opiniones, which makes the passage unintelligible. [TF]

XXIX.

In scientiis, quae in opinionibus et placitis fundatae sunt, bonus est usus *anticipationum* et dialecticae; quando opus est assensum subjugare, non res [37].

[37] If the allusion be to the moral and political sciences, the passage must be ironical, as, in Aphorism 127, Bacon distinctly states that his method is applicable to all sciences alike, and he particularly specifies logic, ethics, and politics. We may, perhaps, represent his thought somewhat as follows: ‘In morals, politics, logic, and sciences of that kind people care so little for truth and so much for disputation and victory, that we may leave them to their own method, till they have changed their aims and point of view. If they wish for truth in these subjects, they must conduct their enquiries according to the new method, duly combining induction with syllogism; but, if they only wish to find arguments for pre-conceived opinions, let them go on in the old fashion.’ [TF]

XXX.

Non, si omnia omnium aetatum ingenia coierint, et labores contulerint et transmiserint, progressus magnus fieri poterit in scientiis per *anticipationes*: quia errores radicales, et in prima digestione mentis, ab excellentia functionum et remediorum sequentium non curantur.

XXXI.

Frustra magnum expectatur augmentum in scientiis ex superinductione et insitione novorum super vetera; sed instauratio facienda est ab imis fundamentis, nisi libeat perpetuo circumvolvi in orbem, cum exili et quasi contemnendo progressu.

XXXII.

Antiquis auctoribus suus constat honos, atque adeo omnibus; quia non ingeniorum aut facultatum inducitur comparatio, sed viae; nosque non judicis, sed indicis [38] personam sustinemus.

[38] ‘My object is to shew men the way to truth, not to assume the office of a judge, and pass sentence on other authors.’ This statement is certainly anything but consistent with the severity of the judgments which Bacon presently proceeds to pass on the majority of his predecessors and contemporaries, and specially on Aristotle and the Aristotelians.

The word 'indicis' throws back light on the title of the work, ‘Novum Organum, sive Indicia vera de Interpretatione Naturae.’ ‘Indicia’ in that place may be represented by the phrase ‘Indications,’ or, as Dr, Kitchin suggests, it may mean ‘the opening out of a new way.’ [TF]

XXXIII.

Nullum (dicendum enim est aperte) recte fieri potest judicium nec de via nostra, nec de iis quae secundum eam inventa sunt, per *anticipationes* (rationem scilicet quae in usu est), quia non postulandum est ut ejus rei judicio stetur, quae ipsa in judicium vocatur.

XXXIV.

Neque etiam tradendi aut explicandi ea, quae adducimus, facilis est ratio; quia, quae in se nova sunt, intelligentur tamen ex analogia veterum [39].

[39] He is calling in question the authority of the court; hence, it is no answer to say that the rules of the court are this and that. He questions the sufficiency of the old logic; hence, it is no answer to say that his methods are not to be found in the old treatises. [TF]

XXXV.

Dixit Borgia de expeditione Gallorum in Italiam, eos venisse cum creta in manibus, ut diversoria notarent, non cum armis, ut perrumperent [40]. Itidem et nostra ratio est, ut doctrina nostra animos idoneos et capaces subintret; confutationum enim nullus est usus, ubi de principiis et ipsis notionibus, atque etiam de formis demonstrationum dissentimus.

[40] ‘This Borgia was Alexander VI, and the expedition of the French that under Charles VIII, which over-ran Italy in five months, A.D. 1494.’ (Dr. Kitchin’s note.) Mr. Ellis quotes the following passage from Nardi: ‘Diceva in quei tempi Papa Alessandro sesto che i Francesi havevano corso l’Italia con gli speroni di legno et presola col gesso: dicendo cosi perché pigliando essi gli alloggiamenti nelle cittk loro furieri segnavano le porte delle case col gesso; et cavalcando per loro diporto i gentil’ huomini per le terre à sollazzo usavano di portare nelle scarpettek calcagni certi stecchi di legno appuntati, delli quali in vece di speroni si servivano per andare le cavalcature.’ — Nardz) Vita di Malespim, [1597,] p. 18. Mr. Ellis adds that ‘In an epitome of the history of Charles the Eighth, which will be found in the “Archives curi eases” of Cember, Vol. I. p. 197, and which was apparently written about the beginning of the seventeenth century, the remark ascribed to Alexander the Sixth by Nardi and Bacon is mentioned as a popular saying.’ [TF]

XXXVI.

Restat vero nobis modus tradendi unus et simplex, ut homines ad ipsa particularia et eorum series et ordines adducamus; et ut illi rursus imperent sibi ad tempus abnegationem notionum, et cum rebus ipsis consuescere incipiant.

XXXVII.

Ratio eorum, qui acatalepsiam [41] tenuerunt, et via nostra initiis suis quodammodo consentiunt; exitu immensum disjunguntur et opponuntur. Illi enim nihil sciri posse simpliciter asserunt; nos, non multum sciri posse in natura, ea, quae nunc in usu est, via [42]: verum illi exinde authoritatem sensus et intellectus destruunt; nos auxilia iisdem excogitamus et subministramus.

[41] ἀκαταληψία. The allusion is to the New Academy, the principal representatives of which were Arcesilaus and Carneades, and which mainly flourished in the third and second centuries B.C. For a detailed account of the doctrines of this school, the reader may refer to any of the more recent Histories of Greek Philosophy, such as Ueberweg's or Zeller's. The following brief notice will enable him to understand Bacon's allusions to the school here and elsewhere.

The New Academy, which, as its name imports, professed to be an offshoot of Platonism, may be regarded partly as a development of the sceptical and negative vein which had, from the first, formed part of the Platonic impulse, partly as a strong reaction against the dogmatism of the Stoics. The Stoics had maintained that, besides ἐπιστήμη, demonstrable knowledge, and δόξα, mere opinion, there is a third and intermediate kind of knowledge, quite trustworthy, but not demonstrable. This was called φαντασία καταληπτική or κατάληψις. According to the Stoics, says Tennemann, 'every original representation is the result of impressions produced upon the mind, and hence of sensational perceptions; and is therefore denominated φαντασία, *visum*. Out of these original and sensational impressions, Reason, a superior and directing power ((τὸ ηγεμονικόν), forms our other representations. The true are styled by Zeno φαντασίαι καταληπτικαί, or καταλήψεις, that is, such as are verified by their correspondence with the object to which they refer, are freely assented to, and constitute the foundation of science.' The greater part of our physical and ethical knowledge the Stoics held to be of this intermediate description. In opposition to this theory, the philosophers of the New Academy maintained the doctrine of καταλήψεις, that is the impossibility of attaining to such ἀκαταληψία. According to the ordinary account, which is that adopted by Bacon, they recognised only one certain proposition, namely, that nothing can be known with certainty. It was this dogmatic scepticism Nova Academia acatalepsiam dogmatizavit et ex professo tenuit' Aphorism 67) which, as is generally supposed, distinguished this school from the Pyrrhonists, Ephectici, or Sceptics proper. The latter school endeavoured to maintain an ἐποχή (suspension of judgment) between the affirmation and negation of propositions, saying that it is impossible to know whether we know anything or not.

The ἀταραξία (or imperturbableness of mind) which the realisation of this uncertainty produces is the supreme end of philosophy.

Ueberweg, however, questions the accuracy of the popular distinction between the New Academy and the Sceptics. He regards, indeed, the scepticism of the former as the less thorough-going of the two, but not for the reason ordinarily assigned. The philosophers of the New Academy, he supposes, differed, in general, from the Sceptics, in not making ἀταραξί, the supreme end of philosophy, and, furthermore, in admitting a theory of probability, which served as a practical guide of life.

This theory of probability recognises three grades. They are derived respectively from (1) φαντασία πιθανῆ, our first impression of an object; (2) φαντασία πιθανὴ Gua καὶ ἀπερισπαστός, the concurrent testimony of our various impressions; (3) φαντασία ἀπερισπαστὸς καὶ διεξωδευμένη, the same concurrent testimony, when thoroughly sifted and examined by the reason. The highest degree of probability takes the place of certainty in other systems. Bacon alludes to the Academic theory of probability in Aphorism 67. [TF]

[42] It will be noticed that Bacon opposes to the 'nihil sciri posse' of the New Academy 'non multum sciri posse,' that he interpolates 'in natura,' and to 'simpliciter' opposes 'ea, quae nunc in usu est, via.' 'In natura' must not be taken as implying that he thought the old method sufficient for the moral and political sciences. See note on Aphorism 29.

The contrast which Bacon here draws between himself and the philosophers of the New Academy can hardly fail to remind us of the similar contrast which has frequently been drawn between Socrates and the leading Sophists of his time. The method of Socrates began in scepticism, but its object was to re-establish the foundations of knowledge. Similarly, Bacon attempts to destroy the credit of the old method of enquiry, only that he may replace it by a new and surer one. There is a passage in the Advancement of Learning (Book i.) in which he says, if not truly, at least finely: 'if a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts (itaque aliquandiu patienter toleret.' De Augmentis Scientiarum), he shall end in certainties.' [TF]

XXXVIII.

Idola [43] et notiones falsae, quae intellectum humanum jam occuparunt atque in eo alte haerent, non solum mentes hominum ita obsident, ut veritati aditus difficilis pateat; sed etiam dato et concesso aditu, illa rursus in ipsa instauratione scientiarum occurrent et molesta erunt; nisi homines praemoniti adversus ea se, quantum fieri potest, muniant.

[43] Here commences the doctrine of the Idola, which is, perhaps, the best-known, as it is, certainly, one of the most important parts of the Novum Organum. On the meaning of the word 'Idola,' see the first note on Aphorism 23. Mr. Ellis draws attention to the various forms in which this doctrine appears in Bacon's different works, but a still more

accurate and elaborate account of the changes is given in a note by Mr. Spedding. See Ellis and Spedding's Bacon, Vol. I. pp. 89-93, and Note C (by Mr. Spedding), pp. 113-117. To these sources the reader who may wish for more information on the subject is referred. It is sufficient here to state that the Idols in their earlier form (as they appear in the English Treatise on the Advancement of Learning) correspond with those of the Tribe, the Cave, and the Market-Place, and that 'the one substantial change which the doctrine of Idols underwent was the admission of the Idola Theatri into the company.' The doctrine occurs in the Valerius Terminus, the Advancement of Learning, the Temporis Partus Masculus, the Partis Secundae Delineatio, the Distributio Operis, and the De Augmentis Scientiarum, but far the most perfect treatment of it is that in the Novum Organum. On the classification of the Idola into groups I shall say something in a note on the next Aphorism.

It has often been remarked that the doctrine of the Idola was anticipated by Bacon's great namesake, Roger Bacon, who gives a four-fold classification of 'offendicula, quae omnem quemcunque sapientem impediunt,' These are unworthy authority, custom, vulgar opinion, and concealment of ignorance combined with the ostentation of apparent wisdom. Mr, Ellis, however (Vol. I. pp. 89, 90), argues very justly that Bacon is not likely to have seen the Opus Majus, which then existed only in manuscript, and, as Mr. Spedding adds, was probably not procurable, and possibly even unknown to him; moreover, the correspondence between the 'idola' and the 'offendicula' is very slight. What probably suggested the idea of the one having been borrowed from the other is the fourfold division which is common to both, but the 'idola,' as we have seen, were, in the original form of the doctrine, enumerated as only three.

Roger Bacon's statement and refutation of the 'offendicula ' will be found worked out at great length in the 1st Part of the Opus Majus, and more briefly in the Opus Tertium, Cap. 22. Mr. Spedding has quoted the opening words of the former passage. I will append those of the latter, in which there are some interesting variations:

'Quatuor vero sunt causae generales omnium malorum nostrorum, et omnem statum a principio mundi corruperunt, et omnem hominem quantumcunque sapientem (praeter Dominum nostrum Jesuni Christum et Beatam Virginem) aliquando extra viam rectam, vel extra ultimam perfectionem coegerunt declinare. Et sunt fragilis auctoritatis exempla, consuetudinis diuturnitas, et sensus multitudinis imperitae, atque praesumptio humanae mentis, qua quilibet nititur suae imperitiae solatium quaerere, et ea, quae nescit, aut non approbare aut reprobare, et illud modicum quod scit vel aestimat scire, licet nesciat, gaudet imprudenter ostentare.' [43.1] The rest of the chapter (which will be found in Mr. Brewer's 'Fr. Rogeri Bacon Opera quaedam inedita,' pp. 69-73) is very curious and well worth the attention of the student. [TF]

[43.1] The quote from Roger Bacon can be translated to "There are, indeed, four general causes of all our evils, which have corrupted the entire order of things from the beginning of the world, and have led every human being—no matter how wise (except our Lord Jesus Christ and the Blessed Virgin)—at some point to deviate from the straight

path or from the highest perfection. These causes are: the example of weak authority, the long-standing force of custom, the unrefined opinion of the ignorant multitude, and the presumption of the human mind, by which each person strives to find comfort in his own ignorance and, concerning the things he does not know, either refuses to affirm or to deny them. That little which he does know—or thinks he knows, though in fact he does not—he is pleased to display with imprudent ostentation." [HJ]

XXXIX.

Quatuor sunt genera idolorum, quae mentes humanas obsident. Iis (docendi gratia) nomina imposuimus; ut primum genus, *idola tribus*; secundum, *idola specus*; tertium, *idola fori* [44]; quartum, *idola theatri*, vocentur [45].

[44] Called in Valerius Terminus Idols of the Palace. [TF]

[45] At the beginning of Aphorism 61, there is a trace of an old classification of the Idola into two groups. In introducing the *idola theatri*, Bacon uses the words 'At *idola theatri* innata non sunt, nec occulto insinuata in intellectum; sed ex fabulis,' etc. These words point to a classification of the Idola as innate, including the first three classes, and adventitious, including the last class or idola theatri only. And this classification we find adopted in the Distributio Operis. 'Idola autem a quibus occupatur mens, vel Aclscititia sunt vel Innata. Adscititia vero immigrarunt in mentes hominum, vel ex philosophorum placitis et sectis vel ex perversis legibus demonstrationum. At Innata inhaerent naturae ipsius intellctus, qui ad errorem longe proclivior esse deprehenditur quani sensus Atque priora ilia duo Idolorum genera aegre, postrema vero haec nullo modo, evelli possunt. Id tantum relinquitur, ut indicentur, atque ut vis ista mentis insidiatrix notetur et convincatur. … . Itaque doctrina ista de expurgatione intellectus ut ipse ad veritatem habilis sit, tribus redargutionibus absolvitur: redargutione philosopbiarum, redargutione demonstrationum, et redargutione rationis humanae nativae.' CP. the Partis Secundae Deiineatio (Ellis and Spedding, Vol. III. p. 548), and see Mr. Spedding's remarks in Note C. to the Preface to the Novum Organum (Vol. I. pp. 113-1 1 7), where the whole question of the higher classification of the Idola is carefully considered. This higher classification of Adscititia and Innata disappears in the Novum Organum, because, as Mr. Spedding says, when Bacon 'came to describe the several Idols one by one, he became aware both of the logical inconsistency of classing the Idola Fori among the Innata, and of the practical inconvenience of classing them among the Adscititia, and therefore resolved to drop the dichotomy altogether and range them in four co-ordinate classes.' [TF]

XL.

Excitatio notionum et axiomatum [46] per *inductionem* veram est certe proprium remedium ad idola arcenda et summovenda; sed tamen indicatio *idolorum* magni est usus. Doctrina enim de *idolis* similiter se habet ad *interpretationem naturae*, sicut doctrina de sophisticis elenchis ad dialecticam vulgarem [47].

[46] Bacon regarded Induction as requisite both to give clearness and precision to our notions and to establish true propositions which might serve as the basis of subsequent reasoning, whether inductive or deductive. But, as we have already seen (note to Aphorism 14), in order to realise or test the truth or adequacy of a notion, we must form at least one, and frequently a number of judgments. When we employ induction, therefore, 'to elicit a notion,' we necessarily also employ it 'to elicit an axiom,' and hence there is no real distinction between the process of induction or generalisation as applied to notions and as applied to judgments, propositions, or axioms. [TF]

[47] That is to say, it is Bacon's Doctrine of Fallacies, and its function is to clear the mind of false notions, in order that it may be open to the reception of true ones. [TF]

XLI.

Idola tribus sunt fundata in ipsa natura humana, atque in ipsa tribu seu gente hominum [48]. Falso enim asseritur, sensum humanum [49] esse mensuram rerum; quin contra, omnes perceptiones, tam sensus quam mentis, sunt ex analogia hominis, non ex analogia universi [50]. Estque intellectus humanus instar speculi inaequalis ad radios rerum, qui suam naturam naturae rerum immiscet, eamque distorquet et inficit.

[48] Must we then despair of the possibility of attaining knowledge? We cannot, indeed, transcend the limitations of our own faculties, or know things except in relation to our own bodily and mental constitution; but by comparing our impressions and inferences, one with another, and with those of other men, and, above all, by constantly reviewing and correcting our conceptions by comparison with the facts of Nature, we are able to detect not only the individual peculiarities of our own minds but also the general tendencies to error which are common to mankind at large. The mind, though it is beset with phantoms, has not entirely lost the power of distinguishing between phantoms and realities. [TF]

[49] If this assertion is meant to represent the dictum of Protagoras, it does so most inadequately. Protagoras asserted, not that the *senses* uncontrolled by reason, but that man, meaning the human faculties generally, was the measure of all things. Πάντων χρημάτων μέτρον ἄνθρωπος, τῶν μὲν ὄντων ὡς ἔστι, τῶν δὲ οὐκ ὄντων ὡς οὐκ ἔστιν. Making due allowance for the relativity of human knowledge, that is, understanding the maxim in the form, 'Man is to *man* the measure of all things,' it seems to be not only true but a truism. And the same remark may be made of the individual form which the maxim sometimes takes: 'Every man is fa himself measure of all things.' In the Theaetetus, however, where the Protagorean dictum is discussed, the theory that Cognition is simply sensible Perception is discussed also, the two enquiries being confounded, and treated as identical. That Protagoras never expressly asserted the latter proposition is almost certain. 'It is not improbable,' says Mr. Grote, 'that the three doctrines' (namely, that man is the measure of all things, that Cognition is sensible Perception, and that Nature consists in a perpetual motion, change, or flux), 'here put

together by Plato and subjected to a common scrutiny, may have been sometimes held by the same philosophers. Nevertheless, the language of Plato himself shews us that Protagoras never expressly affirmed knowledge to be sensible Perception: and that the substantial identity between this doctrine and the different doctrine maintained by Protagoras, is to be regarded as a construction put upon the two by Plato.' The student has already, in a previous note, been referred to Mr. Grote's admirable criticism of the Theaetetus, where the Protagorean dictum, in its various relations, is discussed at great length and with much acuteness.

That the senses alone are competent to furnish knowledge, without any subsequent operation of the intellect upon the materials supplied by them, seems too crude a theory to have ever been seriously entertained except in the infancy of speculation. It is an entirely different position to assert that the perceptions of the senses are an essential *condition* of knowledge, as is done by Locke, by Kant, and, in fact, by Aristotle, and as appears to be implied throughout by Bacon himself. [TF]

[50] The word Analogy is used here, as in Aphorism 34, in its more general sense of 'relation,' and not in either its earlier or later technical sense, as employed in Logic. For these senses, the student may refer to the Editor's works on Deductive Logic, pt. III. Chapter I. n. 2, and on Inductive Logic, Chapter 4,

It is the central thought of the Baconian philosophy that we must lay ourselves, as it were, alongside of nature, and study the facts of the external world, instead of commencing with our own thoughts, and projecting these, as it were, on the universe. Man must look without and not within, if he desires to be truly acquainted with the world around him. This idea is perfectly just, providing we recollect that, after all, we can never know things as they are in themselves, but only as they appear to us. The peculiarities of the human mind generally and of the individual mind in particular must, after all our precautions, have their share in determining the form which our knowledge assumes. By what is true, we mean, in the last analysis, that which all men might be brought to acknowledge, if their faculties were in a healthy and vigorous condition, and if they were supplied with all the materials requisite for forming a judgment.

Malebranche (Recherche de la Vérité, livre II. 2^{me} partie, Chapter 2) refers to these words and the next sentence as 'fort judicieuses.' [TF]

XLII.

Idola specus [51] sunt idola hominis individui. Habet enim unusquisque (praeter aberrationes naturae humanae in genere) specum sive cavernam quandam individuam, quae lumen naturae frangit et corrumpit: vel propter naturam cujusque propriam et singularem; vel propter educationem et conversationem cum aliis; vel propter lectionem librorum, et authoritates eorum quos quisque colit et miratur; vel propter differentias impressionum, prout occurrunt in animo praeoccupato et praedisposito, aut in animo aequo et sedato, vel ejusmodi: ut plane spiritus humanus (prout disponitur in hominibus

singulis) sit res varia, et omnino perturbata, et quasi fortuita [52]. Unde bene Heraclitus, homines scientias quaerere in minoribus mundis, et non in majore sive communi [53].

[51] The metaphor is taken from Plato's Mythe of the Cave, at the opening of the 7th Book of the Republic. But, as is remarked by Sir W. Hamilton (Reid's Works, p. 473, n.), the metaphor applies rather to the Idola Tribus than to the class of fallacies here described; for by Plato all mankind, except the few philosophers who have found their way upwards, are regarded as being bound in the same cave, and as mistaking the shadows which pass before them for realities. By Bacon, on the other hand, each man is pictured as dwelling in his own particular cave, and mistaking his individual impressions for those of mankind at large. [TF]

[52] There is an interesting allusion to the Idola Specus in the Cogitata et Visa (Ellis and Spedding, Vol. III. P. 607): Quin certissimum esse, turn generaliter . . . . tum etiam cuique ex educatione, studiis, et natura sua, vim quandam seductoriam et quasi daemonem familiarem adesse, qui mentem variis et vanis spectris ludat et turbet.' It may be noticed, by the way, that the use of the word 'spectra,' as the equivalent of 'idola,' affords a further proof, if any were wanted, of the sense in which Bacon employed the latter word. Dr. Craik, in proposing to translate 'Idola' as 'spectres,' calls attention to a passage in Cicero's Letters (Ad Fam. xv. 16) [52.1], in which Cicero observes that Catius, the Epicurean, who had lately died, had given the name of *spectra* to what Epicurus himself and, before him, Democritus had called εἴδωλα. [TF]

[52.1] "Ad Fam." = "Epistulae ad Familiares" = a collection of Cicero's letters. [HJ]

[53] Mr. Ellis refers to Sextus Empiricus, Adversus Logicos, I. § 133, and II. § 186 (it should be 286). [TF]

XLIII.

Sunt etiam idola tanquam ex contractu et societate humani generis ad invicem, quae *idola fori* [54], propter hominum commercium et consortium, appellamus. Homines enim per sermones sociantur; at verba ex captu vulgi imponuntur. Itaque mala et inepta verborum impositio miris modis intellectum obsidet. Neque definitiones aut explicationes, quibus homines docti se munire et vindicare in nonnullis consueverunt, rem ullo modo restituunt. Sed verba plane vim faciunt intellectui, et omnia turbant; et homines ad inanes et innumeras controversias et commenta deducunt [55].

[54] The idols of the market-place (or 'palace,' Valerius Terminus) are so called, because words (which are the 'tesserae notionum,' Aphorism 14) are the means by which men carry on their ordinary intercourse in the affairs of life. We exchange words as we exchange wares in the market.

In addition to the sections on the fallacies arising from the ambiguous use of terms, to be found in almost any treatise on Logic, the student should read the third book of

Locke's Essay, and especially Chapters 9, 10, 11, Dugald Stewart's Philosophy of the Human Mind, pt. I. Chapter 4, sects. 4, 5 with Note L, and pt. II. second subdivision, Chapter I. (Of Language), sect. 3, Mackintosh's Dissertation on the Progress of Ethical Philosophy, Introduction, and Mr. Mill's Logic, Book IV, Chapters 3-6. [TF]

[55] 'Men take the words they find in use amongst their neighbours; and, that they may not seem ignorant what they stand for, use them confidently, without much troubling their heads about a certain fixed meaning; whereby, besides the ease of it, they obtain this advantage, that, as in such discourses they seldom are in the right, so they are as seldom to be convinced that they are in the wrong; it being all one to go about to draw those men out of their mistakes, who have no settled notions, as to dispossess a vagrant of his habitation, who has no settled abode. This I guess to be so; and every one may observe in himself and others, whether it be, or no.' — Locke's Essay, Book III. Chapter 10. § 4. [TF]

XLIV.

Sunt denique *idola*, quae immigrarunt in animos hominum ex diversis dogmatibus philosophiarum, ac etiam ex perversis legibus demonstrationum; quae *idola theatri* [56] nominamus; quia quot philosophiae receptae aut inventae sunt, tot fabulas productas et actas censemus, quae mundos effecerunt fictitios et scenicos. Neque de his quae jam habentur, aut etiam de veteribus philosophiis et sectis tantum loquimur, cum complures aliae ejusmodi fabulae componi et concinnari possint; quandoquidem errorum prorsus diversorum causae sint nihilominus fere communes. Neque rursus de philosophiis universalibus tantum hoc intelligimus, sed etiam de principiis et axiomatibus compluribus scientiarum, quae ex traditione et fide et neglectu invaluerunt. Verum de singulis istis generibus *idolorum*, fusius et distinctius dicendum est, ut intellectui humano cautum sit.

[56] In the Temporis Partus Masculus, these are called Idola Scenae. The title is due in either case to the conceit that systems of philosophy and modes of demonstration succeed one another, like plays on the stage.

The twofold source of these Idola, a false philosophy ('ex diversis dogmatibus philosophiarum'), and a false logic ('ex perversis legibus demonstrationum'), should be especially noticed. In the Partis Secundae Delineatio, these subdivisions of the Idola Theatri are ranked as main divisions, and the remaining idola are classified together in a single group as native to the Human Understanding. 'Itaque pars ista, quam destruentem appellamus, tribus redargiitionibus absolvitur: Redargutione Philosophiarum; Redargutione Demonstrationum; et Redargutione Rationis Humanae Nativae.' There is the same division in the Distributio Operis. Cp. note on Aphorism 39. [TF]

XLV.

Intellectus humanus ex proprietate sua [57] facile supponit majorem ordinem et aequalitatem in rebus, quam invenit: et cum multa sint in natura monodica [58], et plena imparitatis, tamen affingit parallela, et correspondentia, et relativa, quae non sunt [59]. Hinc commenta illa, in coelestibus omnia moveri per circulos perfectos, lineis spiralibus et draconibus [60] (nisi nomine tenus) prorsus rejectis. Hinc elementum ignis cum orbe suo introductum est ad constituendum quaternionem cum reliquis tribus, quae subjiciuntur sensui [61]. Etiam elementis (quae vocant) imponitur ad placitum decupla proportio [62] excessus in raritate ad invicem; et hujusmodi somnia. Neque vanitas ista tantum valet in dogmatibus, verum etiam in notionibus simplicibus [63].

[57] 'Owing to its peculiar nature.' CP. 'propter naturam propriam' at the beginning of Aphorism 51. [TF]

[58] That is, monadica. Mr., Ellis observes that, throughout his writings, Bacon has fallen into this error. [TF]

[59] This excessive love of system, or tendency to feign parallels and similitudes where none exist, is, in a logical classification of the fallacies, best referred to False Analogy. See Mr. Mill's Logic, Book V. Chapter 5. § 6, and my Inductive Logic, 4th ed, pp. 326-338. The fanciful application of numbers has always played a great part in fallacious conceptions of this character. See a curious article on the number Seven in the Classical Journal, Vol. VIII. One of the latest instances of the influence exercised on scientific researches by these speculations is afforded in the case of Huyghens. 'The attention which Huyghens,' says Professor Playfair (Preliminary Dissertation to the Encyclopaedia Britannica), 'had paid to the ring of Saturn, led him to the discovery of a satellite of the same planet. His telescopes were not powerful enough to discover more of them than one; he believed, indeed, that there were no more, and that the number of the planets now discovered was complete. The reasoning by which he convinced himself is a proof how slowly men are cured of their prejudices, even with the best talents and the best information. The planets, primary and secondary, thus made up twelve, the double of six, the first of the perfect numbers. In 1671, however, Cassini discovered another satellite, and afterwards three more, making five in all, which the more perfect telescopes of Dr. Herschel have lately augmented to seven.'

It must be remembered, however, that some of the greatest discoveries in science have originated in the bold use of Analogy. Thus, the whole science of Biology has been revolutionised by following out the analogies between vegetable and animal life, between fossil remains and living organisms, between the structure, habits, and faculties of the lower animals and those of men. The extension of the idea of wave-motion to explain the phenomena of light and sound, and the striking and startling analogies which have often given the first clue to ascertaining the affinities of languages, are other instances which will occur to almost every reader. [TF]

[60] The best commentary on this passage is to be found in the Thema Coeli (Ellis and Spedding, Vol. III. pp. 774-5). 'At manifestum est, planetas non solum impari gradu contendere, sed nec ad idem punctum circuli reverti, verum deflectere versus austrum et boream, cujus deflexionis limites sunt tropici; quae deflexio nobis Circulum Obliquum, et Diversam Politatem ejus progenuit; qtiemadmodum ilia celeritatis inaequalitas motum ilium Renitentiae. Neque vero hoc etiam commento naturae rerum opus est, cum recipiendo lineas spirales (id quod proxime accedit ad sensum et factum) res transigatur, et ista sal vent ur. Atque (quod caput rei est) spirae istae nil aliud sunt quam defectioncs a motu circulari perfecto, cujus planetae sunt impatientes. Prout enim substantiae degenerant puritate, et explicatione, ita degenerant et motus.'

The whole passage from which this extract is taken is interesting, as shewing the immature character of Bacon's astronomical theories.

In a note on this Aphorism, Mr. Ellis says: 'It does not appear in what sense Bacon uses the word "draco." In its ordinary acceptation in old astronomy, it denoted the great circle which is approximately the projection on the sphere of the moon's orbit. The ascending node was called the caput draconis, and the descending the cauda draconis. The same terms were occasionally applied to the nodes of the planetary orbits. It is not improbable that Bacon intended to complain of the rejection of spirals of double curvature, or helices, which, traced on the surface of the sphere, might represent inequalities in latitude. Compare (Novum Organum II. 48) what is said of the variations of which the "motus rotationis spontaneus" admits.'

CP. a passage in the De Augmentis Scientiarum, Libro III. Cap. 4 (Ellis and Spedding, Vol. I. p. 552), where Bacon complains: 'At vix quisquam est, qui inquisivit causas physicas turn de … tum de motuum obliquatione, vel per spiras se versus tropicos texendo et retexendo, vel per sinuationes quas Dracones vocant.' [TF]

[61] The four elements were imagined as having each its natural place, earth being lowest and fire highest. As the orb of fire is above that of air, it is too remote from us to be an object of sense. [TF]

[62] This doctrine which prevailed throughout the Schools, though entirely unsupported by evidence and even in spite of the evidence of the senses, owes its origin to a mistaken interpretation of a passage in Aristotle, De Generatione et Corruptione, II. 6 (p. 333 a. 16-34). The student, on referring to the passage, will find that the 'decupla ratio' is only put hypothetically, for the sake of example: 'οιον εἰ ἐξ ὕδατος κοτύλης εἶεν ἀέρος δέκα;' οἷον εἰ κοτύλη ὕδατος ἴσον δύναται ψύχειν καὶ δέκα ἀέρος.' The order of the elements would, of course, be earth, water, air, fire. A fifth element was added by Aristotle and the Peripatetics, which was regarded as peculiar to the celestial regions and as being the material of which the heavenly bodies were composed. It was called aether. See, for instance, Meteorologica, I. 3; De Coelo, I. 3. CP. note on the words 'ut Gilbertus' in II. 36 (5). [TF]

[63] As, for instance, in the personification of inanimate objects, in anthropomorphic conceptions of God, and the manner in which we attribute to Nature designs and modes of operation analogous to those which we experience amongst men. [TF]

XLVI.

Intellectus humanus in iis quae semel placuerunt (aut quia recepta sunt et credita, aut quia delectant), alia etiam omnia trahit ad suffragationem et consensum cum illis [64]: et licet major sit instantiarum vis et copia, quae occurrunt in contrarium; tamen eas aut non observat, aut contemnit, aut distinguendo summovet et rejicit, non sine magno et pernicioso praejudicio, quo prioribus illis syllepsibus [65] authoritas maneat inviolata. Itaque recte respondit ille [66], qui, cum suspensa tabula in templo ei monstraretur eorum qui vota solverant, quod naufragii periculo elapsi sint, atque interrogando premeretur, anne tum quidem Deorum numen agnosceret, quaesivit denuo, *At ubi sunt illi depicti qui post vota nuncupata perierint?* Eadem ratio est fere omnis superstitionis, ut in astrologicis, in somniis, ominibus, nemesibus, et hujusmodi; in quibus homines delectati hujusmodi vanitatibus advertunt eventus, ubi implentur; ast ubi fallunt, licet multo frequentius, tamen negligunt et praetereunt. At longe subtilius serpit hoc malum in philosophiis et scientiis; in quibus quod semel placuit, reliqua (licet multo firmiora et potiora) inficit, et in ordinem redigit. Quinetiam licet abfuerit ea, quam diximus, delectatio et vanitas, is tamen humano intellectui error est proprius et perpetuus, ut magis moveatur et excitetur affirmativis, quam negativis; cum rite et ordine aequum se utrique praebere debeat; quin contra, in omni axiomate vero constituendo, major est vis instantiae negativae [67].

[64] This tendency, when we have once formed an opinion, to attach greater importance to affirmative instances, in support of it, than to negative instances, in contradiction of it, is rightly classed by Mr. Mill under the Fallacies of Non-observation of instances. See Mill's Logic, Book V. Chapter 4. § 3, and my Inductive Logic, 4th Edition, pp. 251-257. For instances of the Fallacy, the reader is referred to those works. [TF]

[65] σύλληψις, a conception. [TF]

[66] Diagoras, surnamed the Atheist, according to Cicero, De Natura Deorum, III. 37, where another story to the same purport is told. Diogenes Laertius tells the story, with a slight variation, of Diogenes the Cynic, but adds that it is also told of Diagoras the Melian: θαυμάζοντος τινὰς τὰ ἐν Σαμοθράκῃ ἀναθήματα, ἔφη, Πολλῷ ἂν εἴη πλείω, εἰ καὶ οἱ μὴ σωθέντες ἀνετίθεσαν. οἱ δὲ τοῦτο Διαγόρου φασὶ τοῦ Μηλίου. [TF]

[67] A single negative instance, if it admit of no explanation, is sufficient to upset a theory, or, at the least, it ought to cause us to suspend our judgment, till we are able either to explain the exception, or to modify the theory in accordance with it, or else to accumulate such an amount of negative evidence as to justify us in rejecting the theory altogether. The negative instance, even where it does not upset a theory, is often

peculiarly valuable, in calling attention to a counteracting cause. This, for example, was the case with the deflexions of the planet Uranus, which, being inexplicable by known causes, directed the attention of astronomers to the existence of a hitherto undiscovered planet, the planet now called Neptune. An example, on the other hand, of a theory which was upset by a single negative instance, is the old doctrine that bodies fall to the ground in times inversely proportioned to their weights; the experiments of Galileo from the leaning tower of Pisa once and for ever put an end to this delusion.

Bacon may possibly, however, be referring to the method of Exclusions, of which we shall hear so much in the Second Book. On this method, see Introduction, § 9. [TF]

XLVII.

Intellectus humanus illis, quae simul et subito mentem ferire et subire possunt, maxime movetur; a quibus phantasia impleri et inflari consuevit: reliqua vero modo quodam, licet imperceptibili, ita se habere fingit et supponit, quomodo se habent pauca illa quibus mens obsidetur [68]; ad illum vero transcursum ad instantias remotas et heterogeneas, [69] per quas axiomata tanquam igne probantur, tardus omnino intellectus est, et inhabilis, nisi hoc illi per duras leges et violentum imperium imponatur.

[68] The mind is unduly influenced by sudden and simultaneous impressions. A familiar example of this tendency is the unreasoning alarm often produced by railway accidents, accidents in mines, collieries, etc. Such accidents, especially if two or more occur about the same time, 'fill the imagination' and excite an alarm out of all proportion to the actual risk incurred. [TF]

[69] Thus, the phenomena of electricity are exhibited on a grand scale in thunder and lightning, which 'strike the mind suddenly and simultaneously,' but the study of these instances ' alone would never have led to the discovery of those singular and subtle laws of electricity which have been gathered from the 'remote and heterogeneous instances' that could have occurred only to the patient student of nature. [TF]

XLVIII.

Gliscit intellectus humanus, neque consistere aut acquiescere potis est, sed ulterius petit; at frustra [70]. Itaque incogitabile est ut sit aliquid extremum aut extimum mundi, sed semper quasi necessario occurrit ut sit aliquid ulterius [71]. Neque rursus cogitari potest quomodo aeternitas defluxerit ad hunc diem; cum distinctio illa, quae recipi consuevit, quod sit infinitum a parte ante, et a parte post, nullo modo constare possit; quia inde sequeretur, quod sit unum infinitum alio infinito majus, atque ut consumatur infinitum, et vergat ad finitum [72]. Similis est subtilitas de lineis semper divisibilibus, ex impotentia cogitationis. At majore cum pernicie intervenit haec impotentia mentis in inventione causarum: nam cum maxime universalia in natura positiva [73] esse debeant, quemadmodum inveniuntur, neque sunt revera causabilia; tamen intellectus humanus,

nescius acquiescere, adhuc appetit notiora [74]. Tum vero, ad ulteriora tendens, ad proximiora recidit, videlicet ad causas finales [75], quae sunt plane ex natura hominis, potius quam universi: atque ex hoc fonte philosophiam miris modis corruperunt. Est autem aeque imperiti et leviter philosophantis, in maxime universalibus causam requirere, ac in subordinatis et subalternis [76] causam non desiderare.

[70] The restless ambition of the intellect is one of the impediments to the attainment of truth. The mind ever desires to penetrate further and further into the nature and causes of things; but in vain. And hence, feeling its helplessness, it falls back upon itself, and supposes the processes of nature to be carried on with the same ends and in the same manner as the works of man.

The first sentence of this Aphorism might almost be adopted as the motto of Kant's Kritik der Reinen Vernunft, which attempts to shew the powerlessness of the human intellect in dealing with the ultimate problems of Metaphysics, while the attraction which they exercise on it is so great, that it cannot refrain from attempting their solution.

This Aphorism touches on a number of philosophical difficulties which it would be impossible within the limits of a work like the present to discuss fully or satisfactorily. I shall confine myself to a brief statement of my own opinions and to such references as I think likely to be of real use to the student. [TF]

[71] The mind is unable to think of the totality of space as finite; for, at whatever point we mentally place ourselves, we cannot but think of some point beyond it. Moreover, if space be finite, it must be bounded by some figure, that is to say, the totality of space must, on this supposition, have some shape or other; but, whether we regard it as spherical, cubical, or of any other shape, there must be some space beyond it in relation to which it is said to be of this or that shape, and in which it is contained. Hence, the proposition that Space (in its totality) is finite or bounded, involves a contradiction in terms; for bounded space must have some space beyond it. But, though we are thus compelled to think of space as infinite, can we conceive infinite space? We certainly cannot realise, imagine, or picture to ourselves infinite space, for it would take an infinity of time to do so. But this circumstance constitutes no valid reason why we should refuse to affirm a proposition, the only alternative of which has been proved to be self-contradictory. We are compelled, therefore, to assert the proposition that Space is not finite, or, in other words, that Space is infinite.

Similarly, we cannot think of time as having had a beginning, for then there would be a time before time; or as about to have an end, for then there would be a time after time. Hence, we are compelled to affirm an infinity of time, as we were before compelled to affirm an infinity of Space.

Again, though we are as little able to picture to our minds the process of infinitesimal subdivision as that of infinite addition, we are compelled by considerations, similar to those which we have already gone through, to affirm the infinite divisibility of both lines

and matter. A line, however small, must have two ends, and so be capable of bisection; an atom must have an upper and an under side, and so be capable of division.

The questions on which I have so briefly touched, and the very conception of infinity itself, have been the occasion of much controversy. The student, who wishes to acquaint himself with the main outlines of these discussions, will do well to read the chapter on 'Infinity' in Locke's Essay (Book II. Chapter 17); Kant's Kritik der Reinen Vernunft, Transcendentale Dialektik, Book II. Chapter 2 (Die Antinomie der Reinen Vernunft), where the antinomies or contradictions connected with Cause and God are discussed, as well as those connected with Space, Time, and Matter; Sir W. Hamilton's Lectures on Metaphysics, Lecture 38; Mr. Mill's Examination of Hamilton, Chapter 6; and, lastly, as a defence of Sir W. Hamilton and a reply to Mr. Mill, Dr. Mansel's ' Philosophy of the Conditioned.' The student of Kant will derive great assistance from consulting, on this subject, the work of Mr. Caird on 'The Philosophy of Kant,' pt. II. Chapters 16, 17. It must be recollected, however, that Mr. Caird's criticisms of Kant, and the extensions which he endeavours to give to Kant's philosophy, are made entirely from the Hegelian standpoint. Much of the difficulty and confusion experienced in dealing with these questions would be avoided, if the student could keep clearly before his mind the fact that the term 'infinite' simply expresses the negation of 'finite.' For 'that alone,' says Locke, 'is infinite, which has no bounds; and that the Idea of Infinity, in which our thoughts can find none.' And again, that is an infinite space or number 'which, in a constant and endless enlarging and progression, the mind can in thought never attain to.' Essay, Book II. Chapter 17. § 8. [TF]

[72] Bacon's criticism is unfortunate and could only arise from his ignorance of mathematics. In reasoning on 'infinities,' it is a first principle that the addition or subtraction of any finite quantity, however large, may, in comparison with infinity, be neglected, $\infty \pm a = \infty$. This formula is entirely independent of the value which we assign to a, provided it be finite.

With regard to the distinction between *infinitum a parte ante* and *infinitum a parte post*, it seems to me that it is not only perfectly legitimate, but that it suggests the only way in which the mind can attempt to picture to itself either infinity of time or infinity of space. We mentally take our position at some particular point or moment, usually the present, and try to conceive of an endless regress or an endless progress, as the case may be, from that point or moment. The endless progress is the *infinitum a parte ante*, the endless regress the *infinitum a parte post*. [TF]

[73] This passage is obscure, but its meaning appears to be that there are certain great laws of nature, or causes, or, as Bacon would probably have said, 'forms,' in which we. ought to acquiesce as ultimate explanations of facts. Such, to take instances from modern science, may, perhaps, be the law of gravity, the law of inertia, and the laws of chemical combination. Now Bacon can hardly mean that these laws, causes, or forms are themselves, as a matter of fact, due to no other cause, but what he does probably mean is that it is in vain for us to inquire into their cause; to us they are and must be

ultimate facts, to be taken for granted, and it is mere idle speculation to try and trace the course of nature beyond them. CP. with this passage, IL 48 (14), and specially De Augmentis Scientiarum, Libro IX. (Ellis and Spedding, Vol. I. p. 833. l. 10, etc.) See also Introduction, p. 63.

The word 'positiva' may be translated 'absolute' or 'ultimate.' It seems intended to express the opposite of 'relative' or 'dependent' that is, relative to or dependent on other causes. These facts are 'to be taken for granted 'instead of 'to be explained.' [TF]

[74] That is, natura notiora or 'still more general laws,' [TF]

[75] For the meaning of the expression 'Final Causes,' the reader may refer to the first foot-note on § 8 of the Introduction, and, for Bacon's criticism of the doctrine, to § 10.

Man projects his own aims and ideas on the Universe, and regards God or Nature as acting in the same way in which he would act himself. Thus, instead of accommodating his thoughts to Nature, he accommodates Nature to his own thoughts. Compare what is said by one of the interlocutors in Galileo's Third Dialogue: 'Great, in my judgment, is the folly of those who would have had God to have made the World more proportional to the narrow capacities of their reason, than to his immense, yea infinite power.' (Sir Thomas Salusbury's Translation, p. 335.) [TF]

[76] A logical term, denoting particular propositions in relation to their corresponding universals. Thus, Some X is Y is 'subaltern' to All X is Y. Mr. Ellis very appropriately quotes Aristotle, Metaphysics III. 4 (1006 a. 6-9). ἔστι yap ἀπαιδευσία τὸ μὴ γιγνώσκειν τίνων δεῖ ζητεῖν ἀπόδειξιν καὶ τίνων οὐ δεῖ. ὅλως μὲν γὰρ ἁπάντων ἀδύνατον ἀπόδειξιν εἶναι" εἰς ἄπειρον yap ἂν βαδίζοι, ὥστε μηδ᾽ οὕτως εἶναι ἀπόδειξιν. [TF]

XLIX.

Intellectus humanus luminis sicci non est [77]; sed recipit infusionem a voluntate et affectibus, id quod generat *ad quod vult* [78] *scientias*: quod enim mavult homo verum esse, id potius credit [79]. Rejicit itaque difficilia, ob inquirendi impatientiam; sobria, quia coarctant spem; altiora naturae, propter superstitionem [80]; lumen experientiae, propter arrogantiam et fastum, ne videatur mens versari in vilibus et fluxis; paradoxa, propter opinionem vulgi; denique innumeris modis, iisque interdum imperceptibilibus, affectus intellectum imbuit et inficit.

[77] Compare the often-quoted maxim of Heraclitus; αὔη ξηρὴ ψυχὴ σοφωτάτη or ξηρὴ ψυχὴ σοφωτάτη καὶ ἀρίστη. The authorities for these maxims are given in Ritter and Preller's Historia Philosophiae, 2nd ed., p. 26. [TF]

[78] Capricious or arbitrary. [TF]

[79] Bacon means that the Will and the Affections often exert an influence in warping our judgments. Familiar illustrations are the obstinacy with which men defend opinions to which they have once committed themselves, and the jealousy and repugnance with which they are apt to receive those of their antagonists or rivals. It was a saying of Archbishop Whately, that men are much more 'anxious to have truth on their side, than to be on the side of truth.

It does not appear to me that Bacon either states or implies that, if the Intellect were freed from the warping influences of the Will and the Affections, its conclusions would be infallibly true. A later school of English moralists, of whom Dr. Samuel Clarke is the principal representative, maintained the doctrine that the Affections are the sole cause of moral aberrations, but to ascribe this or any similar theory to Bacon would involve an anachronism and be inconsistent with the language of the preceding Aphorisms.

Spinoza, in his brief criticism of Bacon's philosophy (see his letter to Oldenburg, Epist. 2, ed. Bruder, Vol. II. pp. 146, 7), makes special reference to this Aphorism. [TF]

[80] The thought is that Superstition makes men afraid of enquiring into the 'deep things' of nature, and so determines them to refer to the action or intentions of a First Cause, what is really due to second causes. [TF]

L.

At longe maximum impedimentum et aberratio intellectus humani provenit a stupore et incompetentia et fallaciis sensuum [81]; ut ea, quae sensum feriunt, illis, quae sensum immediate non feriunt, licet potioribus, praeponderent. Itaque contemplatio fere desinit cum aspectu; adeo ut rerum invisibilium exigua aut nulla sit observatio. Itaque omnis operatio spirituum [82] in corporibus tangibilibus inclusorum latet, et homines fugit. Omnis etiam subtilior meta schematismus [83] in partibus rerum crassiorum (quem vulgo alterationem vocant, cum sit revera latio per minima [84]) latet similiter: et tamen nisi duo ista, quae diximus, explorata fuerint et in lucem producta, nihil magni fieri potest in natura quoad opera. Rursus ipsa natura aëris communis et corporum omnium, quae aërem tenuitate superant (quae plurima sunt), fere incognita est. Sensus enim per se res infirma est, et aberrans: neque organa ad amplificandos sensus aut acuendos multum valent; sed omnis verior interpretatio naturae conficitur per instantias, et experimenta idonea et apposita; ubi sensus de experimento tantum, experimentum de natura et re ipsa judicat.

[81] It is, perhaps, almost superfluous to remark that, since Bacon's time, the 'dulness, incompetency, and deceptions' of the senses have been, to a great extent, remedied by the discovery of new instruments, by methods of corrections, and by a more careful discrimination between our original perceptions and the subsequent operations of the intellect upon them. [TF]

[82] This idea of 'spirits' shut up in bodies, inanimate as well as animate, is of frequent occurrence in the 2nd Book. See, for instance, the 7th and 40th Aphorisms, where some of the statements and speculations are very curious. Immediately borrowed, perhaps, from Paracelsus, or taken generally from the physical philosophy of the day, this doctrine seems to have had a peculiar attraction for Bacon. 'The idea,' says Mr. Ellis (Preface to the Historia Vitae et Mortis, Ellis and Spedding, Vol. II. p. 94), 'on which Bacon's theory of longevity is founded, namely, that the principle of life resides in a subtle fluid or spirit which permeates the tangible parts of the organisation of plants and animals, seems to be coeval with the first origin of speculative physiology. Bacon was one of those by whom this idea was extended from organised to inorganic bodies: in all substances, according to him, resides a portion of spirit which manifests itself only in its operations, being altogether intangible and without weight. This doctrine appeared to him to be of most certain truth, but he has nowhere stated the grounds of his conviction, nor even indicated the kind of evidence by which the existence of the spiritus is to be established. In living bodies he conceived that two kinds of spirits exist: a crude or mortuary spirit, such as is present in other substances; and the animal or vital spirit, to which the phenomena of life are to be referred. To keep this vital spirit, the wine of life, from oozing away, ought to be the aim of the physician who attempts to increase the number of our few and evil days.'

This physical, or rather metaphysical, theory of a subtle, invisible, and intangible fluid or ether, permeating every material substance, whether animate or inanimate, may be regarded as a curious survival of a primitive, fetichistic era, when men literally believed that every object around them was animated or possessed by a soul or ' spirit ' similar to their own, and that this soul or spirit was itself a material, though it might be an invisible, substance. The student will find some most interesting and suggestive remarks on this subject in Dr. Tylor's Primitive Culture, Vol. II. Chapters 14, 15. [TF]

[83] Bacon appears to have adopted a theory of the ultimate constitution of matter, in some respects similar to that of the Atomists (see especially Book II. Aphorism 8); and hence his partiality for the school of Democritus. He rejected, however, the hypothesis of a vacuum, and it does not appear whether his atoms (or rather particles, as he preferred to call them) differed in material or only in shape and arrangement. Any way, all material objects, he conceived, if only we could penetrate to their ultimate structure or constitution, would be found to consist of a number of small particles, arranged in some definite manner with reference to each other. This arrangement, as it escapes detection, is called *Latens Schematismus*, and any change in it is termed *Meta-Schematismus*; moreover, as the internal process by which such change takes place is unknown to us, it is called *Latens Processus*, (See Book II. Aphorisms 6, 7; and CP. II. 48 ad fin [83.1]., where Bacon contests Democritus' theory of the rigidity or unchangeability of the atoms.) [TF]

[83.1] "ad fin." = ""ad finem" = "near the end". [HJ]

[84] It follows from Bacon's theory of the ultimate constitution of matter that any alteration (ἀλλοίωσις) in a body is simply a motion amongst the minute particles, a change in their arrangement, 'latio per minima.' [TF]

LI.

Intellectus humanus fertur ad abstracta propter naturam propriam; atque ea, quae fluxa sunt, fingit esse constantia. Melius autem est naturam secare, quam abstrahere [85]; id quod Democriti schola fecit, quae magis penetravit in naturam, quam reliquae. Materia potius considerari debet, et ejus schematismi, et meta-schematismi, atque actus purus [86], et lex actus sive motus; formae enim commenta animi humani sunt [87], nisi libeat leges illas actus formas appellare.

[85] It is better to dissect nature by means of analysis, than to form abstract theories about her, which have no foundation in fact or experiment. The work of 'abstraction' that is of forming abstract or general theories, is, of course, indispensable in the interpretation of nature, but it ought to follow and not precede the work of 'dissection,' that is, the minute examination and interrogation of natural facts. It is on account of its patience or supposed patience in the investigation of nature that the school of Leucippus and Democritus seems to have been preferred by Bacon to the other schools of antiquity. [TF]

[86] This expression is the scholastic equivalent for the Aristotelian term ἐνέργεια or ἐντελέχεια as opposed to δύναμις, and, as such, may either mean actual, as opposed to possible motion, growth, or development, or actual, as opposed to possible existence. For a δύναμις may either be a possibility of motion (taking that word in the wide sense in which it is employed by Aristotle), or a possibility of existence. If it be a possibility of existence, the existence itself, when realised, is called an ἐνέργεια or ἐντελέχεια. But, if it be a possibility of motion, we have two cases, according as the motion or process is (i) an end in itself, or (2) results in something beyond itself, an ἔργον τι. Now, in the first case, as, for instance, in walking for the sake of exercise, the actual as opposed to the possible motion may be indifferently called a κίνησις, an ἐνέργεια, and, though hardly with equal propriety, an ἐντελέχεια. In the second case, suppose we take house-building as our instance, we have (α) the mere δύναμις or possibility of house-building, (β) the process itself, οἰκοδομική, (γ) the result, τὸ ἔργον, the house. Here, οἰκοδομική, the process, ought strictly speaking to be called a κίνησις, but it is also called, though with less propriety, an ἐνέργεια or even an ἐντελέχεια; but the end or result, the house itself, can only be said to exist ἐνεργείᾳ or ἐντελεχείᾳ, and the latter expression seems the more appropriate of the two. The terms ἐνέργεια and ἐντελέχεια are often used interchangeably by Aristotle, but, strictly speaking, it would seem that ἐνέργεια (ἐνἔργῳ) should be appropriated to a motion which is an end in itself, while ἐντελέχεια (ἐν τέλει ἔχειν) ought to be appropriated to the result of a motion or process, or to actual as opposed to possible existence.

On this distinction, the student is specially recommended to read Trendelenburg's first note to De Anima, Book II. Chapter i, and to compare the passages in Aristotle's works, where the terms ἐνέργεια and ἐντελέχεια occur. He should notice particularly Metaphysics VIII. 6 and Eth. VII. 14 (8). Sir Alexander Grant treats of this distinction at some length in one of the Essays appended to his edition of Aristotle's Ethics.

'Actus Purus,' in the present passage, may mean either the process of development by which one material substance passes into another or the final result which follows from the meta-schematismus, that is to say, the change in its structure. Thus, the actus purus might either be the process by which the acorn passes into the oak or iron into rust, or it might be the oak or the rust itself. Conformably with these alternatives, 'lex actus sive motus' may denote either the law governing the process by which the final result is attained, or the law expressing the conditions of the result itself, that is to say, it may denote either a dynamical law or a statical law. 1 am inclined to think that, in this place, it has the former meaning. CP. Introduction, Section 8. [TF]

[87] He here alludes to the ἰδέαι of Plato, which were conceived as having a supra-sensible existence independent of and out of relation to matter. He himself adopts the phrase 'Forms,' but in a peculiar sense of his own, which I have discussed at length in the section of the Introduction just referred to. [TF]

LII.

Hujusmodi itaque sunt *idola*, quae vocamus *idola tribus*; quae ortum habent aut ex aequalitate substantiae spiritus humani [88]; aut ex praeoccupatione ejus; aut ab angustiis ejus; aut ab inquieto motu ejus; aut ab infusione affectuum; aut ab incompetentia sensuum; aut ab impressionis modo [89].

[88] By this singular expression he appears to mean that the human mind, being of an uniform substance, is inadequate to represent the inequalities and varieties of nature, and hence that it feigns uniformities and analogies which do not exist Cp. Aphorisms 41 and 45. [TF]

[89] These words must refer to the last Aphorism, though the meaning of the reference is not altogether clear. We are 'impressed' with the general and abstract relations of things rather than with their minute structure. The reason at once seizes on or even 'anticipates' the former, while the latter is concealed from the observation of the senses. [TF]

LIII.

Idola specus ortum habent ex propria cujusque natura et animi et corporis; atque etiam ex educatione, et consuetudine, et fortuitis. Quod genus, licet sit varium et multiplex,

tamen ea proponemus, in quibus maxima cautio est, quaeque plurimum valent ad polluendum intellectum, ne sit purus.

LIV.

Adamant homines scientias et contemplationes particulares; aut quia authores et inventores se earum credunt; aut quia plurimum in illis operae posuerunt, iisque maxime assueverunt. Hujusmodi vero homines, si ad philosophiam et contemplationes universales se contulerint, illas ex prioribus phantasiis detorquent, et corrumpunt; id quod maxime conspicuum cernitur in Aristotele, qui naturalem suam philosophiam logicae suae prorsus mancipavit, ut eam fere inutilem et contentiosam reddiderit [90]. Chemicorum autem genus, ex paucis experimentis fornacis, philosophiam constituerunt phantasticam, et ad pauca spectantem [91]: quinetiam Gilbertus, postquam in contemplationibus magnetis se laboriosissime exercuisset, confinxit statim philosophiam consentaneam rei apud ipsum praepollenti [92].

[90] Compare the far more vehement attack on Aristotle in Temporis Partus Mascuius, Cap. 2 (Ellis and Spedding, Vol. III. pp. 529, 530): 'Itaque citetur Aristoteles, pessimus sophista, inutili subtilitate attonitus, verborum vile ludibrium. Ausus etiam, turn cum forte mens humana ad veritatem aliquam casu qiiopiam tanquam secunda tempestate delata acquiesceret, injicere durissimas animis compedes, artemque quandam insaniae componere, nosque verbis addicere.' Bacon, however, is not always consistent in his abuse of Aristotle. Sometimes he speaks of him in terms of eulogy, as, for instance, in Aphorism 98 and in the following passage of the Redargutio Philosophiarum: 'Itaque hos duos viros, Platonem et Aristotelem, si quis inter maxima mortalium ingenia non numerat aut minus perspicit aut minus aequus est.'

The specific charge against Aristotle that he subordinated his natural philosophy to his logic is doubtedly founded in part on his partiality for the technical forms and terminology of the syllogism. This circumstance often obscures his argument (as we may see even in the 6th and 7th Books of the Ethics), and also often has a tendency to divert his attention from the arbitrary or questionable character of the principles on which his reasoning proceeds. But, under the phrase 'logicae suae,' Bacon probably includes not only logic' properly so called, but also the metaphysical distinctions which are of such frequent occurrence in Aristotle's works. Instead of explaining physical phenomena in their true relations or by reference to their true causes, Aristotle frequently, if not generally, deems it sufficient to bring them under his metaphysical distinctions of δύναμις and ἐνέργεια, matter, form, and privation, the four causes, the ten categories, the different kinds of motion, and the like. Of this tendency we have a notable instance in the De Coelo, where we should naturally expect to find a careful account of observed facts with reference to the earth and the heavenly bodies; instead of this account, we have interminable discussions on substance, qualities, the various kinds of motion, and other topics of a like metaphysical character. The title of this treatise, however, was not given by Aristotle himself. [TF]

[91] Bacon frequently refers to the 'Chemists' or 'Alchemists,' and generally in the same terms. See Aphorisms 64 and 73. They are criticised at length, both on their practical and speculative side, in the Redargutio Philosophiarum (Ellis and Spedding, III. 575, 576). There is also an interesting notice of them in the De Augmentis Scientiarum, Libro I. (Vol. i, p. 457).

In the word 'phantasticam,' he probably has specially in view the speculations of Paracelsus and his school; in the expression 'ad pauca spectantem' the narrow range of objects, such as the transformation of metals and the discovery of the elixir vitae, to which the Chemists or Alchemists of that time confined their attention.

Professor Playfair, in a passage already referred to, says (Encycl. Brit., Prel. Diss.): 'Chemistry in this state might be said to have an Elective Attraction for all that was most absurd and extravagant in the other parts of knowledge.' [TF]

[92] William Gilbert of Colchester (1540-1603), Court-Physician to Queen Elisabeth and author of the celebrated treatise 'De Magnete ' published in 1600, was really the founder of the sciences of Electricity and Magnetism. It is, however, indisputable that he regarded his discoveries as admitting of a wider application than was really the case. Thus, he assigned to magnetism some of the phenomena which were afterwards explained by gravitation.

Gilbert (who is repeatedly referred to by Bacon both in the Novum Organum and elsewhere) is mentioned with more respect in Book II. Aphorism 35, and with considerable respect in Book II. Aphorism 36. Mr. Spedding observes (Vol. III. p. 516): 'Bacon praises him both for his industry and his method; censuring him only for endeavouring to build a universal philosophy upon so narrow a basis.' Thus, in the following quaint passage (from the 'Aditus ad Historiam Gravis et Levis,' Ellis and Spedding, Vol. II. p. 80), he combines both praise and blame: 'Itaque vires magneticas non inscite introduxit Gilbertus, sed et ipse factus magnes; nimio scilicet plura quam oportet ad illas trahens, et navem aedificans ex scalmo.' [TF]

LV.

Maximum et velut radicale discrimen ingeniorum, quoad philosophiam et scientias, illud est; quod alia ingenia sint fortiora et aptiora ad notandas rerum differentias; alia, ad notandas rerum similitudines [93]. Ingenia enim constantia et acuta figere contemplationes, et morari, et haerere in omni subtilitate differentiarum possunt: ingenia autem sublimia et discursiva etiam tenuissimas et catholicas rerum similitudines et agnoscunt et componunt: utrumque autem ingenium facile labitur in excessum, prensando aut gradus rerum, aut umbras.

[93] This Aphorism is suggestive of an important psychological fact. The tendency to note resemblances and the tendency to note differences rarely co-exist in an equal degree. Men who have a tendency to note resemblances rather than differences have an

imaginative, and frequently a philosophical or poetical turn of mind; men who have a tendency to note differences rather than resemblances have a logical or critical turn of mind. Plato, Shakspeare, and Bacon himself (though he claims to unite both faculties; see De Interpretatione Naturae Prooemium, Ellis and Spedding, Vol. III. p. 518) furnish good instances of the one tendency, Aristotle of the other. As literature accumulates, and thought tends to lose its freshness, men seem to be apt to note differences rather than resemblances. Logic and criticism advance at the expense of poetry and creative philosophy.

Wit has frequently been defined as a faculty of noticing remote resemblances.

The student may compare with this Aphorism a passage in Kant's Kritik der Reinen Vernunft, Anhang zur transcendentalen Dialektik, ed. Hartenstein, Vol. III. p. 442 (Meiklejohn's English Translation, p. 401). [TF]

LVI.

Reperiuntur ingenia alia in admirationem antiquitatis [94], alia in amorem et amplexum novitatis effusa; pauca vero ejus temperamenti sunt, ut modum tenere possint, quin aut quae recte posita sunt ab antiquis convellant, aut ea contemnant quae recte afferuntur a novis. Hoc vero magno scientiarum et philosophiae detrimento fit, quum studia potius sint antiquitatis et novitatis, quam judicia: veritas autem non a felicitate temporis alicujus, quae res varia est; sed a lumine naturae et experientiae, quod aeternum est, petenda est. Itaque abneganda sunt ista studia; et videndum, ne intellectus ab illis ad consensum abripiatur.

[94] See Aphorism 84, and the notes on that Aphorism. [TF]

LVII.

Contemplationes naturae et corporum in simplicitate sua intellectum frangunt et comminuunt; contemplationes vero naturae et corporum in compositione et configuratione sua intellectum stupefaciunt et solvunt [95]. Id optime cernitur in schola Leucippi et Democriti, collata cum reliquis philosophiis. Illa enim ita versatur in particulis rerum, ut fabricas fere negligat; reliquae autem ita fabricas intuentur attonitae, ut ad simplicitatem naturae non penetrent: itaque alternandae sunt contemplationes istae, et vicissim sumendae; ut intellectus reddatur simul penetrans et capax; et evitentur ea, quae diximus, incommoda, atque *idola* ex iis provenientia.

[95] These are bold, and somewhat harsh, metaphors. By exclusive attention to the ultimate constitution of nature, in its minute particles, the human intellect is, as it were, broken, and frittered away; on the other hand, by the attempt to grasp nature as a whole, it evaporates and is lost in amazement. The precept with which the Aphorism concludes,

commending the combination of minute research with general speculations, is of the utmost practical importance, and could hardly be stated in more felicitous language than that in which Bacon has presented it. [TF]

LVIII.

Talis itaque esto prudentia contemplativa in arcendis et summovendis *idolis specus*; quae aut ex praedominantia, aut ex excessu compositionis et divisionis, aut ex studiis erga tempora, aut ex objectis largis et minutis, maxime ortum habent. Generaliter autem pro suspecto habendum unicuique rerum naturam contemplanti quicquid intellectum suum potissimum capit et detinet; tantoque major adhibenda in hujusmodi placitis est cautio, ut intellectus servetur aequus et purus.

LIX.

At idola fori omnium molestissima sunt; quae ex foedere verborum et nominum [96] se insinuarunt in intellectum. Credunt enim homines, rationem suam verbis imperare. Sed fit etiam ut verba vim suam super intellectum retorqueant et reflectant; quod philosophiam et scientias reddidit sophisticas et inactivas. Verba autem plerunque ex captu vulgi induntur, atque per lineas vulgari intellectui maxime conspicuas res secant [97]. Quum autem intellectus acutior, aut observatio diligentior, eas lineas transferre velit, ut illae sint magis secundum naturam; verba obstrepunt. Unde fit, ut magnae et solennes disputationes hominum doctorum saepe in controversias circa verba et nomina desinant [98]; a quibus (ex more et prudentia mathematicorum) incipere consultius foret, easque per definitiones in ordinem redigere. Quae tamen definitiones, in naturalibus et materiatis, huic malo mederi non possunt [99]; quoniam et ipsae definitiones ex verbis constant, et verba gignunt verba: adeo ut necesse sit ad instantias particulares, earumque series et ordines recurrere; ut mox dicemus, quum ad modum et rationem constituendi notiones et axiomata deventum fuerit.

[96] From the association of words and names with things.' For references illustrative of the Idola Fori, see notes on Aphorism 43. [TF]

[97] CP. Cogitata et Visa, Ellis and Spedding, Vol. III. P. 599. It sometimes happens that a word only partly expresses the conception which we wish to convey; sometimes it expresses more. There is a similar defect in the distinctions which we attempt to express by two or more contrasted words, such as organic and inorganic, animal and vegetable, rational and irrational, virtue and vice, science and art, and the like. Such words require constant rectification and definition, in order to make them express exactly what we wish to express and no more. Words, as Bacon says, are inherited from vulgar use, and hence there is often the greatest difficulty in attaching to them any precise, scientific sense, nor, even when this is done, will men always agree to accept or employ them in the sense thus attached to them. [TF]

[98] We need only instance such words as idea, sense, cause, reason, substance, etc., in mental philosophy, and cause, force, form, essence, motion, etc., in physical philosophy. The truth of this remark as applied to the questions agitated in morals, politics, and theology will be familiar to every student. [TF]

[99] Considerable confusion has arisen in the discussion of questions relating to scientific method from not observing that Definitions are of a very different character and occupy a very different position in the moral and physical sciences, on the one hand, and in the mathematical sciences, on the other. In Mathematics, the inductions by which we gain the most fundamental truths with respect to space and number are peculiarly simple and are performed with such rapidity and, for the most part, at so early an age, that we are hardly conscious of having ever gone through them. Hence, we are able almost at once to construct definitions for the purpose of explaining the most important distinctions which we either find obtruded on our notice, or think it desirable to establish. Moreover, these definitions, when constructed, do not pretend to represent concrete facts but only certain abstract relations of figures and numbers. That such relations exist, if not strictly, at least approximately, no one disputes; they can generally be expressed in a few words, which adequately and exhaustively represent them, and a single technical term is easily invented or appropriated, by means of which the definition can in future be summoned before the mind. About the adequacy or correctness of these definitions there is seldom any difference of opinion, and, even if there be, it does not affect the validity of the subsequent reasoning; for, provided that the same relation be invariably designated by the same name, and that the logical operations be correctly performed, there can be no error in the result. But, when we come to deal with the complex relations of nature and life, it is widely different. Here, Induction occupies a far more important place, and, till we have ascertained, distinguished, and classified the more important properties of the objects under investigation, it is in vain to begin the work of Definition. It is only after we have completed the inductive stage of the enquiry that we are in a position to draw up a list of definitions, or, if we venture to do so before, we ought to regard them simply as incomplete and provisional, and hold ourselves in constant readiness to review and correct them. Hence, while the inductive stage of a science is progressive, and therefore incomplete, it is natural that much controversy should turn on the definitions. 'It is necessary,' as Bacon says, 'to be constantly recurring to particular instances,' and we cannot safely reason deductively from the definitions as data, till we have firmly established the inductions on which they rest, and of which they are frequently the expressions, and, indeed, the summaries.

On the nature and place of Definition in mathematics, the student may refer to Dugald Stewart's Section, entitled 'Of Mathematical Demonstration,' in the Philosophy of the Human Mind (Hamilton's Ed., Vol. II. pp. 113-152), and Mill's Logic, Book II, Chapters 5,6; and on the distinction between 'Final and Complete' and 'Incomplete and Provisional' Definitions, to the Editor's chapter on Definitions in his Elements of Deductive Logic. [TF]

[I jump over "100" and re-start from "101", because the book goes from "99" to "1".]

LX.

Idola, quae per verba intellectui imponuntur, duorum generum sunt [101]; aut enim sunt rerum nomina, quae non sunt (quemadmodum enim sunt res, quae nomine carent per inobservationem [102]; ita sunt et nomina, quae carent rebus, per suppositionem [103] phantasticam), aut sunt nomina rerum, quae sunt, sed confusa et male terminata, et temere et inaequaliter [104] a rebus abstracta. Prioris generis sunt, fortuna [105], primum mobile [106], planetarum orbes [107], elementum ignis [108], et hujusmodi commenta, quae a vanis et falsis theoriis ortum habent. Atque hoc genus *idolorum* facilius ejicitur, quia per constantem abnegationem et antiquationem theoriarum exterminari possunt.

[101] This division of the Idola Fori is important. Sometimes we are deceived by words expressing supposed entities which have no actual existence; sometimes by words which inadequately or erroneously represent actually existing things or properties. [TF]

[102] Thus, Naturalists are constantly inventing new names for newly discovered species or varieties. The reader of Aristotle's Ethics will recollect several moral states which Aristotle describes, but designates as nameless. It hardly needs to be observed that, as a science advances, it finds names for these 'nameless' things or qualities. [TF]

[103] This word may here be used in its technical sense, for which see Sanderson's Logic, Book II. Chapter 2. [TF]

[104] CP. Aphorism 41, 'Estque intellectus' etc. We might translate inaequaliter as 'partially.' Due care has not been given to the patient examination of all the cases with ail their attendant circumstances, and to the abstraction of all disturbing influences in the human mind itself. [TF]

[105] Thus, one of the dicta ascribed to Anaxagoras is that Fortune (τύχη) is nothing more than a cause undiscovered by human reasoning, ἄδηλος αἰτία ἀνθρωπίνῳ λογισμῷ. CP. Juvenal, Sat. x. 365-6:

'Nullum numen habes, si sit prudentia: nos te
Nos facimus, Fortuna, deam coeloque locamus.' [TF]

[106] In some of the ancient systems of Astronomy, the heavens were supposed to consist of a number of hollow and concentric crystalline spheres revolving at different rates of velocity round the earth, and carrying with them the stars and planets; all these moveable spheres being contained within a fixed sphere, or empyrean heaven, which 'was supposed to be illimitable in extent and to encircle all the others. The 'primum mobile' was the outermost of the moveable spheres, and was in some systems identified with, in others distinguished from, the coelum stellatum or sphere containing the fixed stars. It was regarded as communicating a motion to all the other spheres, apart from

their proper or independent motion, and with them revolving round the earth once in twenty-four hours. [TF]

[107] These are the spheres in which the planets were supposed to be set, and by which they were supposed to be carried round the earth, each with its own peculiar motion. Dr. Kitchin quotes Milton, Paradise Lost, V. 176:

'The fixed stars, fixed in their orb that flies.'

There was supposed to be a similar sphere, external to the others, in which the fixed stars were set. See last note. The reader of Plato's Republic will remember a curious illustration of these crude astronomical theories in the Myth of Er at the end of the tenth Book. [TF]

[108] See note 61 on Aphorism 45. [TF]

At alterum genus perplexum est, et alte haerens; quod ex mala et imperita abstractione excitatur. Exempli gratia, accipiatur aliquod verbum (*humidum*, si placet), et videamus quomodo sibi constent quae per hoc verbum significantur: et invenietur verbum istud, *humidum*, nihil aliud quam nota confusa diversarum actionum, quae nullam constantiam aut reductionem patiuntur. Significat enim et quod circa aliud corpus facile se circumfundit; et quod in se est indeterminabile, nec consistere potest; et quod facile cedit undique; et quod facile se dividit et dispergit; et quod facile se unit et colligit; et quod facile fluit et in motu ponitur; et quod alteri corpori facile adhaeret, idque madefacit; et quod facile reducitur in liquidum, sive colliquatur, cum antea consisteret. Itaque quum ad hujus nominis praedicationem et impositionem ventum sit; si alia accipias, flamma humida est; si alia accipias, aer humidus non est; si alia, pulvis minutus humidus est; si alia, vitrum humidum est: ut facile appareat istam notionem ex aqua tantum et communibus et vulgaribus liquoribus, absque ulla debita verificatione, temere abstractam esse.

In verbis autem gradus sunt quidam pravitatis et erroris. Minus vitiosum genus est nominum substantiae alicujus, praesertim specierum infirmarum, et bene deductarum (nam notio cretae, luti, bona; terrae, mala): vitiosius genus est actionum, ut *generare*, *corrumpere* [109], *alterare*: vitiosissimum qualitatum (exceptis objectis sensus immediatis), ut *gravis*, *levis*, *tenuis*, *densi*, etc.; et tamen in omnibus istis fieri non potest, quin sint aliae notiones aliis paulo meliores, prout in sensum humanum incidit rerum copia [110].

[109] In Herschel's Discourse on the Study of Natural Philosophy [109.1], § 101, note, the student will find a curious example of the kind of verbal jugglery which the ancient reasoners were enabled to carry on by the vague and shifting use of such words as generation, corruption, motion, and the like. [TF]

[109.1] The full title of the book by John Frederick William Herschel (1792-1871) is "A Preliminary Discourse on the Study of Natural Philosophy", published in 1831. The quote that Fowler refers to might be the following:

"*Galileo exposes unsparingly the Aristotelian style of reasoning. The reader may take the following from him as a specimen of its quality. The object is to prove the immutability and incorruptibility of the heavens; and thus it is done:*

I. Mutation is either generation or corruption.
II. Generation and corruption only happen between contraries.
III. The motions of contraries are contrary.
IV. The celestial motions are circular.
V. Circular motions have no contraries.
α. Because there can be but three simple motions.
1 . To a centre.
2. Round a centre.
3. From a centre.
β. Of three things, one only can be contrary to one.
γ. But a motion to a centre is manifestly the contrary to a motion from a centre.
δ. Therefore a motion round a centre (i. e. a circular motion) remains without a contrary,
VI. Therefore celestial motions have no contraries — therefore among celestial things there are no contraries — therefore the heavens are eternal, immutable, incorruptible, and so forth." [HJ]

[110] That is, according to the extent of our experience of the objects. [TF]

LXI.

At *idola theatri* innata non sunt, nec occulto insinuata in intellectum [111]; sed ex fabulis theoriarum, et perversis legibus demonstrationum, plane indita et recepta. In his autem confutationes tentare et suscipere consentaneum prorsus non est illis, quae a nobis dicta sunt. Quum enim nec de principiis consentiamus, nec de demonstrationibus, tollitur omnis argumentatio. Id vero bono fit fato, ut antiquis suus constet honos [112]. Nihil enim illis detrahitur, quum de via omnino quaestio sit. Claudus enim (ut dicitur) in via antevertit cursorem extra viam. Etiam illud manifesto liquet, currenti extra viam, quo habilior sit et velocior, eo majorem contingere aberrationem.

[111] The words 'insinuata in intellectum' apply to the Idola Fori. For the various divisions of the Idola given in the different works of Bacon, see notes on Aphorisms 38, 39. We have here a trace of the old division into 'innata,' including the Idola Tribus and Idola Specus, and 'adscititia,' which were co-extensive with the Idola Theatri. Cp. pp. 174, 175. The Idola Fori, as failing under neither division, created a difficulty, and seem here to be regarded as intermediate between the two.

The two divisions of the Idola Theatri, namely, those arising from false systems of philosophy and those arising from perverse laws of demonstration, are sometimes treated by Bacon, as, for instance, in the Distributio Operis, as if they were distinct classes of Idola. Corresponding with them, he proposes to furnish in the Novum Organum a 'Redargutio Philosophiarum' and a 'Redargutio Demonstrationum.' But these 'Redargutiones,' it will be found, are not kept altogether distinct in the Aphorisms which follow. With the remaining * Idola ' corresponds the 'Redargutio Rationis humanae nativae.' CP. p. 175. [TF]

[112] In this and similar passages, which abound throughout the Novum Organum, we cannot fail to notice an air of contemptuous superiority. 'Why should I contend with the ancients for the palm of genius, when it is enough for me that I am on the right road, and they on the wrong one. Let them run as fast as they like. They will only run the further from the truth.' [112.1] [TF]

[112.1] Compare with the following passage from Lewis Carroll (1871), *Through the Looking-Glass and What Alice Found There*, Chapter 2:

"'Well, in our country,' said Alice, still panting a little, 'you'd generally get to somewhere else—if you run very fast for a long time, as we've been doing.'

'A slow sort of country!' said the Queen. 'Now, here, you see, it takes all the running you can do, to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that!'" [HJ]

Nostra vero inveniendi scientias ea est ratio, ut non multum ingeniorum acumini et robori relinquatur; sed quae ingenia et intellectus fere exaequet [113]. Quemadmodum enim ad hoc ut linea recta fiat, aut circulus perfectus describatur, multum est in constantia et exercitatione manus, si fiat ex vi manus propria, sin autem adhibeatur regula, aut circinus, parum aut nihil; omnino similis est nostra ratio. Licet autem confutationum particularium nullus sit usus; de sectis tamen et generibus hujusmodi theoriarum nonnihil dicendum est; atque etiam paulo post de signis exterioribus, quod se male habeant; et postremo de causis tantae infelicitatis et tam diuturni et generalis in errore consensus; ut ad vera minus difficilis sit aditus, et intellectus humanus volentius expurgetur et idola dimittat.

[113] Commenting on this passage, Macaulay (Essay on Bacon) says: 'This really seems to us as extravagant as it would have been in Bindley Murray to announce that every body who should learn his Grammar would write as good English as Dryden, or in , that very able writer, the Archbishop of Dublin, to promise that all the readers of his Logic would reason like Chillingworth, and that all the readers of his Rhetoric would speak like Burke. That Bacon was altogether mistaken as to this point will now hardly be disputed. His philosophy has flourished during two hundred years, and has produced none of this levelling. The interval between a man of talents and a dunce is as wide as ever; and is never more clearly discernible than when they engage in researches which require the constant use of induction.'

Bacon's promise never has been, and never can be, fulfilled. In the Inductive Sciences, there is the same scope for the play of the Imagination, for the work of the creative and inventive faculty, as in Art or Poetry; and there is at least as much occasion for acuteness and rapidity of reasoning as in what are called the exact sciences. The greatest discoveries in science have always been made by men with a keen perception of the analogies of nature, and, consequently, with an aptitude for framing bold, and, at the same time, just hypotheses. The study of scientific method may, and, I believe, does, strengthen and cultivate a man's original powers, but it can never create them or supply their place. It must not be forgotten, however, that, in the work of science, even the humblest intellect can do good service in the way of collecting and arranging materials for subsequent investigation.

I shall recur to this topic in a note on the parallel passage in Aphorism 122. [TF]

LXII.

Idola theatri, sive theoriarum, multa sunt, et multo plura esse possunt, et aliquando fortasse erunt. Nisi enim per multa jam saecula hominum ingenia circa religionem et theologiam occupata fuissent; atque etiam politiae civiles (praesertim monarchiae) ab istiusmodi novitatibus, etiam in contemplationibus, essent aversae; ut cum periculo et detrimento fortunarum suarum in illas homines incumbant, non solum praemio destituti, sed etiam contemptui et invidiae expositi; complures aliae proculdubio philosophiarum et theoriarum sectae, similes illis, quae magna varietate olim apud Graecos floruerunt introductae fuissent. Quemadmodum enim super *phaenomena* aetheris plura *themata* coeli confingi possunt; similiter, et multo magis, super *phaenomena* philosophiae fundari possunt et constitui varia dogmata. Atque hujusmodi *theatri* fabulae habent etiam illud, quod in theatro poetarum usu venit; ut narrationes fictae ad scenam narrationibus ex historia veris concinniores sint et elegantiores, et quales quis magis vellet.

In genere autem, in materiam philosophiae sumitur aut multum ex paucis, aut parum ex multis [114]; ut utrinque philosophia super experientiae et naturalis historiae nimis angustam [115] basin fundata sit, atque ex paucioribus, quam par est, pronunciet. Rationale [116] enim genus philosophantium ex experientia arripiunt varia et vulgaria, eaque neque certo comperta, nec diligenter examinata et pensitata; reliqua in meditatione atque ingenii agitatione ponunt.

[114] 'Multum ex paucis' evidently refers to the Empirical School, as described below and in many other passages, and, consequently, 'parum ex multis' must refer to the Rational or Sophistic School. But its meaning, as referred to this school, is not obvious, the charge against it usually being that it founds propositions of too wide a degree of generality on too slender a basis of fact. Can the phrase mean that the *first* inferences drawn by the Rational School, instead of being true 'axiomata infima' and therefore just covering the facts and no more, are of too vague and general a character, being based

on a cursory view of a great number of facts, to be of any service with respect to subsequent inductions? The whole passage might then be paraphrased as follows: 'The Empirical School examines minutely a small number of facts, and bases far too many inferences upon them; the Rational or Sophistic School examines cursorily a large number of facts, and infers from them too few conclusions, while those conclusions are of so vague a character as to be practically useless.' It must be remembered that the 'axiomata infima,' or *first* inferences from the facts, would, according to Bacon's ideal, be very numerous, and would furnish the basis for subsequent inductions of various degrees. [TF]

[115] In the first case, the basis of facts is too small; in the second case, the 'axiomata infima,' from which subsequent axioms are to be inferred, are too few. [TF]

[116] Called below 'Sophistic.' This division of philosophers trusts too much to mere reasoning, as the next trusts too much to mere experience. [TF]

Est et aliud genus philosophantium, qui in paucis experimentis sedulo et accurate elaborarunt, atque inde philosophias educere et confingere ausi sunt; reliqua miris modis ad ea detorquentes [117].

[117] He here probably alludes specially to Paracelsus. [TF]

Est et tertium genus eorum, qui theologiam et traditiones ex fide et veneratione immiscent; inter quos vanitas nonnullorum ad petendas et derivandas scientias a spiritibus scilicet et geniis [118] deflexit; ita ut stirps errorum et philosophia falsa genere triplex sit: *sophistica*, *empirica*, et *superstitiosa*.

[118] The allusion here is probably to the Neo-Platonists and Cabbalists, or possibly again to Paracelsus, or, perhaps, to the followers of what Bacon elsewhere calls 'Superstitious Magic.' [TF]

LXIII.

Primi generis exemplum in Aristotele maxime conspicuum est, qui philosophiam naturalem dialectica sua corrupit [119]: quum mundum ex categoriis effecerit [120]; animae humanae, nobilissimae substantiae, genus ex vocibus secundae intentionis tribuerit [121]; negotium *densi* et *rari*, per quod corpora subeunt majores et minores dimensiones sive spatia, per frigidam distinctionem actus et potentiae transegerit [122]; motum singulis corporibus unicum et proprium, et, si participent ex alio motu, id aliunde moveri, asseruerit [123]: et innumera alia, pro arbitrio suo, naturae rerum imposuerit: magis ubique sollicitus [124] quomodo quis respondendo se explicet, et aliquid reddatur in verbis positivum, quam de interna rerum veritate; quod etiam optime se ostendit in comparatione philosophiae ejus ad alias philosophias quae apud Graecos celebrabantur. Habent enim homoiomera Anaxagorae [125], atomi Leucippi et Democriti [126], coelum et terra Parmenidis [127], lis et amicitia Empedoclis [128], resolutio corporum in

adiaphoram naturam ignis et replicatio eorundem ad densum Heracliti [129], aliquid ex philosopho naturali; et rerum naturam, et experientiam, et corpora sapiunt [130]; ubi Aristotelis physica nihil aliud quam dialecticae voces plerunque sonet: quam etiam in metaphysicis sub solenniore nomine [131], et ut magis scilicet realis, non nominalis [132], retractavit. Neque illud quenquam moveat, quod in libris ejus *De animalibus*, et in *Problematibus*, et in aliis suis tractatibus, versatio frequens sit in experimentis. Ille enim prius decreverat, neque experientiam ad constituenda decreta et axiomata rite consuluit; sed postquam pro arbitrio suo decrevisset, experientiam ad sua placita tortam circumducit et captivam; ut hoc etiam nomine magis accusandus sit, quam sectatores ejus moderni (scholasticorum philosophorum genus) qui experientiam omnino deseruerunt [133].

[119] See note 90 on Aphorism 54. [TF]

[120] This may be a specific reference to the opening chapters of the De Coelo, for an account of which the student, who is not familiar with the physical works of Aristotle, may consult Mr. Lewes' Aristotle, Chapter 7 (pp. 136, etc.). Or it may refer generally to Aristotle's frequent practice of substituting for the physical explanation of a physical phenomenon its reduction to one of the Categories or to some other arbitrary metaphysical or logical distinction of his own. Or, lastly, it may mean that Aristotle dogmatically attempted to include all forms of existence under one or other of his Categories. Whether, if this last be Bacon's meaning, he has rightly interpreted Aristotle's doctrine of Categories, this is not the place to enquire. The work called the 'Categories' is of doubtful authority, but the distinction itself occurs or is implied in many other works, which are undoubtedly Aristotelian.

There is a parallel passage in the Cogitata et Visa (Ellis and Spedding, Vol. III. p. 601): 'Hujus autem philosophiae [sc. [120.1] Philosophiae Naturalis, quam a Graecis accepimus] jam consensu principem Aristotelem, Intacta fere ac illibata Natura, in communibus notionibus, atque earum inter se compa-ratione, collisione, et reductione inutiliter versatuni esse. Neque sane quicquam solidi ab eo sperari, qui etiam mundum e categoriis effecerit: Parum enim interesse, utitim quis materiam formam et privationem, an substantiam qualitatem et relationem, principia lerum posuerit.' [TF]

[120.1] Abbreviation 'sc.' = "Scilicet" = "it is permitted to know" ("namely"). [HJ]

[121] This is probably a criticism of a passage in the De Anima, II. i (5), which, however, applies, not to the human soul only, but to life in general: διὸ ψυχή ἐστιν ἐντελέχεια ἡ πρώτη σώματος φυσικοῦ δυνάμει ζωὴν ἔχοντος, Without some explanation of this definition, Bacon's criticism is unintelligible, and, bearing in mind the account, given in note E;6 on Aphorism 51, of the technical terms ἐνέργειά and ἐντελέχεια, this explanation may easily be supplied.

The lifeless body, as, for instance, the embryo, may be regarded as capable of life. It attains its actuality, as soon as it begins to live. Thus, ψυχή is the actual manifestation

(ἐντελέχεια) of - that life which every organized body has potentially. But why ἡ πρώτη? We must recollect that δύναμις and ἐνέργεια or ἐντελέχεια are purely relative terms; what is a δύναμις in one relation may be an ἐνέργεια or ἐνέργεια in another. Now Ψυχή, as we have seen, is the ἐνέργεια or ἐντελέχεια of σῶμα, but σῶμα, when once manifested, begins to perform various functions (such as, in the case of man, are perception, thought, etc.). These acts or functions are themselves ἐνέργειαι, of which ψυχή, its dormant state, may be regarded as the δύναμις., Hence, while the manifestations of Ψυχή are, as it were, δεύτεραι ἐνέργειαι, ψυχή itself is a πρώτη ἐνέργεια.

That the technical terms of which the definition of ψυχή is composed represent 'second intentions' or 'second notions' is plain enough. The student, who is not acquainted with the distinction between 'first' and 'second' notions, should refer to Sir W. Hamilton's Essay on Logic (Discussions, p. 139) or Dr. Hansel's edition of Aldrich's Logic, Cap. I. § 3. div, 8, note. It is possible, however, that Bacon may use the phrase in its later sense, as employed by Aldrich and others, in which case it is equally applicable to the terms of the definition criticised. [TF]

[122] Bacon is here probably referring to a passage in the Physics, IV. 5 (6) [p. 213 a. 1-4]: οὕτω δὲ Kal ἀὴρ ἔχει πρὸς ὕδωρ" οἷον ὕλη yap, τὸ δ᾽ εἶδος, τὸ μὲν ὕδωρ ὕλη ἀέρος, ὁ δ᾽ ἀὴρ οἷον ἐνέργειά τις ἐκείνου: τὸ γὰρ ὕδωρ δυνάμει ἀήρ ἐστιν, ὁ δ᾽ ἀὴρ δυνάμει ὕδωρ ἄλλον τρύπον. Water is regarded as condensed air, and air as rarefied water, and, therefore, either may, in a certain sense, be regarded as being the other potentially. 'Actus' and 'potentia,' of course, correspond respectively with ἐνέργεια and δύναμις.

Mr. Ellis in his Preface to the Historia Densi et Rari (Vol. II. pp. 236-7) refers to another passage in Aristotle (Categ. Chapter 8. p. 10 a. 16-24), where the dense and the rare are explained as due to different modes of the disposition of particles, the particles in dense bodies being near one another, and in rare bodies standing further apart. [TF]

[123] This is an allusion to the Scholastic distinction of 'Motus Proprius' and 'Motus Alienus.' All bodies were supposed to have some one motion, and one motion only, proper to them. But, in addition to this motion, they might participate in one or more other motions communicated to them by other bodies. Thus, for instance, the wheel of a watch has a proper motion of one kind only, but, besides this, it may share in the motion of the watch, and the wearer of the watch. And if the wearer of the watch is sailing on the sea, it may participate in no less than four 'extraneous and common' motions, namely the motion of the wearer, the motion of the ship, the motion of the sea, and, when the wearer breathes, the motion of the watch itself. This distinction is often applied by Aristotle to the motions of the heavenly bodies. See, for instance, De Coelo, II. 13 (p. 293 a. 1, etc.), Phys. VIII. 6 (259 b. 28, Sec.). CP. De Coelo, II. 14 (296 b. 27, Sec.). The Aristotelian terms by which Proper Motion is expressed are οἰκείᾳ or ἴδιος φορά. [TF]

[124] This tendency is abundantly exemplified in Aristotle's physical works. He is so anxious to solve every difficulty which presents itself to his mind, that he is seldom content with a bare statement of facts, without starting some theory in explanation of them. As a consequence of this tendency, the facts are often very meagre, and the theories very crude. [TF]

[125] τὰ ὁμοιομερῆ may denote either aggregates composed of like parts, or these ' like parts ' themselves. Anaxagoras maintained that there was an infinity of elements, some of which were homogeneous with others, though in the original chaos they were all mixed up in inextricable confusion. Thus, there existed from the first particles of flesh, bone, etc., which, by a process of σύγκρισις and διάκρισις, have been disentangled from the disorderly mass and fashioned by or the Supreme Intelligence into flesh, bone, etc., as we now find them in the κόσμος or orderly universe. Πάντα χρήματα ἦν ὁμοῦ" εἶτα νοῦς ἐλθὼν αὐτὰ διεκόσμησε. See Metaphysics I. 3.

For the various philosophical theories mentioned in this paragraph, the student should refer to the passages collected in Ritter and Preller's Historia Philosophiae, as well as to some good History of Philosophy, such as that of Ueberweg or Zeller. [TF]

[126] These atoms, unlike the homoiomera of Anaxagoras, had no qualitative difference. They were supposed to differ only in shape (σχήματι) as A and N, or arrangement (τάξει) as AN and NA, or position (θέσει) as Z and N. The κόσμος resulted from these atoms through ἀνάγκη. See Metaphysics I. 4. The atoms of Democritus were conceived of as rigid and unchangeable (non fluxae), as having existed from eternity, and as moving *in vacuo*. Bacon combats these various positions in Novum Organum II. 8, 48 ad fin., and other parts of his works. [TF]

[127] Coelum et terra = πύρ καὶ γῆ. It is questionable how far Parmenides intended to express physical conceptions by these words, and how far he intended them to be simply symbolic of the metaphysical contrast of being and non-being. Τούτων δέ, says Aristotle, τὸ μὲν κατὰ τὸ ὂν, τὸ θερμὸν τάττει, θάτερον δὲ κατὰ τὸ μὴ ὄν. See Metaphysics 1.' S* The student might Iiere, with advantage, consult Schwegler's History of Philosophy, in addition to Ueberweg and Ritter and Preller. [TF]

[128] The well-known four elements of Empedocles, which were generally accepted till a comparatively recent date, were supposed by him to have been mixed up at first in chaotic confusion. In order to produce the κόσμος, they required to be separated and then re-combined in orderly proportion. The agents in this process were respectively νεῖκος and φιλία., See Metaphysics I. 4. [TF]

[129] By fire Heraclitus understood not flame, but a kind of warm, dry ether or refined air, which he identified with soul and with the Divine Spirit. This fire was regarded as undergoing a constant process of evolution (πάντα pei). By condensation it passes into the other and grosser elements, and then these by rarefaction pass back again into it. Being thus, as it were, the common element or basis, the ὕλη, so to speak, of all other

existences, it may be regarded as itself ‘without distinctive properties,’ or ‘adiaphora.’ [TF]

[130] The student who has acquainted himself with the speculations of the last three philosophers whom Bacon cites will hardly be disposed to accord to them this praise. Their conceptions and theories, when divested of the metaphorical language in which they are clothed, are certainly of a metaphysical rather than a physical character. Of Anaxagoras and Democritus the same remark is also, to some extent, true. [TF]

[131] This phrase convicts Bacon of a literary error. The books entitled Metaphysics (τὰ μετὰ τὰ φυσικά) were so called simply because of the place. assigned to them in the collected works of Aristotle, as next to the Physics. The designation of these books has, however, been the origin of the terms Metaphysics, Metaphysical, etc. Aristotle himself calls the science treated of in the ‘Metaphysics’ σοφία, θεολογικῆ, ΟὐΡ πρώτη ἐπιστήμη. [TF]

[132] The question whether Aristotle was a realist, a nominalist, or a conceptualist has been frequently debated. Confining ourselves to the issue between the nominalists and realists, the general drift of his writings and a majority of individual passages would favour the alternative that, had the precise question between Nominalism and Realism been raised in his time, he would have adopted the nominalist solution of the question as to the nature of Universals. The most emphatic passage, perhaps, in support of this view is that in the Categories, Chapter 5 (p. 2 a. 11 etc.): Οὐσία δέ ἐστιν ἢ κυριώτατά ΤΕ καὶ πρώτως καὶ μάλιστα λεγομένη, ἢ μήτε καθ᾽ ὑποκειμένου τινὸς λέγεται μήτ᾽ ἐν ὑποκειμένῳ τινί ἐστιν, οἷον ὁ τὶς ἄνθρωπος ἢ ὁ τὶς ἵππος. Δεύτεραι δὲ οὐσίαι λέγονται, ἐν οἷς εἴδεσιν αἱ πρώτως οὐσίαι λεγόμεναι ὑπάρ- χουσι, ταῦτά τε καὶ τὰ τῶν εἰδῶν τούτων γένη, οἷον ὁ τὶς ἄνθρωπος ἐν εἴδει μὲν ὑπάρχει τῷ ἀνθρώπῳ, γένος δὲ τοῦ εἴδους ἐστὶ τὸ ζῷον᾽ δεύτεραι οὖν αὗται λέγονται οὐσίαι, οἷον 6 τε ἄνθρωπος καὶ τὸ ζῷον. . .. Τῶν δὲ δευτέρων οὐσιῶν μᾶλλον οὐσία τὸ εἶδος τοῦ γένους" ἔγγιον γὰρ τῆς πρώτης οὐσίας ἐστίν. CP. p. 3, b. I0-23. Some suspicion, however, attaches to the genuineness of the two first treatises included in the Organon. Still, independently of the Categories, the balance of evidence is in favour of ranking Aristotle amongst the opponents of the doctrines which were subsequently designated as Realist; though he certainly seems to have held the doctrine of absolute differentiae, and of a fixed and definite series of subordinate genera and species intervening between the summa genera and the infimae species (see especially Top. IV. 2; IV. 6; vi. Chapters 2-6: Post. An. II. 13). It must be remembered, however, that the precise question agitated by the Schoolmen had not been raised in his time. On the subject of Aristotle’s opinions in relation to this controversy, it is impossible to enter here at any length, but the student may read with advantage Hauréau’s Histoire de la Philosophie Scolastique, Chapter 5, and Ueberweg’s History of Philosophy, On Aristotle’s Metaphysics (Translation, Vol. I. pp. 160-1). [TF]

[133] On experiment as. employed and interpreted by Aristotle, and generally on the reasons of Aristotle's comparative failure in the Physical Sciences, see Introduction, § il. [TF]

LXIV.

At philosophiae genus *empiricum* placita magis deformia et monstrosa educit, quam *sophisticum* aut rationale genus; quia non in luce notionum vulgarium (quae licet tenuis sit et superficialis, tamen est quodammodo universalis, et ad multa pertinens) sed in paucorum experimentorum angustiis et obscuritate fundatum est. Itaque talis philosophia illis, qui in hujusmodi experimentis quotidie versantur atque ex ipsis phantasiam contaminarunt, probabilis videtur et quasi certa; caeteris, incredibilis et vana. Cujus exemplum notabile est in chemicis, eorumque dogmatibus; alibi autem vix hoc tempore invenitur, nisi forte in philosophia Gilberti [134]. Sed tamen circa hujusmodi philosophias cautio nullo modo praetermittenda erat; quia mente jam praevidemus et auguramur, si quando homines, nostris monitis excitati, ad experientiam se serio contulerint (valere jussis doctrinis sophisticis), tum demum, propter praematuram et praeproperam intellectus festinationem, et saltum sive volatum ad generalia et rerum principia, fore ut magnum ab hujusmodi philosophiis periculum immineat; cui malo etiam nunc obviam ire debemus.

[134] On the Chemists or Alchemists and Gilbert, see notes 91, 92 on Aphorism 54. [TF]

LXV.

At corruptio philosophiae ex *superstitione*, et theologia admista, latius omnino patet, et plurimum mali infert, aut in philosophias integras, aut in earum partes. Humanus enim intellectus non minus impressionibus phantasiae est obnoxius, quam impressionibus vulgarium notionum. Pugnax enim genus philosophiae et *sophisticum* illaqueat intellectum: at illud alterum phantasticum, et tumidum, et quasi poeticum, magis blanditur intellectui [135]. Inest enim homini quaedam intellectus ambitio, non minor quam voluntatis; praesertim in ingeniis altis et elevatis.

[135] The one school ensnares the intellect by its specious and fallacious reasonings; the other flatters it by exciting its ambition to penetrate to ultimate causes. Aphorism 48 furnishes a good commentary on the words 'blanditur intellectui.' [TF]

Hujus autem generis exemplum inter Graecos illucescit, praecipue in Pythagora [136], sed cum *superstitione* magis crassa et onerosa conjunctum; at periculosius et subtilius in Platone [137] atque ejus schola [138]. Invenitur etiam hoc genus mali in partibus philosophiarum reliquarum, introducendo formas abstractas [139], et causas finales, et causas primas [140]; omittendo saepissime medias, et hujusmodi. Huic autem rei summa adhibenda est cautio. Pessima enim res est errorum *apotheosis* [141], et pro peste intellectus habenda est, si vanis accedat veneratio. Huic autem vanitati nonnulli ex

modernis [142] summa levitate ita indulserunt, ut in primo capitulo Geneseos, et in libro Job, et aliis Scripturis sacris, philosophiam naturalem fundare conati sint; inter *viva quaerentes mortua* [143]. Tantoque magis haec vanitas inhibenda venit, et coercenda, quia ex divinorum et humanorum malsana admistione non solum educitur philosophia phantasica, sed etiam religio haeretica. Itaque salutare admodum est, si mente sobria fidei tantum dentur quae fidei sunt.

[136] As in his mystical theories about numbers, his doctrines of metempsychosis, of the harmony of the spheres, etc. On the personal character of Pythagoras, and his position as the founder of a religious brotherhood, there is an excellent chapter in Grote's History of Greece. See pt. II. Chapter 37. [TF]

[137] The allusion is, perhaps, specially to the theory of Ideas, and to the use made by Plato of Final Causes and Divine Agency in dialogues such as the Timaeus.

CP. Cogitata et Visa (Ellis and Spedding, Vol. III. pp. 601-2): 'Eundem (sc. Platonem) Naturam non minus. Theologia quam Axistotelem Dialectica inficere: et si veruni dicendum est, tarn prope ad poetae, quam iilum ad sophistae partes accedere.'

In the Temporis Partus Masculus, the attack on Plato is far more vehement: 'Citetur jam et Plato, cavillator urbanus, tumidus poeta, theologus mente captus,' etc. See Ellis and Spedding, Vol. III. pp. 530-1. [TF]

[138] The reference may be either to the immediate followers of Plato, that is to the Old Academy, or to the Neoplatonists, called in Aphorism 96 'secunda schola Platonis.' To the latter, whose philosophy was mainly mystical, it would be peculiarly applicable. To the New Academy, which was properly 'secunda schola Platonis,' it would be inapplicable, as the tendencies of that school were of quite a different character. [TF]

[139] Forms abstracted from matter, as opposed to determined in matter. Some of the more extreme realists maintained that forms or essences had an existence independent of and anterior to the individual objects in which they are manifested. This was the doctrine of 'universalia ante rem.' [TF]

[140] Bacon always insists on referring physical events to physical causes, and not, as was far more frequently the case in his time than our own, to the immediate action of God. Cp. Advancement of Learning, Book i, (E, and S., Vol. III. p. 267): 'For certain it is that God worketh nothing in nature but by second causes; and if they would have it otherwise believed, it is mere imposture, as it were in favour towards God; and nothing else but to offer to the author of truth the unclean sacrifice of a lie.' In the corresponding passage of the De Augmentis Scientiarum, Book I. (Ellis and Spedding, Vol. I. p. 436), he speaks rather more cautiously: 'Liquet enim Deum nihil operari ordinario in natura nisi per secundas causas,' etc. [TF]

[141] CP. the Temporis Partus Masculus (Ellis and Spedding, Vol. III. p. 531), where, in addressing Plato, he says: 'Deinde etiam tu scelere baud minore stultitiae apotheosin introduxisti, et vilissimas cogitationes religione munire ausus es.' [TF]

[142] Bacon is probably alluding more especially to his contemporary Dr. Robert Fludd (b. 1574, d. 1637), whose writings present a strange jumble of physics, theology, and mysticism. He was the author of many works on science and medicine, but the one to which Bacon probably here alludes is that entitled: 'Utriusque Cosmi metaphysica, physica atque technica historia,' published in 1617. A second volume of this work appeared in 1619, with the quaint title: 'Tomus Secundus De Supernaturali, Naturali, Praetematurali, et Contranaturali Microcosmi historia.' Any one acquainted with the history of Geology will recall many striking illustrations, some of them comparatively recent, of Bacon's criticism. [TF]

[143] See Luke XXIV. 5. CP. De Augmentis Scientiarum, Libro IX. (Ellis and Spedding, Vol. I. p. 835): 'At in interpretandi modo Soluto duo interveniunt excessus: alter ejusmodi praesupponit in Scripturis perfectionem, ut etiam oinnis philosophia ex earum fontibus peti debeat; ac si philosophia alia quaevis res profana esset et ethnica. Haec intemperies in schola Paracelsi praecipue, necnon apud alios invaluit: initia autem ejus a Rabbinis et Cabalistis defluxerunt. Verum istiusmodi homines non id assequnntur quod volunt; neque enim honorem, ut putant, Scripturis deferunt; sed easdem potius deprimunt et polluunt, Coeium enim materiatum et terram qui in Verbo Dei quaesiverit (de quo dictum est; Coeliwi et Terra pertransibunt Verbum autem meum non pertransibit), is sane transitoria inter aeterna temere persequitur. Quemadmodum enim Theoiogiam in Philosophia quaerere, perinde est ac si vivos qiiaeras inter mortuos; ita e contra Phiiosophiam in Theologia quaerere, non aliud est quam mortuos quaerere inter vivos.'

We must recollect that sentiments of this kind, which with us have become common-places, were in Bacon's time novel and almost paradoxical. The attempt to find a solution of scientific questions in the Scriptures, and the practice of opposing Scriptural authority to scientific conclusions, have hardly even yet become obsolete; but, in Bacon's time, they were the rule, while with us they are the exception. [TF]

LXVI.

Et de malis authoritatibus philosophiarum, quae aut in *vulgaribus notionibus*, aut in *paucis experimentis*, aut in *superstitione* fundatae sunt, jam dictum est. Dicendum porro est et de vitiosa materia contemplationum [144], praesertim in philosophia naturali. Inficitur autem intellectus humanus ex intuitu eorum quae in artibus mechanicis fiunt, in quibus corpora per compositiones aut separationes ut plurimum alterantur; ut cogitet simile quiddam etiam in natura rerum universali fieri [145]. Unde fluxit commentum illud elementorum, atque illorum concursu [146], ad constituenda corpora naturalia Rursus, quum homo naturae libertatem contemplatur, incidit in species rerum, animalium, plantarum, mineralium; unde facile in eam labitur cogitationem, ut existimet esse in natura quasdam formas rerum primarias, quas natura educere molitur: atque reliquam

varietatem ex impedimentis et aberrationibus naturae in opere suo conficiendo, aut ex diversarum specierum conflictu, et transplantatione alterius in alteram, provenire [147]. Atque prima cogitatio qualitates primas elementares [148], secunda proprietates occultas et virtutes specificas [149] nobis peperit; quarum utraque pertinet ad inania contemplationum compendia, in quibus acquiescit animus et a solidioribus avertitur. At medici in secundis rerum qualitatibus et operationibus, attrahendi, repellendi, attenuandi, inspissandi [150], dilatandi, astringendi, discutiendi, maturandi, et hujusmodi, operam praestant meliorem; atque, nixi ex illis duobus (quae dixi) compendiis (qualitatibus scilicet elementaribus, et virtutibus specificis) illa altera (quae recte notata sunt) corrumperent, reducendo illa ad primas qualitates earumque mixturas subtiles et incommensurabiles, aut ea non producendo cum majore et diligentiore observatione ad qualitates tertias et quartas, sed contemplationem intempestive abrumpendo, illi multo melius profecissent. Neque hujusmodi virtutes (non dico eaedem, sed similes) in humani corporis medicinis tantum exquirendae sunt; sed etiam in caeterorum corporum naturalium mutationibus.

[144] He now passes from erroneous modes of philosophising, sophistic, empiric, and superstitious, to fictitious or ill-selected objects of investigation, such as typical forms, specific virtues, occult properties, and the like. [TF]

[145] This error consists in supposing that all the processes of nature may be explained by the idea of Mechanical Composition. On the confusion between chemical and mechanical composition, the student may refer to Mill's Logic, Book III. Chapter 6. Hence, says Bacon, has arisen the fiction of elementary qualities. These were enumerated by the Peripatetics, following Aristotle, as hot and cold, dry and moist. The four elements were
supposed to result from combinations of these elementary qualities, taken two and two together. Thus fire is constituted by the combination of hot and dry; water by that of cold and moist, and so on. Out of the four elements themselves, are composed the various natural bodies, as we actually find them.

Bouiliet notices that, in the Thema Coeli (Ellis and Spedding, Vol. III. p. 777), hardness and softness are counted amongst the 'elementary qualities.' [TF]

[146] We must obviously read either concursus, or deque instead of atque. [TF]

[147] This is an excellent statement of the hypothesis by which the Realists attempted to account at once for the permanence and variety in the forms of animal and vegetable life. The 'primary forms' or types were, according to the strictest and most consistent school of Realists, supposed to have existed prior to any of the individual objects in which they are embodied. These types 'natura educere molitur.'

It is, perhaps, superfluous to remark that, since the publication of Mr. Darwin's work on the 'Origin of Species,' the questions glanced at in this paragraph have assumed, even

amongst those who do not accept Mr. Darwin's hypotheses, an altogether different form and received an altogether different solution from that which was formerly current.

[148] See note 45. All the remaining qualities of bodies were called secondary. This distinction is, of course, quite different from that of the primary and secondary qualities of bodies, as stated by Descartes, Locke, and subsequent writers. See Hamilton on Reid, pp. 836-7. [TF]

[149] CP. Newton's Optics, Book III. (Works, Ed. Horsley, Vol. IV. p. 261), where, speaking of the Principles of Motion, he says: 'And the Aristotelians gave the name of Occult qualities not to manifest qualities, but to such qualities only as they supposed to lie bid in bodies, and to be the unknown causes of manifest effects: such as would be the causes of gravity, and of Magnetic and Electric attractions, and of fermentations, if we should suppose that these forces, or actions, arose from qualities unknown to us, and incapable of being discovered and made manifest Such Occult qualities put a stop to the improvement of Natural Philosophy, and therefore of late years have been rejected. To tell us, that every species of things is endowed with an occult specific quality, by which it acts and produces manifest effects, is to tell us nothing: but to derive two or three general principles of motion from phaenomena, and afterwards to tell us how the properties and actions of all corporeal things follow from those manifest principles, would be a very great step in philosophy, though the causes of those principles were not yet discovered: and therefore I scruple not to propose the principles of motion above-mentioned, they being of very general extent, and leave their causes to be found out.'

The conceptions of 'occult properties' and 'specific virtues' belong to that stage of speculation in which men believed that the properties of objects were distinct entities, separable, as it were, from the objects themselves, and dwelling in them. In a still prior stage of speculation, these properties had been personified and regarded as divine. See Mommsen's History of Rome, Book I. Chapter 12 (Dickson's Translation, Vol. I. pp. 171-3), and Tylor's Primitive; Culture, Chapter 15 (Vol. II. first ed. pp. 220-223, second ed. pp. 242-246). [TF]

[150] 'Inspissandi stands over against Attenuandi; its meaning being "condensation." It does not occur in [classical] Latin writers.' (Dr. Kitchin's note.) [TF]

Sed multo adhuc majore cum malo fit, quod quiescentia rerum principia, *ex quibus* [151]; et non moventia, *per quae* res fiunt, contemplentur et inquirant. Illa enim ad sermones, ista ad opera spectant. Neque enim vulgars illae differentiae motus, quae in naturali philosophia recepta notantur, *generationis*, *corruptionis*, *augmentationis*, *diminutionis*, *alterationis*, et *lationis* [152], ullius sunt pretii. Quippe hoc sibi volunt; si corpus, alias non mutatum, loco tamen moveatur, hoc lationem esse; si, manente et loco et specie, qualitate mutetur, hoc *alterationem* esse; si vero ex illa mutatione moles ipsa et quantitas corporis non eadem maneat, hoc *augmentationis* et *diminutionis* motum esse; si eatenus mutentur, ut speciem ipsam et substantiam mutent, et in alia migrent, hoc *generationem* et *corruptionem* esse. At ista mere popularia sunt, et nullo modo in

naturam penetrant; suntque mensurae et periodi tantum, non species motus. Innuunt enim illud, *hucusque*, et non *quomodo*, vel *ex quo fonte*. Neque enim de corporum appetitu, aut de partium eorum processu, aliquid significant; sed tantum quum motus ille rem aliter ac prius, crasso modo, sensui exhibeat, inde divisionem suam auspicantur. Etiam quum de causis motuum aliquid significare volunt, atque divisionem ex illis instituere, differentiam motus naturalis et violenti, maxima cum socordia, introducunt; quae et ipsa omnino ex notione vulgari est; cum omnis motus violentus etiam naturalis revera sit, scilicet cum externum efficiens naturam alio modo in opere ponet quam quo prius.

[151] The third error arises from concentrating our attention too exclusively on the ^ principia ex quibus,' to the neglect of the 'principia per quae/ that is, on the material to the neglect of the efficient cause. For practical puiposes, it is far more important to ask how a thing may be produced, than what it is. Bacon's frequent remarks on the Latens Schematismus and on the Atomistic Philosophy shew, however, the importance which he attached to the enquiry into the Material Cause, and, in the De Augmentis Scientiarum (Libro III. Cap. 4), he specifies the Material and Efficient Causes as the appropriate objects of Physics, the Final and Formal Causes being relegated to. Metaphysics. [TF]

[152] See Categories, Chapter 14 (p. 15 a. 13, 14): Κινήσεως δέ ἐστιν εἴδη ἕξ, γένεσις, φθορά, αὔξησις, μείωσις, ἀλλοίωσις, ἡ κατὰ τόπον μεταβολή. In the Physics, Book V. Chapter i (p, 325 a. 25-34), γένεσις and φθορά are excluded from the divisions of motion. The only one of these divisions which we call motion is ἡ κατὰ τόπον μεταβολή or latio, or, as it is sometimes less properly called by Aristotle, φορά. The others are motions amongst the parts of the body, not motion of the body as a whole. For the above use of φορά, see Phys. V. 2. 226 a. 33; VIII. 7. 260 a. 26-9. But, sometimes, φορά, is regarded as only a particular species of ἡ κατὰ τόπον μεταβολῆ. See Top. IV. 2. p. 122 b. 25-35, and CP. 226 a. 34 — b. 1. [TF]

At hisce omissis; si quis (exempli gratia) observaverit, inesse corporibus appetitum contactus [154] ad invicem, ut non patiantur unitatem naturae prorsus dirimi aut abscindi, ut vacuum detur: aut si quis dicat, inesse corporibus appetitum se recipiendi in naturalem suam dimensionem vel tensuram [155], ut, si ultra eam aut citra eam comprimantur aut distrahantur, statim in veterem sphaeram et exporrectionem suam se recuperare et remittere moliantur: aut si quis dicat, inesse corporibus appetitum congregationis ad massas connaturalium suorum, densorum videlicet versus orbem terrae, tenuiorum et rariorum versus ambitum coeli [156]: haec et hujusmodi vere physica sunt genera motuum. At illa altera plane logica sunt et scholastica, ut ex hac collatione eorum manifesto liquet.

[154] This clause, as Dr, Kitchin says, embodies 'a dim notion of attraction, based on the old opinion as to Nature's abhorrence of a Vacuum.' It is, perhaps, needless to add that the fact of attraction of adhesion (for it is to this that Bacon appears to allude) has been established by subsequent researches, whereas the theory that 'Nature abhors a

vacuum' has long ago been exploded. On the latter theory and the experiments which led to its final abandonment, see Herschel's Discourse on the Study of Natural Philosophy, §§ 244-246. [TF]

[155] This is obviously a description of the phenomenon of Elasticity. [TF]

[156] CP. II. 48 (7). Bacon is peculiarly unfortunate in his illustration of the notion of Affinity. The aggregation of bodies or rather particles which are chemically homogeneous into large masses is an undoubted fact, but the affinity of heavy things for the earth and of light things for the sky is a mere fancy, implying the now exploded theory of absolute levity. Heavy and light are, of course, only relative terms, and are better expressed by more or less heavy; all bodies possessing weight, however various it may be in amount. On the supposed substance Phlogiston, which was regarded as essentially light, and the reasoning by which its existence has been disproved, see Herschel's Discourse on the Study of Natural Philosophy, § 336. The notion of absolute levity is connected with that of natural motion, discussed under note 53 on this Aphorism. [TF]

Neque minus etiam malum est, quod in philosophiis et contemplationibus suis, in principiis rerum atque ultimatibus naturae investigandis et tractandis, opera insumatur; cum omnis utilitas et facultas operandi in mediis consistat [157]. Hinc fit, ut abstrahere naturam homines non desinant, donec ad materiam potentialem et informem [158] ventum fuerit; nec rursus secare naturam desinant, donec perventum fuerit ad atomum; quae, etiamsi vera essent, tamen ad juvandas hominum fortunas parum possunt [159].

[157] The fifth and last error under this head consists in the neglect of intermediate axioms, and the excessive attention paid to the principles of things and the ultimate constitution of nature. CP. Aphorism 104, where this idea is still further expanded. It is undoubtedly true that the practical applications of science are usually deduced from axiomata media rather than from the highest generalisations, but these last are, at the same time, indispensable to the complete constitution of a science. To be of scientific value, however, they must not be mere intellectual abstractions, but duly based on facts and capable of verification, 'talia scilicet, quae non abstracta sint, sed per haec media vere limitantur.' [TF]

[158] The ὕλη of the Greek Philosophers. [TF]

[159] This remark is hardly consistent with Bacon's frequent praise of Democritus, or with the importance which he attaches to the discovery of the latens processus and the latens schematismus (see especially Book II. Aphorisms 6-9).

From a full consideration of the various passages in which he alludes to, or discusses the question, I am of opinion that Bacon, while adopting the atomic theory as to the ultimate constitution of matter, rejected the vacuum by which the minute particles were supposed to be separated, as well as the eternal, rigid and unchangeable character

ascribed to the particles or atoms themselves. Hence the varying terms in which he speaks of Democritus. See my notes on I. 63, II. 8 ad init., II. 48 (2), and II. 48 (conclusion). [TF]

LXVII.

Danda est etiam cautio intellectui de intemperantiis philosophiarum, quoad assensum praebendum aut cohibendum; quia hujusmodi intemperantiae videntur *idola* figere, et quodammodo perpetuare, ne detur aditus ad ea summovenda.

Duplex autem est excessus: alter eorum, qui facile *pronunciant*, et scientias reddunt positivas et magistrales; alter eorum, qui *acatalepsiam* introduxerunt, et inquisitionem vagam sine termino; quorum primus intellectum deprimit, alter enervat. Nam Aristotelis philosophia, postquam caeteras philosophias (more Ottomanorum erga fratres suos) pugnacibus confutationibus contrucidasset [160], de singulis pronunciavit; et ipse rursus quaestiones ex arbitrio suo subornat, deinde conficit; ut omnia certa sint et decreta [161]: quod etiam apud successiones suas valet et in usu est.

[160] CP. Campanella, Metaphysics Libro I. Prooemium: 'Ambitione Aristotcles volens videri omnium sapientissimus, dogmata antiquomm falsificat, impugnat, et torquet, et furatur, contraria dicens et sentiens, ut inquit Lactantius in eum, et Patres multij et D. Thom. 4 de Reg. Princ. 4, et quam ipse ignorat veritatem, proponit tanquam sdens, tegendo suam ignorantiam argutiis et eorum contemptu.' Several other passages to the same effect from writers anterior to or contemporary with Bacon are quoted in the Introduction, § 12. [TF]

[161] Bacon here undoubtedly exaggerates Aristotle's tendency to dogmatism. The student of Aristotle will recall several passages where, after stating different solutions of a question, the author leaves his own opinion doubtful. This occasional uncertainty as to the precise character of his own conclusions is, in fact, one of the main sources of difficulty to those who are beginning the study of Aristotle's works. [TF]

At Platonis schola *acatalepsiam* introduxit [162], primo tanquam per jocum et ironiam, in odium veterum sophistarum [163], Protagorae, Hippiae, et reliquorum, qui nihil tam verebantur, quam ne dubitare de re aliqua viderentur. At nova academia *acatalepsiam* dogmatizavit, et ex professo tenuit: quae licet honestior ratio sit, quam *pronunciandi* licentia, quum ipsi pro se dicant se minime confundere inquisitionem, ut Pyrrho fecit et Ephectici, sed habere quod sequantur ut probabile [164], licet non habeant quod teneant ut verum; tamen postquam animus humanus de veritate invenienda semel desperaverit, omnino omnia fiunt languidiora: ex quo fit, ut deflectant homines potius ad amoenas disputationes et discursus, et rerum quasdam peragrationes, quam in severitate inquisitionis se sustineant. Verum, quod a principio diximus et perpetuo agimus, sensui et intellectui humano eorumque infirmitati authoritas non est deroganda, sed auxilia praebenda.

[162] On the doctrines of the New Academy, see note 41 on Aphorism 37. The process by which the dogmatism of the early Platonists passed into the scepticism of the New Academy would form an interesting enquiry in the history of philosophy. In the first place, it may be observed that there was from the beginning a well-marked negative vein in the philosophy of Socrates and Plato. This tendency, which was connected with their dialectical method and the determination to examine all sides of a question, even if the examination led to no further result, is well brought out by Mr. Grote both in the chapter on Socrates in his History of Greece and in the 6th chapter of his work on Plato. When men found that a question might be discussed with so much ability on all sides, and that often without attaining any positive result, it was not unnatural to conclude that there was no result to be attained. Then, the , εἰρωνεία,or affectation of ignorance, which was so marked a feature in the conversation of Socrates, and which is so carefully and frequently depicted in the dialogues of Plato, must have had a similar effect in leading men to despair of the possibility of knowledge. To this characteristic Bacon here alludes in the words, 'primo tanquam per jocum et ironiam,' etc. The object of Socrates, however, was not to induce scepticism, but to purify the mind from all pre-conceived opinions, in order to prepare it for the more impartial investigation of truth. Lastly, Plato had spared no pains in demolishing the general belief in the trustworthiness and accuracy of sense-knowledge, in order to rear on its ruins his theory of Ideas. This doctrine, in its turn, had been severely criticised, and, in the opinion of many, refuted by Aristotle. Hence, we cannot be surprised if to some there seemed to be no way out of the dialectical puzzles and subtleties by which the question of the reality of knowledge was perplexed. The solution of these difficulties offered by the philosophers of the New Academy, in their ascending grades of probability, has been already given in note 41 on Aphorism 37.

In the De Augmentis Scientiarum, Libro 2. (Ellis and Spedding, Vol. I. p. 462), Bacon couples the name of Socrates with that of the [New] Academy: 'Non negaverim in summariis libellis ad praxim desdnatis hanc formulam scribendi retineri posse, verum in justis tractatibus de scientiis utrumque extremum vitandum censeo, tarn Velleii Epicurei, nil tam metuentis quam ne dubitare de re aliqua videretur, quam Socratis et Academiae omnia in dubio relinquentium.' The allusion to Velleius, the Epicurean, is borrowed from Cicero, De Natura Deorum, Libro I. Cap. 8: 'Tum Velleius, fidenter sane, ut solent isti, nihil tam verens, quam ne dubitare aliqua de re videretur: tanquam modo ex deorum concilio et ex Epicuri intermundiis descendisset.' In this Aphorism there is no allusion to Velleius by name, but a portion of the passage in the De Natura Deorum is incorporated in the text. [TF]

[163] The positive and dogmatic character of the old Sophists is well illustrated in the 1st book of Plato's Republic, in the person of Thrasymachus, who, however, must be regarded as a caricature. The English reader may be referred, on the subject of the Sophists, to Mr. Lewes' History of Philosophy, Crete's chapter on the Sophists in his History of Greece and his work on Plato throughout, Sir Alexander Grant's second Essay

prefixed to his edition of Aristotle's Ethics, and Mr. Henry Sidgwick's papers in the Journal of Philology. [TF]

[164] For these grades of probability, see note 41 on Aphorism 37. On the distinctions, real or supposed, between the doctrines of the New Academy and the Sceptics proper, see the same note. ' The school of Pyrrho (often called Pyrrhonists as well as Sceptics) was prior to that of the New Academy, Pyrrho himself being contemporary with Alexander the Great, but it was revived at a much later period by Ænesidemus and his successors, among whom was Sextus Empiricus. [TF]

LXVIII.

Atque de idolorum singulis generibus, eorumque apparatu jam diximus; quae omnia constanti et solenni decreto sunt abneganda et renuncianda, et intellectus ab iis omnino liberandus est et expurgandus; ut non alius fere sit aditus ad regnum hominis, quod fundatur in scientiis, quam ad regnum coelorum, *in quod, nisi sub persona infantis, intrare non datur.*

LXIX.

At pravae demonstrationes, idolorum veluti munitiones quaedam sunt et praesidia [165]; eaeque, quas in dialecticis habemus, id fere agunt, ut mundum plane cogitationibus humanis, cogitationes autem verbis addicant et mancipent [166]. Demonstrationes vero potentia quadam [167] philosophiae ipsae sunt et scientiae. Quales enim eae sunt, ac prout rite aut male institutae, tales sequuntur philosophiae et contemplationes. Fallunt autem et incompetentes sunt eae quibus utimur in universo illo processu, qui a sensu et rebus ducit ad axiomata et conclusiones. Qui quidem processus quadruplex [168] est, et vitia ejus totidem. Primo, impressiones sensus ipsius vitiosae sunt; sensus enim et destituit et fallit. At destitutionibus substitutiones, fallaciis rectificationes debentur [169]. Secundo, notiones ab impressionibus sensuum male abstrahuntur, et interminatae et confusae sunt, quas terminatas et bene finitas esse oportuit. Tertio, inductio mala est, quae per enumerationem simplicem principia concludit scientiarum, non adhibitis exclusionibus et solutionibus, sive separationibus naturae debitis [170]. Postremo, modus ille inveniendi et probandi, ut primo principia maxime generalia constituantur, deinde media axiomata ad ea applicentur et probentur, errorum mater est, et scientiarum omnium calamitas [171]. Verum de istis, quae jam obiter perstringimus, fusius [172] dicemus, quum veram interpretandae naturae viam, absolutis istis expiationibus et expurgationibus mentis, proponemus.

[165] It would seem from this passage as if the 'pravae demonstrationes' were to be discussed as supplemental to the 'idola.' But they are themselves (see Aphorism 61) a subdivision of the 'Idola theatri,' which originate 'ex fabulis theoriarum et perversis legibus demonstrationum.' [TF]

[166] This is a good example of the pregnancy and suggestiveness of many, of Bacon's sayings. It is singularly applicable to many metaphysical systems, both ancient and modern. Men, neglecting the facts of nature and mind, often attempt to construct an a priori system of the universe, enslaving the world to their own thoughts,' while their thoughts themselves are concealed and fettered in the meshes of a technical terminology.

Cp. De Principiis atque Originibus, secundum fabulas Cupidinis et Coeli (Ellis and Spedding, Vol. III. pp. 85-6): ' Itaque hi omnes' (Empedocles, Anaxagoras, etc.) 'mentem rebus submiserunt. At Plato mundum cogitationibus, Aristoteles vero etiam cogitariones verbis, adjudicarunt.' [TF]

[167] Thus, for instance, the failure of the ancients in the Physical Sciences was due largely to their disproportionate employment of the Deductive method. Their success, on the other hand, in some branches of Mathematics was due to the extent to which this method had been already elaborated.

Again, it has often been remarked that fundamental differences in opinion generally turn on fundamental differences in method. Thus, the method of Locke, which is mainly inductive, and the method of Descartes, which is mainly a priori, result in two widely different systems of mental philosophy. The introspective method of Butler and the historical method of Hume, again, though both of them essentially inductive, lead to very divergent theories of ethics. The position, in fact, might be illustrated to almost any extent in the history of either ancient or modern philosophy. [TF]

[168] Bacon points out four respects in which the present methods of demonstration are defective:

(1) The senses frequently fail or deceive us;
(2) Our notions are confused and ill-defined;
(3) We employ the vicious method of Inductio per Enumerationem Simplicem;
(4) We fly off at once to the principia maxime generalia, instead of ascending to them gradually through the axiomata infima and media. [TF]

[169] Bacon might have added that the substitutions are to be supplied mainly by instruments, the rectifications mainly by methods. [TF]

[170] In opposition to the ordinary method of Inductio per Enumerationem Simplicem, Bacon proposes a method of elimination. It is not, however, quite clear what is the precise character of the method which he has in view. We may take his words either in a general sense or with special reference to the methods described in Book II. In the former case, the passage might be paraphrased as follows: ^We ought to exclude ail instances which do not throw light on the object of enquiry, resolve complex into more simple cases, and isolate phenomena so as to simplify our investigations.' According to

the. latter alternative, he has in mind the process described in Book II. Aphorisms 18, 19. The true method of induction, Bacon appears to have thought, was to draw up tables of presence, absence, d:c., and then, by means of these, to reject out of all the possible explanations, causes, or forms of the phenomenon, first one, and then another, thus leaving a residuum of explanations, or possible causes, out of which the true one was to be found. If one only remained, this would be the true explanation, cause, or 'form,' 'forma affirmativa, solida, er vera, et bene terminata' (ii. 16). If more than one remained, the 'exclusiva' might be perfected by means of the 'praerogativae instantiarum' and other 'aids of the understanding' (see II. 21 u till, at last, the search was narrowed down to some one 'form,' which would be the form required, or to a small number amongst which the true form, cause, or explanation would have to be sought in all future investigations. For further information on Bacon's 'Method of Exclusions,' see Introduction, § 9. [TF]

[171] See note on Aphorism 19, where it is shewn that the fault lies not so much in framing these wide hypotheses, as in taking them for ascertained truths and not insisting on their due verification. [TF]

[172] Dr. Kitchin refers to I. 100-105. I think that the reference is rather to the Second Book. [TF]

LXX.

Sed demonstratio longe optima est experientia [173]; modo haereat in ipso experimento. Nam si traducatur ad alia quae similia existimantur, nisi rite et ordine fiat illa traductio, res fallax est [174]. At modus experiendi, quo homines nunc utuntur, caecus est et stupidus [175]. Itaque cum errant et vagantur nulla via certa [176], sed ex occursu rerum tantum consilium capiunt, circumferuntur ad multa, sed parum promovent; et quandoque gestiunt, quandoque distrahuntur; et semper inveniunt quod ulterius quaerant. Fere autem ita fit, ut homines leviter et tanquam per ludum experiantur, variando paululum experimenta jam cognita; et, si res non succedat, fastidiendo et conatum deserendo. Quod si magis serio et constanter ac laboriose ad experimenta se accingant, tamen in uno aliquo experimento eruendo operam collocant; quemadmodum Gilbertus in magnete, Chymici in auro. Hoc autem faciunt homines instituto non minus imperito quam tenui. Nemo enim alicujus rei naturam in ipsa re feliciter perscrutatur; sed amplianda est inquisitio ad magis communia.

[173] We may, perhaps, here detect the germ of the doctrine, afterwards propounded with such emphasis, by Locke and his successors, that all our knowledge may ultimately be traced to experience. That this is the case even with Geometrical Axioms (one of the strongest instances in opposition to this doctrine adduced by the rival school of psychologists) has been recently argued on novel grounds, and with a force amounting almost to demonstration, by Professor Helmholtz, following Riemann, in two articles in 'Mind,' No. 3 and No. 10. To individual experience, how-ever, must be added the facility, acquired by hereditary transmission, of forming certain ideas and realising certain

principles, which, in the history of the race, have, through constant experience, become specially familiar to the human mind. [TF]

[174] With certain exceptions (which are enumerated in my Inductive Logic, 4th ed., pp. 7-9) the detection of a law of Causation can alone warrant us in founding a general conclusion on our observations and experiments. On the distinction between Laws of Causation and Empirical Laws, which are unfit to be relied on beyond the limits of time, place, and circumstance, in which the observations have been made,' see Mill's Logic, Book III. eh. 16. Mr. Mill, however, uses the expression 'Empirical Laws' somewhat loosely. It would be better to confine it entirely to those secondary laws which are the result of an Inductio per Enumerationem Simplicem as distinguished from the results given by the Inductive Methods, in which there is always some evidence of facts of causation. See my Inductive Logic, Chapter 4 (4th Ed., pp. 220-222).

There are many departments of knowledge and practice in which it is almost impossible to exaggerate the importance of insisting on a precise repetition of *all* the circumstances (or, at least, all the material circumstances) of the case, before inferring that the same result will recur. This fact is strikingly illustrated by the widely different effects of medicines in different climates. See, for instances, the Introduction to Dr. Paris' Pharmacologia, pp. 120-123. [TF]

[175] The faults in experimentation as then practised, which are noted by Bacon in this Aphorism, may be enumerated as five:

(1) Undue extension of inferences based on experience to other instances apparently similar, without sufficient caution in allowing for possible differences of circumstances;
(2) Hap-hazard experiment, without pursuing any definite order or making any selection of instances;
{3) Insufficient variation of experiments;
(4) Pursuit of one experiment, or subject, to the neglect of all others;
(5) Excessive eagerness to arrive at the practical application.

'The account of the last three of these faults is borrowed from Dr. Kitchin's note. He gives a fourfold division, but, though there is some obscurity in the early part of the Aphorism, I am inclined to think that the passage from 'Sed demonstratio' down to 'deserendo' is intended to specify three distinct faults. [TF]

[176] Bacon is here probably alluding to the fashion of trying experiments without any order or method, 'mera palpatio' as he calls it in Aphorism 100 and the De Augmentis Scientiarum. CP. Libro V. Cap. 2: 'Ars ista Indicii (ita enimeam appellabimus) duas habet partes. Aut enim defer tur Indicium *ab experlmentis ad experimenta*; aut *ab experimentis ad axiomata*, quae et ipsa nova experimenta designent Priorem harum Experientiam Literatam nominabimus, posteriorem vero Interpretationem Naturae, sive Novum Organum. Prior quidem (ut alibi attigimus) vix pro Arte habenda est aut parte

Phiiosophiae, sed pro Sagadtate quadam: unde etiam earn Venationem Panis (hoc nomen ex fabula mutuati) qiiandoque appellamus. Attamen quemadmodum possit quis in via sua triplici modo progredi; aut cum *palpet ipse in tenebris*; aut cum *alterius manu ducatur, ipse parum videns*; aut denique cum *vestigia lumine adhibiio regat*: similiter cum quis *experimenta omnigena absque ulla serie aut methodo tentet*, ea demum mera est palpatio; cum vero *nonnulla utatur in experimenfando directione et ordine*, perinde est ac si manu ducatur: atque hoc illud est quod per Experientiam Literatam intelligimus. Nam *Lumen ipsum*, quod tertium fuit, ab Interpretatione Naturae, sive Novo Organo, petendum est.' [TF]

Quod si etiam scientiam quandam et dogmata ex experimentis moliantur; tamen semper fere studio praepropero et intempestivo deflectunt ad praxin: non tantum propter usum et fructum ejusmodi praxeos, sed ut in opere aliquo novo veluti pignus sibi arripiant, se non inutiliter in reliquis versaturos: atque etiam aliis se venditent [177], ad existimationem meliorem comparandam de iis in quibus occupati sunt. Ita fit ut, more Atalantae [178], de via decedant ad tollendum aureum pomum; interim vero cursum interrumpant, et victoriam emittant e manibus. Verum in experientiae vero curriculo eoque ad nova opera producendo, Divina Sapientia [179] omnino et ordo pro exemplari sumenda sunt. Deus autem primo die creationis lucem tantum creavit, eique operi diem integrum attribuit; nec aliquid materiati operis eo die creavit. Similiter et ex omnimoda experientia, primum inventio causarum et axiomatum verorum elicienda est: et lucifera experimenta, non fructifera quaerenda [180]. Axiomata autem recte inventa et constituta praxin non strictim sed confertim instruunt; et operum agmina ac turmas post se trahunt. Verum de experiendi viis, quae non minus quam viae judicandi obsessae sunt et interclusae, postea dicemus [181]; impraesentiarum de experientia vulgari, tanquam de mala demonstratione, tantum loquuti. Jam vero postulat ordo rerum, ut de iis quorum paulo ante mentionem fecimus, signis, quod philosophiae et contemplationes in usu male se habeant, et de causis rei primo intuitu tam mirabilis et incredibilis, quaedam subjungamus. Signorum enim notio praeparat assensum: causarum vero explicatio tollit miraculum. Quae duo ad extirpationem *idolorum* ex intellectu faciliorem et clementiorem multum juvant.

[177] 'Puff themselves,' as tradesmen puff their wares, is the explanation which Dr. Kitchin rightly gives of this phrase. [TF]

[178] Bacon is very fond of this comparison. For the Fable and its interpretation, see De Sapientia Veterum, Fab. 25, 'Atalanta sive Lucrum.' [TF]

[179] In the text of the first Edition, we have Prudentia, but, in the list of Errata at the end of the Book, Sapientia is substituted. [TF]

[180] Bacon frequently employs this metaphor. He conceived that the 'light-bearing experiments' would bring more fruit at the last. There is, therefore, no contradiction between what he says here and in those passages where he insists on the practical aims

of his philosophy, such, for instance, as that in Aphorism 81: 'Meta autem scientiarum vera et legitima non alia est quam ut dotetur vita humana novis inventis et copiis.'

The history of science abounds in instances of discoveries which at first appeared to have no practical bearing, though they have subsequently resulted in the most important additions to human power and the conveniences of life. It will be sufficient to mention the elasticity of steam and the phenomena of electricity and magnetism. [TF]

[181] The reference may be to I. 98-107, but it is more probably to Book II. in general, or, perhaps, specially to the Aphorisms on the Praerogativae Instantiarum. [TF]

LXXI. [182]

[182] Here begin the five signs of the weakness and insufficiency of the preceding philosophies. The first sign, which is taken from their origin amongst the Greeks, is discussed under two heads: (α) 'ex ortu et gente philosophiae,' treated in Aphorism 71; (β) 'ex natura temporis et aetatis,' treated in Aphorism 72. [TF]

Scientiae, quas habemus, fere a Graecis fluxerunt. Quae enim scriptores Romani, aut Arabes [183], aut recentiores addiderunt, non multa aut magni momenti sunt: et qualiacunque sint, fundata sunt super basin eorum quae inventa sunt a Graecis. Erat autem sapientia Graecorum professoria, et in disputationes effusa [184]: quod genus inquisitioni veritatis adversissimum est. Itaque nomen illud sophistarum [185], quod per contemptum ab iis, qui se philosophos haberi voluerunt, in antiquos rhetores rejectum et traductum est, Gorgiam, Protagoram, Hippiam, Polum, etiam universo generi competit, Platoni, Aristoteli, Zenoni, Epicuro, Theophrasto, et eorum successoribus, Chrysippo, Carneadi, reliquis. Hoc tantum intererat: quod prius genus vagum fuerit et mercenarium, civitates circumcursando, et sapientiam suam ostentando, et mercedem exigendo; alterum vero solennius et generosius, quippe eorum qui sedes fixas habuerunt, et scholas aperuerunt, et gratis philosophati sunt. Sed tamen utrumque genus (licet caetera dispar) professorium erat, et ad disputationes rem deducebat, et sectas quasdam atque haereses philosophiae instituebat et propugnabat: ut essent fere doctrinae eorum (quod non male cavillatus est Dionysius in Platonem) *Verba otiosorum senum ad imperitos juvenes* [186]. At antiquiores illi ex Graecis [187], Empedocles, Anaxagoras, Leucippus, Democritus, Parmenides, Heraclitus, Xenophanes, Philolaus, reliqui (nam Pythagoram, ut superstitiosum [188], omittimus), scholas (quod novimus) non aperuerunt: sed majore silentio, et severius, et simplicius, id est, minore cum affectatione et ostentatione, ad inquisitionem veritatis se contulerunt. Itaque et melius, ut arbitramur, se gesserunt; nisi quod opera eorum a levioribus istis, qui vulgari captui et affectui magis respondent ac placent, tractu temporis extincta sint: tempore (ut fluvio) leviora et magis inflata ad nos devehente, graviora et solida mergente [189]. Neque tamen isti a nationis vitio [190] prorsus immunes erant: sed in ambitionem et vanitatem sectae condendae et aurae popularis captandae nimium propendebant. Pro desperata autem habenda est veritatis inquisitio, cum ad hujusmodi inania deflectat. Etiam non omittendum videtur judicium illud, sive vaticinium potius, sacerdotis Aegyptii de Graecis

[191]: *Quod semper pueri essent; neque haberent antiquitatem scientiae, aut scientiam antiquitatis*. Et certe habent id quod puerorum est; ut ad garriendum prompti sint, generare autem non possint: nam verbosa videtur sapientia eorum, et operum sterilis. Itaque ex ortu et gente philosophiae quae in usu est, quae capiuntur signa bona non sunt.

[183] It is almost needless to observe that this censure is too severe. The Romans might, at least, have been credited with the mechanical skill which enabled them to construct such magnificent roads, aqueducts, bridges, amphitheatres, etc., and the Arabians (even if Bacon despised the share they had in reviving the study of the Aristotelian philosophy in Europe) with their part in the invention of our present numerals and of the science of Algebra, with the discovery of distillation, with their contributions to the science of medicine, with the first essays at a science of chemistry, etc. In the desire to lay the foundations of a new method and a new body of science, there can be no question that Bacon was disposed to undervalue what had already been achieved. Towards the 'recentiores' he assumes a fairer tone in Aphorism 109. [TF]

[184] In this tendency to questioning and disputation, however, originated philosophy and abstract speculation. The Hindoos and Greeks alone, in the ancient world, appear to have possessed such a tendency in any marked degree. Without it, poetry, practical inventions, and maxims of conduct are possible, but not philosophy, or, to any great extent, even scientific theory. [TF]

[185] The following sentences are remarkable, as containing a view of the Sophists which has now been rendered familiar to English readers by the works of Mr. Lewes and Mr. Grote. In pointing out the original application of the term 'Sophists' to all philosophers indifferently, in glancing at the connexion between the Sophists properly so called and the Rhetors, and in specifying the wandering life and the taking of fees as the characteristics mainly distinguishing the Sophists so-called from the philosophers so-called, Bacon undoubtedly anticipates some of the principal points for which Mr. Grote contends.

CP. a similar passage in the Redargutio Philosophiarum (Ellis and Spedding, Vol. III. pp. 565-6), where he ranks Plato and Aristotle amongst the Sophists, distinguishing favourably from them Empedocles, Heraclitus, Democritus, Anaxagoras, and Parmenides: 'Neque enim reperietis hos scholas aperuisse, sed tandem speculationes et inventa sua in scripta redegisse, et posteris transmisisse.' Of Plato and Aristotle he says: 'Itaque non haesitabo apud vos dicere, me locum Platoni et Aristoteli tribuere inter Sophistas: sed tanquam ordinis emendati et reformati, Eandem enim rem prorsus video. Aberat fortasse loci mutatio et circumeursatio, et mercedis indignitas, et inepta ostehtatio; atque iucet in illis certe quiddam solennius et nobilius sed aderant schola, auditor, secta, Itaque genus ipsum profecto cernitis. [TF]

[186] The story is given by Diogenes Laertius, Libro III. segm. 18: Τρὶς δὲ πέπλευκεν εἰς Σικελίαν᾽ πρῶτον μὲν κατὰ θέαν τῆς νήσου καὶ ΤΟΥ ΚραΤΗραr, ὅτε καὶ Διονύσιος ὁ

Ἑρμοκράτους, τύραννος ὢν, ἠνάγκασεν ὥστε συμμίξαι αὐτῷ. ὁ δέ, διαλεγόμενος περὶ τυραννίδος, καὶ φάσκων ὡς οὐκ ἔστι τοῦτο κρεῖττον ὃ συμφέρον αὐτῷ μόνον, εἰ μὴ καὶ ἀρετῇ διαφέροι, προσέκρουσεν αὐτῷ" ὀργισθεὶς γάρ, Οἱ λόγοι σου, φησί, γεροντιῶσι᾽ καὶ ds, Σοῦ δέ γε τυραννιῶσιν. [TF]

[187] M. Bouillet calls attention to a passage in the Redargutio Philosophiarum (Ellis and Spedding, Vol. III. pp, 569, 570), shewing the diligence with which Bacon professed to have studied these philosophers: ‘Scitote nos summa cum diligentia et cura omnes vel tenuissimas auras circa horum virorum opiniones et placita captasse: ut quicquid de illis, vel dum ab Aristotele confutantur, vel dum a Platone et Cicerone citantur, vel in Plutarch i fasciculo, vel in Laertii vitis, vel in Lucretii poemate, vel in aliquibus Lagmentis, vel in quavis alia sparsa memoria et mentione, inveniri possit, evolverimus; neque cursim aut contemptini, sed cum fide et deiiberatione examinaverimus.’ [TF]

[188] CP. Aphorism 65. [TF]

[189] This is a good instance of False Analogy. Bacon, as Dr. Kitchin observes, seems partial to this metaphor. It occurs again almost immediately in Aphorism 77, as well as in other places. [TF]

[190] ‘Erat autem sapientia Graecorum professoria, et in disputationes effusa.’ [TF]

[191] See Plato, Timaeus, p. 22 b: Kai τινα εἰπεῖν τῶν ἱερέων (one of the Egyptian priests) εἶπεν [191.1] μάλα παλαιόν" Ὦ Σόλων, Σόλων, Ἕλληνες ἀεὶ παῖδές ἐστε, γέρων δὲ Ἕλλην οὐκ ἔστιν. ᾽Ακούσας οὖν, πῶς τί τοῦτο λέγεις ; φάναι. Νέοι ἐστέ, εἰπεῖν, τὰς ψυχὰς πάντες" οὐδεμίαν γὰρ ἐν αὐταῖς ἔχετε δι’ ἀρχαίαν ἀκοὴν παλαιὰν δόξαν οὐδὲ μάθημα χρόνῳ πολιὸν οὐδέν. [TF]

[191.1] In the printed version this was written as “εν” (epsilon nu). However, “εἶπεν” maybe is a better word. [HJ]

LXXII.

Neque multo meliora sunt signa quae ex natura temporis et aetatis capi possunt, quam quae ex natura loci et nationis. Angusta enim erat et tenuis notitia per illam aetatem vel temporis vel orbis [192]: quod longe pessimum est, praesertim iis qui mnia in experientia ponunt. Neque enim mille annorum historiam [193], quae digna erat nomine historiae, habebant; sed fabulas et rumores antiquitatis. Regionum vero tractuumque mundi exiguam partem noverant: cum omnes hyperboreos, Scythas, omnes occidentales, Celtas indistincte appellarent; nil in Africa ultra citimam Aethiopiae partem, nil in Asia ultra Gangem, multo minus novi orbis provincias, ne per auditum sane aut famam aliquam certam et constantem, nossent; imo et plurima climata et zonae, in quibus populi infiniti spirant et degunt, tanquam inhabitabiles ab illis pronuntiata sint; quinetiam peregrinationes Democriti, Platonis, Pythagorae, non longinquae profecto, sed potius suburbanae, ut magnum aliquid celebrarentur. Nostris autem temporibus, et

novi orbis partes complures et veteris orbis extrema undique innotescunt; et in infinitum experimentorum cumulus excrevit. Quare si ex nativitatis aut geniturae tempore (astrologorum more) signa capienda sint, nil magni de istis philosophiis significari videtur.

[192] We must recollect how rapidly the knowledge of the surface of the globe had been spreading in the time of Bacon and that immediately preceding him. To say nothing of earlier discoverers; Drake, Frobisher, Raleigh, and the three Hawkinses were all his contemporaries. Hence, the geographical knowledge possessed by the ancients was already beginning to appear contemptible. The frontispiece of the first edition of the Novum Organum represents a vessel in full sail, passing between two pillars, with the motto 'Multi pertransibunt, et augebitur scientia.' (Daniel XII. 4.) [1921] [TF]

[192.1] Bacon and his interpreters, and I guess many of the Christian authors of that time, refer to the Bible either directly or indirectly. Whether they knew the Bible by heart, or had a copy of the Bible at hand, is unknown to me. In any case, I doubt it the Bible knowledge is now as high as it was then. Here, I write Daniel XII:4 in full: "But you, Daniel, roll up and seal the words of the scroll until the time of the end. Many will go here and there to increase knowledge." [HJ]

[193] In the 'Praise of Knowledge,' given in Spedding's Letters and Life of Bacon (Vol. I. p. 124), Bacon says: 'The Greeks knew (except fables) not much above five hundred years before themselves.' Taking roughly the period of literary activity amongst the Greeks at five hundred years, the two passages would be consistent. [TF]

Mr. Grote is of opinion that we have no trustworthy information regarding Greek history till the first recorded Olympiad, 776 B.C. We must, of course, distinguish between definite historical statements and the evidence afforded by institutions, customs, folklore, language, etc., which may stretch much further back. [TF]

LXXIII.

Inter signa, nullum magis certum aut nobile est, quam quod ex fructibus. Fructus enim et opera inventa pro veritate philosophiarum velut sponsores et fidejussores sunt. Atque ex philosophiis istis Graecorum, et derivationibus earum per particulares scientias, jam per tot annorum spatia, vix unum experimentum adduci potest, quod ad hominum statum levandum et juvandum spectet, et philosophiae speculationibus ac dogmatibus vere acceptum referri possit [194]. Idque Celsus [195] ingenue ac prudenter fatetur; nimirum, experimenta medicinae primo inventa fuisse, ac postea homines circa ea philosophatos esse et causas indagasse et assignasse; non ordine inverso evenisse, ut ex philosophia et causarum cognitione ipsa experimenta inventa aut deprompta essent. Itaque mirum non erat, apud Aegyptios (qui rerum inventoribus divinitatem et consecrationem attribuerunt) plures fuisse brutorum animalium imagines quam hominum: quia bruta animalia, per instinctus naturales, multa inventa perpererunt; ubi homines, ex sermonibus et conclusionibus rationalibus, pauca aut nulla exhibuerint.

[194] With regard to mechanical inventions, this charge is, in the main, true. These, so far as they existed in the ancient world, seem to have been due to the Egyptians and the Oriental nations rather than to the Greeks, whose intellect was speculative and aesthetic rather than practical.

It should be noticed that Bacon ignores the whole aesthetic side of Greek development. [TF]

[195] 'Repertis deinde medicinae remediis homines de rationibus eorum disserere coepisse: nec post rationem medicinam esse inventam, sed post inventam medicinam rationem esse quaesitam.' Celsus de Re Medica. Praefatio.

'But this remark,' says Mr. Ellis, 'is not made by Celsus as the expression of his own opinion; on the contrary it occurs in his statement of the views entertained by the empirical, school of medicine, to which he is decidedly opposed. The error of citing Celsus as an authority for it is repeated in several parts of Bacon's works.' Mr. Spedding refers to De Augmentis Scientiarum, V. 2. [195.1] Other places are Valerius Terminus {Ellis and Spedding, Vol. III. p. 232) and the Redargutio Philosophiarum (Vol. III. p. 578). [TF]

[195.1] I guess "V. 2." Is a typo! It probably is "Vol. 2.". [HJ]

At Chymicorum industria nonnulla peperit; sed tanquam fortuito et obiter, aut per experimentorum quandam variationem (ut mechanici solent), non ex arte aut theoria aliqua; nam ea, quam confinxerunt, experimenta magis perturbat, quam juvat. Eorum etiam, qui in magia (quam vocant) naturali [196] versati sunt, pauca reperiuntur inventa; eaque levia, et imposturae propiora. Quocirca, quemadmodum in religione cavetur, ut fides ex operibus monstretur; idem etiam ad philosophiam optime traducitur, ut ex fructibus judicetur et vana habeatur quae sterilis sit: atque eo magis si, loco fructuum uvae et olivae, producat disputationum et contentionum carduos et spinas.

[196] CP. note 6 on Aphorism 5. [TF]

LXXIV.

Capienda etiam sunt signa ex incrementis et progressibus philosophiarum et scientiarum. Quae enim in natura fundata sunt, crescunt et augentur: quae autem in opinione, variantur, non augentur [197]. Itaque si istae doctrinae plane instar plantae a stirpibus suis revulsae non essent, sed utero naturae adhaererent atque ab eadem alerentur, id minime eventurum fuisset, quod per annos bis mille jam fieri videmus: nempe, ut scientiae suis haereant vestigiis, et in eodem fere statu maneant, neque augmentum aliquod memorabile sumpserint; quin potius in primo authore maxime floruerint, et deinceps declinaverint. In artibus autem mechanicis [198], quae in natura et experientiae luce fundatae sunt, contra evenire videmus: quae (quamdiu placent) veluti spiritu quodam repletae continuo vegetant et crescunt; primo rudes, deinde commodae, postea excultae, et perpetuo auctae.

[197] This is one of Bacon's happiest thoughts. I may add that, if in any subject we have a mere variation of opinion, without growth, it proves either that the subject is incapable of scientific treatment, or else that the scientific mode of treating it has. not yet been discovered. Thus, the ontological problems, which constituted, so large a part of the Greek philosophy, did not, I conceive, admit of any scientific solution, while to much of the physical speculation of the Greek philosophers no scientific treatment had yet been applied.

It has often been brought as a charge against the moral and mental sciences that they are a mere record of opinions, and admit of no growth. Provided, however, to adopt Bacon's language, they are 'founded in nature,' that is to say, in the study of man and society, I believe this charge to be emphatically untrue. The phenomena, indeed, are here more complex than in the physical sciences, and there is a larger amount of uneducated opinion to be replaced by the results of scientific investigation; hence, undoubtedly, the process of growth is slower, but I believe that, with each generation of cultivated men, the materials for a knowledge of mind, life, and conduct are surely accumulating, while scientific conceptions, when once applied to these materials, admit of constant development and further and further applications. It may be added that in these sciences, owing to the exceeding familiarity of the phenomena with which they deal, there are certain early generalizations which it is comparatively easy to make; and hence, in the philosophies of Plato and Aristotle, there is a larger amount of sound speculation in these departments than in any others. But, though, perhaps, they are amongst the first to blossom, they are the last to ripen. [TF]

[198] CP. Cogitata et Visa (Ellis and Spedding, Vol. III. p. 616): 'Artes enim Mechanicas, ut aurae cujusdam vitalis participes, quotidie crescere et perfici; Philosophiam vero statuae more adorari et celebrari, nec moveri. Atque ilias in primis authoribus rudes et fere informes ac onerosas se ostendere: postea novas vires et commoditates adipisci. Hanc autem in primo quoque authore maxime vigere, ac dein ceps declinare. Neque aliam hujus contrarii successes causam veriorem esse, quam quod in Mechanicis multorum ingenia in unum coëunt; in Philosophia autem, singulorum ingenia ab imo quopiam destruuntur. Nam postquam deditii facti sunt, amplitudinem non addere; sed in uno ornando aut stipando servili officio occupari. Quare omnem philosophiam ab experientiae radicibus ex quibus primum puilulavit et incrementum eepit avuisam, rem mortuam esse.' [TF]

LXXV.

Etiam aliud signum capiendum est (si modo signi appellatio huic competat; cum potius testimonium sit, atque adeo testimoniorum omnium validissimum); hoc est, propria confessio authorum, quos homines nunc sequuntur. Nam et illi qui tanta fiducia de rebus pronuntiant, tamen per intervalla cum ad se redeunt, ad querimonias de naturae subtilitate, rerum obscuritate, humani ingenii infirmitate, se convertunt [199]. Hoc vero si simpliciter fieret, alios fortasse, qui sunt timidiores, ab ulteriori inquisitione deterrere,

alios vero, qui sunt ingenio alacriori et magis fidenti, ad ulteriorem progressum acuere et incitare possit. Verum non satis illis est de se confiteri, sed quicquid sibi ipsis aut magistris suis incognitum aut intactum fuerit id extra terminos possibilis ponunt, et tanquam ex arte [201] cognitu aut factu impossiblile pronuntiant: summa superbia et invidia suorum inventorum infirmitatem in naturae ipsius calumniam et aliorum omnium desperationem vertentes. Hinc schola Academiae novae, quae *acatalepsiam* ex professo tenuit, et homines ad sempiternas tenebras damnavit [202]. Hinc opinio, quod formae sive verae rerum differentiae (quae revera sunt leges actus puri) inventu impossibiles sint, et ultra hominem [203]. Hinc opiniones illae in activa et operativa parte: calorem solis et ignis toto genere differre [204]; ne scilicet homines putent se per opera ignis aliquid simile iis quae in natura fiunt educere et formare posse. Hinc illud: compositionem tantum opus hominis, mistionem vero opus solius naturae esse [205]; ne scilicet homines sperent aliquam ex arte corporum naturalium generationem aut transformationem. Itaque ex hoc signo homines sibi persuaderi facile patientur, ne cum dogmatibus non solum desperatis, sed etiam desperationi devotis, fortunas suas et labores misceant.

[199] Compare, for instance, the words ascribed to Xenophanes:

> Καὶ τὸ μὲν οὖν σαφὲς οὔτις ἀνὴρ ἴδεν οὐδέ τις ἔσται
> εἰδώς, ἀμφὶ θεῶν τε καὶ ἅσσα λέγω περὶ πάντων"
> εἰ γὰρ καὶ τὰ μάλιστα τύχοι τετελεσμένον εἰπών,
> αὐτὸς ὅμως οὐκ οἶδε· δοκὸς δ᾽ ἐπὶ πᾶσι τέτυκται. [TF]

[201] 'As if on the authority of their art,' or perhaps 'as if they had scientific grounds for saying so.' [TF]

[202] From what has already been said on the New Academy (Aphorism 37, n. 41), it will be seen that this is an exaggerated view of their position. Though they rejected 'certainty,' they constituted various grades of probability, and, therefore, can hardly be said to have condemned men to eternal darkness. [TF]

[203] On Bacon's use of the word Form, see Introduction, § 8. [TF]

The opinion that the discovery of the Form is impossible is discussed again in Book II. Aphorisms 2, 3, and also in De Augmentis Scientiarum, Libro III. Cap. 4, Valerius Terminus (Ellis and Spedding., Vol. III. p. 239), and other places. Some of these passages are considered in the Introduction. [TF]

[204] In the 'Instantiae convenientes in natura calidi' in Book II, both these descriptions of heat are included.

Apostrophising Galen in the Temporis Partus Masculus (Ellis and Spedding, Vol. III. p. 531) Bacon breaks out: canicula! O pestis! . . . . . tu inter calores astri et ignis seditionem

avide arripiens et ostentans, ubique humanam potestatem malitiose in ordinem redigis, et ignorantiam desperatione in aeternum munire cupis.' [TF]

[205] The two processes here contrasted are mechanical and chemical composition. What follows is obscure, but it seems to mean that man may, if he is only bold enough, obtain the power of so subtly mixing ingredients, or 'superinducing Forms,' as to effect the generation of a body or the transformation of one body into another. The best explanation of the passage is to be found by comparing it with Book II. Aphorism 5.

Mr. Spedding (quoting a note by Mr. Ellis to Temporis Partus Masculus, Ellis and Spedding, Vol. III. p. 551) says that the reference is to Galen, who in his treatise De Naturalibus Facultatibus contrasts the inwardly formative power of nature with the external operations of art. [TF]

LXXVI.

Neque illud signum praetermittendum est, quod tanta fuerit inter philosophos olim dissensio et scholarum ipsarum varietas: quod satis ostendit, viam a sensu ad intellectum [206] non bene munitam fuisse, cum eadem materia philosophiae (natura scilicet rerum) in tam vagos et multiplices errores abrepta fuerit et distracta. Atque licet hisce temporibus dissensiones et dogmatum diversitates circa principia ipsa, et philosophias integras, ut plurimum extinctae sint; tamen circa partes philosophiae innumerae manent quaestiones et controversiae; ut plane appareat, neque in philosophiis ipsis, neque in modis demonstrationum aliquid certi aut sani esse.

[206] That is, from observation and experiment to inductive generalisations, or, in other words, from facts to theories. [TF]

LXXVII.

Quod vero putant homines, in philosophia Aristotelis magnum utique consensum esse; cum post illam editam antiquorum philosophiae cessaverint et exoleverint; ast apud tempora, quae sequuta sunt, nil melius inventum fuerit; adeo ut illa tam bene posita et fundata videatur, ut utrumque tempus ad se traxerit: primo, quod de cessatione antiquarum philosophiarum post Aristotelis opera edita homines cogitant, id falsum est; diu enim postea, usque ad tempora Ciceronis et secula sequentia, manserunt opera veterum philosophorum [207]. Sed temporibus insequentibus, ex inundatione Barbarorum in imperium Romanum, postquam doctrina humana velut naufragium perpessa esset; tum demum philosophiae Aristotelis et Platonis, tanquam tabulae ex materia leviore et minus solida, per fluctus temporum servatae sunt [208]. Illud etiam de consensu fallit homines, si acutius rem introspiciant. Verus enim consensus is est, qui ex libertate judicii (re prius explorata) in idem conveniete consistit [209]. At numerus longe maximus eorum, qui in Aristotelis philosophiam consenserunt, ex praejudicio et authoritate aliorum se illi mancipavit: ut sequacitas sit potius et coitio, quam consensus

[210]. Quod si fuisset ille verus consensus et late patens, tantum abest ut consensus pro vera et solida authoritate haberi debeat, ut etiam violentam praesumptionem inducat in contrarium [211]. Pessimum enim omnium est augurium, quod ex consensu capitur in rebus intellectualibus: exceptis divinis et politicis, in quibus suffragiorum jus est [212]. Nihil enim multis placet, nisi imaginationem feriat, aut intellectum vulgarium notionum nodis astringat, ut supra dictum est [213]. Itaque optime traducitur illud Phocionis [214] a moribus ad intellectualia: Ut statim se examinare debeant homines, quid erraverint aut peccaverint, si multitudo consentiat et complaudat. Hoc signum igitur ex aversissimis est. Itaque quod signa veritatis et sanitatis philosophiarum et scientiarum, quae in usu sunt, male se habeant; sive capiantur ex originibus ipsarum, sive ex fructibus, sive ex progressibus, sive ex confessionibus authorum, sive ex consensu; jam dictum est.

[207] This statement is proved not only by the citations in Cicero, but also by the work of Diogenes Laertius, which, though of uncertain date, is placed by some authorities as late as the time of Constantine the Great, as well as by the references in the Christian Fathers of the third and fourth centuries. [TF]

[208] See note 89 on Aphorism 71. [TF]

[209] There are really three conditions of 'verus consensus,' of which Bacon enumerates only the two last, taking probably the first for granted:

(1) The judges must be competent;
(2) The matter in question must. have been thoroughly examined, before judgment is pronounced;
(3) The consent must be free, that is to say, the judges must not have been influenced by each other,

On the abuse and limits of the arguments from Authority and from Universal Consent, see my Inductive; Logic, 4th ed., pp. 287-295. [TF]

[210] There is a story of the late Bishop Thirlwall that, on one occasion, distinguishing between the few competent and the many incompetent signatories of a memorial, he described the latter as so many ciphers after a decimal point.

On this 'sequacitas et coitio' in, the case, of Aristotle, CP. the beginning of Campanella's treatise 'Philosopiiia sensibus demonstrate,' etc. (published at Naples in 1591), where we find him complaining: 'Et si quando quaestionem sensatae rei tractant, non quod in re est vident; sed quod in verbis Aristotelis scriptum inveniunt, et ex eis arguunt, et ex eis respondent, et si ipsa rei natura sensibus contrariam Aristoteli se offerat noientibus et invitis, dicunt Aristotelem non errasse.' 'Hinc fugientes rerum scientias, conterunt inter se tempus de subjectis scientiarum apud Aristotelem . . . . . Ita quod nunquam (Mehercule) vidi unum ex eis res inspicere, ad campos tendere, maria, et montes, ut res spectent, nec in propriis domibus, sed tantum a libris Aristotelis, et super his stant semper.' pp. 2, 3.

Many similar illustrations will be found among the passages quoted from the opponents of the Aristotelian philosophy in the Introduction, § 12. [TF]

[211] Bacon's impatience with the ever-recurring appeal to authority has, of course, here betrayed him into exaggeration. Consent, however dangerous it may be to accept it as an ultimate argument, is, there can be no doubt, rather a presumption in favour of an opinion than against it. 'Securus judicat orbis terrarum' is an over-strained axiom, but, of the two exaggerations, it is nearer the truth than the 'Pessimum omnium est augurium' etc. of Bacon. [TF]

[212] There may be a touch of irony in this exception. The allusion is to Parliaments and Councils, which decide by a majority of suffrages. [TF]

[213] See Aphorisms 28 and 47. [TF]

[214] See Plutarch's Life of Phocion, Chapter 8: Ἐπεὶ δὲ λέγων ποτὲ γνώμην πρὸς τὸν δῆμον εὐδοκίμει, καὶ πάντας ὁμαλῶς ἐώρα τὸν λόγον ἀποδεχομένους, ἐπιστρα- φεὶς πρὸς τοὺς φίλους εἶπεν: Οὐ δή πού τι κακὸν λέγων ἐμαυτὸν λέληθα. [TF]

LXXVIII.

Jam vero veniendum ad causas errorum [215], et tam diuturnae in illis per tot secula morae; quae plurimae sunt et potentissimae: ut tollatur omnis admiratio, haec quae adducimus homines hucusque latuisse et fugisse; et maneat tantum admiratio, illa nunc tandem alicui mortalium in mentem venire potuisse, aut cogitationem cujuspiam subiisse: quod etiam (ut nos existimamus) foelicitatis magis est cujusdam, quam excellentis alicujus facultatis; ut potius pro temporis partu haberi debeat, quam pro partu ingenii [216].

[215] Here begin the causes of error and of so long continuance in it. They are enumerated as fifteen. [TF]

[216] CP. Aphorism 122. One of Bacon's works is called 'Temporis Partus Masculus.' In a letter to Father Fuigentio, given in Mr. Spedding's Letters and Life of Bacon (Vol. VII. p. 532), he says: 'Equidem memini me, quadraginta abhinc annis, juvenile opusculum circa has res confecisse, quod magna prorsus fiducia et magnifico tituio "Temporis Partum Maximum" inscripsi.' Of this juvenile work no trace probably is left. [TF]

Primo autem tot seculorum numerus, vere rem reputanti, ad magnas angustias recidit. Nam ex viginti quinque annorum centuriis, in quibus memoria et doctrina hominum fere versatur, vix sex centuriae [217] seponi et excerpi possunt, quae scientiarum feraces earumve proventui utiles fuerunt. Sunt enim non minus temporum quam regionum eremi et vastitates. Tres enim tantum doctrinarum revolutiones et periodi recte numerari possunt: una, apud Graecos; altera, apud Romanos; ultima, apud nos,

occidentales scilicet Europae nationes: quibus singulis vix duae centuriae annorum merito attribui possunt. Media mundi tempora, quoad scientiarum segetem uberem aut laetam, infelicia fuerunt. Neque enim causa est ut vel Arabum vel scholasticorum [218] mentio fiat: qui per intermedia tempora scientias potius contriverunt numerosis tractatibus, quam pondus earum auxerunt. Itaque prima causa tam pusilli in scientiis profectus ad angustias temporis erga illas propitii rite et ordine refertur.

[217] In the Cogitata et Visa (Ellis and Spedding, pp. 613, 614), he says 'scarce five centuries.' He there makes no mention of the three periods.

As Dr. Kitchin observes, the duration of these 'three periods' is unduly narrowed. But Bacon probably wished, in estimating the duration of the Greek period, to exclude the philosophy of Plato and Aristotle, and, in estimating the duration of the modern period, to exclude the philosophy of the Schoolmen. If this be the case, we may fix the Greek period from Thales to Plato, the Roman period from Cicero or Lucretius to Marcus Aurelius, and the modem period from the beginning of the revolt against Aristotle, or, perhaps, from the invention of Printing, to Bacon's own time. [TF]

[218] It is now almost superfluous to remark that Bacon is unjust both to the Arabians and to the Schoolmen. Their services to philosophy and literature cannot, it is true, be compared with those of the Greeks or Romans, or with those of the Renaissance, but it was the fashion of Bacon's age unduly to depreciate the studies and the philosophical and scientific results of the Middle Ages, as, in its turn, it has become the fashion of our own time to over-estimate them. [TF]

LXXIX.

At secundo loco se offert causa illa magni certe per omnia momenti: ea videlicet, quod per illas ipsas aetates, quibus hominum ingenia et literae maxime vel etiam mediocriter floruerint, naturalis philosophia minimam partem humanae operae sortita sit. Atque haec ipsa nihilominus pro magna scientiarum matre haberi debet. Omnes enim artes et scientiae, ab hac stirpe revulsae, poliuntur fortasse et in usum effinguntur; sed nil admodum crescunt [219]. At manifestum est, postquam Christiana fides recepta fuisset et adolevisset, longe maximam ingeniorum praestantissimorum partem ad theologiam se contulisse; atque huic rei et amplissima praemia proposita, et omnis generis adjumenta copiosissime subministrata fuisse: atque hoc theologiae studium praecipue occupasse tertiam illam partem sive periodum temporis apud nos Europaeos occidentales; eo magis, quod sub idem fere tempus et literae florere, et controversiae circa religionem pullulare coeperint. At aevo superiori, durante periodo illa secunda apud Romanos, potissimae philosophorum meditationes et industriae in morali philosophia (quae ethnicis vice theologiae erat [220]) occupatae et consumptae fuerunt: etiam summa ingenia illis temporibus ut plurimum ad res civiles se applicuerunt, propter magnitudinem imperii Romani, quod plurimorum hominum opera indigebat. At illa aetas, qua naturalis philosophia apud Graecos maxime florere visa est, particula fuit temporis minime diuturna; cum et antiquioribus temporibus septem illi, qui sapientes

nominabantur, omnes (praeter Thaletem) ad moralem philosophiam et civilia se applicuerint; et posterioribus temporibus postquam Socrates philosophiam de coelo in terras deduxisset [221], adhuc magis invaluerit moralis philosophia, et ingenia hominum a naturali averterit.

[219] It is somewhat difficult to reconcile Bacon's conception of Natural Philosophy, so far as we can discover it from this and the next Aphorism, with the account of it given in De Augmentis Scientiarum, Book III. In these Aphorisms, Natural Philosophy is described as 'magna ista scientiarum mater,' and as the 'root' and 'trunk' from which the arts and sciences branch. But in the De Augmentis Scientiarum, this language is used not of Natural Philosophy, but of the Philosophia Prima. 'Quoniam autem partitiones scientiarum non sunt lineis diversis similes, quae coëunt ad unum angulum; sed potius ramis arborum, qui conjunguntur in uno trunco (qui etiam truncus ad spatium nonnullum integer est et continuus, antequam se partiatur in ramos): idcirco postulat res, ut priusquam prioris partitionis membra persequamur, constituatur una Scientia Universalis, quae sit mater reliquarum, et habeatur in progressu doctrinarum tanquam portio viae communis antequam viae se separent et disjungant.' De Augmentis Scientiarum, Libro III. Cap. I. Natural Philosophy, again, in the De Augmentis Scientiarum is confined to the knowledge of Nature, there being distinct divisions of philosophy assigned to the knowledge of God and the knowledge of Man, But, in Aphorism 80, 'philosophia moralis et dvilis, et scientiae logicae' are regarded as receiving their proper nutriment from Natural Philosophy, which has for its object not only motions, rays, sounds, etc., but also 'affectus, et prehensiones intellectuales.' In the two books of the Advancement of Learning, the account of the respective functions of the Philosophia Prima and Natural Philosophy is substantially the same as that in the De Augmentis Scientiarum. CP. also Book I. Aphorism 127 of the Novum Organum. One can hardly avoid the conclusion that, in the Aphorisms now under discussion, Bacon has confounded the conception of Natural Philosophy with that of the Philosophia Prima.

This difficulty having been pointed out, the subsequent notes to these two Aphorisms must be regarded as applying to Natural Philosophy only as here understood. [TF]

[220] In the corresponding passage of the Cogitata et Visa, Gruter, though not the Queen's College MS., reads 'quae Ethnicis, magna ex parte, vice Theologiae erat.'

The Greek and Roman religions contained little theology in our sense of the term. They recognised no creeds, catechisms, or articles of faith. Nor were the priests of the classical religions, like ours, moral and religious teachers. The religion was mainly a cult, and the priests were almost exclusively the performers of rites and sacrifices. Into a man's religious convictions, so long as he kept the required religious observances, few cared to enquire. Nor, again, though certain crimes, such as homicide, the refusal of hospitality, the breach of an oath, the removal of a boundary, etc., were supposed to be avenged by certain deities, was there any definite and detailed connexion between the religion and the morality of classical times. Of the divorce between the popular religion and what we

understand by morality, we cannot have better examples than those adduced by Plato in the 2nd and 3rd Books of the Republic.

Hence, it naturally happened that the discussions as to the nature of the Gods and the grounds and precepts of morality fell into the hands of the philosophers. Theology, as treated by them, assumed a metaphysical character, having little or no practical bearing on the affairs of life (witness the discussions in the so-called 'Metaphysics' of Aristotle), and, consequently, possessed no attractions for ordinary men. The belief or disbelief in the propositions maintained by the philosophers was not regarded as likely to affect a man's lot either in this world or the next. The tendency of speculation, therefore, both among the later Greeks and the Romans, was towards a philosophy of life, character, and conduct, and this tendency amongst the Romans was specially assisted by the legal and practical direction of their minds. The favourite topics of discussion were not the nature of the Gods and our relations to them, much less our duties towards them, but our relations and duties to each other, the main objects of life, wherein consists the perfection of human nature, by what means we can attain that perfection, and other questions of a similar character. It was the answer to these questions, we might say, and not the answer to theological enquiries, which furnished the spiritual sustenance of the Greeks and Romans. Hence, Bacon's remark that moral philosophy, in classical times, supplied the place of theology, if not accurately, is at least approximately true. [TF]

[221] See Cicero's Tusculan Disputations, Book V. Chapter 4: 'Socrates autem primus philosophiam devocavit e coelo, et in urbibus collocavit, et in domos etiam introduxit, et coegit de vita, et moribus, rebusque bonis et malis quaerere.' CP. Academics, I. 4. [TF]

At ipsissima illa periodus temporis, in qua inquisitiones de natura [222] viguerunt, contradictionibus et novorum placitorum ambitione corrupta est, et inutilis reddita. Itaque quandoquidem per tres istas periodos naturalis philosophia majorem in modum neglecta aut impedita fuerit, nil mirum si homines parum in ea re profecerint, cum omnino aliud egerint.

[222] In this concluding paragraph, Bacon seems to employ the phrase Natural Philosophy in the same sense as in the De Augmentis Scientiarum. [TF]

LXXX.

Accedit et illud, quod naturalis philosophia in iis ipsis viris, qui ei incubuerint, vacantem et integrum hominem, praesertim his recentioribus temporibus, vix nacta sit; nisi forte quis monachi alicujus in cellula, aut nobilis in villula lucubrantis, exemplum adduxerit [223]: sed facta est demum naturalis philosophia instar transitus cujusdam et pontisternii ad alia.

[223] In the Cogitata et Visa (Ellis and Spedding, Vol. III. p. 595), Bacon adds quod et rarissimum reperietur.'

It has sometimes been suggested that the allusions in this passage are specifically to Roger Bacon and Descartes. But Descartes had not yet (1620) published any works, and, as he was only born in 1596, he cannot possibly have been alluded to by Bacon in the Cogitata et Visa, which was composed about 1607. [TF]

Atque magna ista scientiarum mater mira indignitate ad officia ancillae detrusa est; quae medicinae aut mathematices [224] operibus ministret, et rursus quae adolescentium immatura ingenia lavet et imbuat velut tinctura quadam prima, ut aliam postea foelicius et commodius excipiant. Interim nemo expectet magnum progressum in scientiis (praesertim in parte earum operativa), nisi philosophia naturalis ad scientias particulares producta fuerit, et scientiae particulares rursus ad naturalem philosophiam reductae. Hinc enim fit, ut astronomia, optica, musica, plurimae artes mechanicae, atque ipsa medicina, atque (quod quis magis miretur) philosophia moralis et civilis, et scientiae logicae, nil fere habeant altitudinis in profundo: sed per superficiem et varietatem rerum tantum labantur: quia, postquam particulares istae scientiae dispertitae et constitutae fuerint, a philosophia naturali non amplius aluntur; quae ex fontibus et veris contemplationibus motuum, radiorum, sonorum, texturae, et schematismi corporum, affectuum, et prehensionum intellectualium, novas vires et augmenta illis impertiri potuerit [225]. Itaque minime mirum est si scientiae non crescant, cum a radicibus suis sint separatae.

[224] In the De Augmentis Scientiarum, Mathematics are called the ‘great Appendix’ of Natural Philosophy (Libro III. Cap. 6), while Medicine is one of the divisions of Human Philosophy, ‘Doctrina de Homine' (Libro IV. Cap. 2). [TF]

[225] Apart from the question of the appropriate or inappropriate use of the term ‘Natural Philosophy,’ there can be little question that Bacon’s thought here is a just one. Every special art or science ought to be treated in reference to the general science under which it falls. Thus, Logic is empirical, unless based on Psychology; Medicine, unless based on a knowledge of Physiology; Mechanics, unless based on the Laws of Motion, Force, etc.; and so on throughout the sciences- Bacon seems here to have conceived of Natural Philosophy as the one general science with which the more special sciences Should be brought into connexion, and which should deal with the laws of nature and man in a more comprehensive manner than it was possible for the more special sciences to do. It was to give, as it were, a general survey of nature, and then the more special sciences were to follow out in detail particular departments, never, however, losing sight of the common stock with which they were connected.

The inclusion of ‘affectus, et prehensiones intellectuales' among the objects of Natural Philosophy, though inconsistent with Bacon’s employment of the word in the De Augmentis Scientiarum, is in accordance with ancient usage. The word Psychology is comparatively modern, and the questions of which that science treats were included by ancient authors under Physiology or Physics. Thus, the De Anima was always ranked among the physical works of Aristotle. In the old Statutes of the University of Oxford, among the books on which the ‘Praelector Naturalis Philosophiae’ was to lecture were

the ‘libri de Anima.’ For instances of the Aristotelian use of the words ‘physical’ and ‘physiological,’ as including what we should call ‘psychological,’ see Eth. VII. 3 (9. 12) [225.1]. [TF]

[225.1] Aristotle has two books that can be abbreviated to “Eth.” They are “Ethica Nicomachea” and “Ethica Eudemia”. It is not clear to me which of these is referred to by Fowler. [HJ]

LXXXI.

Rursus se ostendit alia causa potens et magna, cur scientiae parum promoverint. Ea vero haec est; quod fieri non possit, ut recte procedatur in curriculo, ubi ipsa meta non recte posita sit et defixa. Meta autem scientiarum vera et legitima non alia est quam ut dotetur vita humana novis inventis et copiis [226]. At turba longe maxima nihil ex hoc sapit, sed meritoria plane est et professoria; nisi forte quandoque eveniat, ut artifex aliquis acrioris ingenii, et gloriae cupidus, novo alicui invento det operam; quod fere fit cum facultatum dispendio. At apud plerosque tantum abest ut homines id sibi proponant, ut scientiarum et artium massa augmentum obtineat, ut ex ea, quae praesto est, massa nil amplius sumant aut quaerant, quam quantum ad usum professorium aut lucrum aut existimationem aut hujusmodi compendia convertere possint [227]. Quod si quis ex tanta multitudine scientiam affectu ingenuo et propter se expetat; invenietur tamen ille ipse potius contemplationum et doctrinarum varietatem, quam veritatis severam et rigidam inquisitionem sequi. Rursus, si alius quispiam fortasse veritatis inquisitor sit severior; tamen et ille ipse talem sibi proponet veritatis conditionem, quae menti et intellectui satisfaciat in redditione causarum rerum quae jampridem sunt cognitae; non eam, quae nova operum pignora, et novam axiomatum lucem assequatur. Itaque, si finis scientiarum a nemine adhuc bene positus sit, non mirum est si in iis, quae sunt subordinata ad finem, sequatur aberatio.

[226] CP. Cogitata et Visa (Ellis and Spedding, Vol. III. p. 595): ‘Metam autem non aliam esse, quam ut genus humanum novis operibus et potestatibus continuo dotetur.’

This, as I have pointed out in the Introduction (pp. 129, 130, and elsewhere), is one of the watchwords of the Baconian philosophy. But we must, at least, take it in conjunction with the maxim which Bacon is never weary of repeating: ‘Lucifera experimenta, non fructifera quaerenda.’ It often happens that enquiries which at first sight appear to have no practical bearing are ultimately found to contribute largely to the comforts and conveniences of life. But, even if this were not the case, it might be maintained, and maintained rightly, that knowledge should be sought for its own sake. No reason can be given why man should not be at full liberty to gratify his desire of knowledge, his curiosity to know all that is about and within him, as much as any other desire of his nature. As Bacon himself says in the Praise of Knowledge, ‘Are not the pleasures of the affections greater than the pleasures of the senses? And are not the pleasures of the intellect greater than the pleasures of the affections? Is not knowledge a true and only natural pleasure, whereof there is no satiety?’

On ‘the limits and end of knowledge,’ there is a long chapter in the Valerius Terminus (Ellis and Spedding, Vol. III. pp. 117-224). There Bacon takes, as I conceive, an unduly narrow view. All knowledge,’ he says, ‘should be referred to use and action.’ ‘Knowledge that tendeth but to satisfaction is but as a courtesan, which is for pleasure and not for fruit or generation.’ In the same spirit, or in exaggeration of the same spirit, Comte objects to the continued cultivation of sidereal astronomy, the search into the internal constitution of the sun, and other pursuits which are not likely to contribute to the welfare of mankind. But, apart from the legitimate and often exquisite pleasure to be derived from these investigations, may they not be justified by their tendency to divert us from merely selfish aims, by the interests which they excite in objects external to ourselves, and by the widening and elevating influence which they so frequently exert on the intellect and character?

For a different and more liberal view of the relation between knowledge and practice, ‘veritas et utilitas,’ see Aphorism 124; and CP. my notes upon it. [TF]

[227] CP. De Augmentis Scientiarum, Libro I. (Ellis and Spedding, Vol. I. pp. 462-3): ‘Omnium autem gravissimus error in deviatione ab ultimo doctrinarum fine consistit. Appetunt enim homines scientiam, alii ex insita curiositate et irrequieta; alii animi causa et delectationis; alii existimationis gratia; alii contentionis ergo, atque ut in disserendo superiores sint; plerique propter lucrum et victum; paucissimi ut donum rationis divinitus datum in usus humani generis impendant. Plane, quasi in doctrina quaereretur lectulus, in quo tumultuans ingenium et aestuans requiesceret; aut xystus sive porticus, in quo animus deambularet liber aut vagus; aut turris alta et edita, de qua mens ambitiosa et superba despectaret; aut arx et propugnaculum ad contentiones et praelia; aut officina ad quaestum et mercatum; et non potius locuples armarium et gazophylacium, ad opificis rerum omnium gloriam et vitae humanae subsidium. Hoc enim illud est, quod revera doctrinam atque artes condecoraret et attolleret, si contemplatio et actio arctiore quam adhuc vinculo copiilarentur. Quae certe conjunctio tails foret, qualis est supremorum duorum planetarum , syzygia, cum Saturnus, quietis et contempiationis dux, cum Jove, duce societatis agendique, conspiret.’

The whole of the First Book of the De Augmentis Scientiarum is occupied with a defence of Knowledge and a statement of its dignity and ends. [TF]

LXXXII.

Quemadmodum autem finis et meta scientiarum male posita sunt apud homines; ita rursus etiamsi illa recte posita fuissent, viam tamen sibi delegerunt omnino erroneam et imperviam [228]. Quod stupore quodam animum rite rem reputanti perculserit; non ulli mortalium curae aut cordi fuisse, ut intellectui humano ab ipso sensu et experientia ordinata et bene condita via aperiretur et muniretur; sed omnia vel traditionum caligini, vel argumentorum vertigini et turbini, vel casus et experientiae vagae et inconditae undis et ambagibus permissa esse. Atque cogitet quis sobrie et diligenter, qualis sit ea via,

quam in inquisitione et inventione alicujus rei homines adhibere consueverunt. Et primo notabit proculdubio inveniendi modum simplicem et inartificiosum, qui hominibus maxime est familiaris. Hic autem non alius est, quam ut is, qui se ad inveniendum aliquid comparat et accingit, primo quae ab aliis circa illa dicta sint inquirat et evolvat; deinde propriam meditationem addat, atque per mentis multam agitationem spiritum suum proprium sollicitet, et quasi invocet, ut sibi oracula pandat: quae res omnino sine fundamento est, et in opinionibus tantum volvitur.

[228] There is little in this Aphorism which Bacon has not already said. But it is often striking in expression, and may be taken as a summary statement of the false methods which men pursue in their enquiries. The first of these is to collect opinions and authorities, and then, by comparing them and reflecting on them, to attempt to arrive at an opinion of our own. The second is to follow the dialectical (or syllogistical) method, not examining the first principles, but either taking them for granted or borrowing them from the professors of the several arts, and then pursuing these first principles to their remote consequences, without pausing to enquire into the truth of the data on which they are based. The third and last is to consult experience, but without any definite order or method, groping, as it were, in the dark, instead of guiding our steps by a light. [TF]

At alius quispiam dialecticam ad inveniendum advocet, quae nomine tenus tantum ad id quod agitur pertinet. Inventio enim dialecticae non est principiorum et axiomatum praecipuorum, ex quibus artes constant, sed eorum tantum quae illis consentanea videntur. Dialectica enim magis curiosos et importunos, et sibi negotium facessentes, eamque interpellantes de probationibus et inventionibus principiorum, sive axiomatum primorum, ad fidem, et veluti sacramentum cuilibet arti praestandum, notissimo responso rejicit.

Restat experientia mera: quae, si occurrat, casus; si quaesita sit, experimentum nominatur. Hoc autem experientiae genus nihil aliud est, quam (quod aiunt) scopae dissolutae [229], et mera palpatio [230], quali homines noctu utuntur, omnia pertentando, si forte in rectam viam incidere detur; quibus multo satius et consultius foret diem praestolari [231], aut lumen accendere, et deinceps viam inire. At contra, verus experientiae ordo primo lumen accendit, deinde per lumen iter demonstrat, incipiendo ab experientia ordinata et digesta, et minime praepostera aut erratica, atque ex ea educendo axiomata, atque ex axiomatibus constitutis rursus experimenta nova; quum nec verbum divinum in rerum massam absque ordine operatum sit.

[229] 'Loose twigs,' 'Scopas dissolvere,' to untie a broom, was a proverb for throwing anything into confusion and disorder. See Cicero, Orator, Chapter 71: Msti autem cum dissolvunt orationem, in qua nec res nec verbum ullum est, nisi abjectum: non clypeum, sed, ut in proverbio est (etsi humllius dictum est, tamen consimile est) scopas mihi videntur dissolvere.' There is a similar application of the proverb in the Epistles to Atticus, Libro VII. ep. 13: Caesarem vidi Minturnis, cum absurdissimis mandatis, non hominem, sed scopas solutas.' The proverb may have had its origin in the Fable of the Father and his Sons, 'as inculcating Unity,' [TF]

[230] See the passage from the De Augmentis Scientiarum, Libro V. Cap. 2, already quoted in note 76 to Aphorism 70. [TF]

[231] ὕστερον πρύτερον; observing m order or method, or, perhaps, the wrong order. [TF]

Itaque desinant homines mirari si spatium scientiarum non confectum sit, cum a via omnino aberraverint; relicta prorsus et deserta experientia, aut in ipsa (tanquam in labyrintho) se intricando, et circumcursando; cum rite institutus ordo per experientiae sylvas [232] ad aperta axiomatum tramite constanti ducat.

[232] Bacon gave the title of 'Sylva Sylvarum' to his 'Ten Centuries' of 'Natural History.'

Dr. Kitchin quotes, as illustrating this metaphor, an apposite passage from one of Bacon's Fragments: 'We endeavour to penetrate and pass through the woods of Nature, thick set and darkened with a great variety of experiments, as with leaves; and entangled and twined together, like shrubs and bushes, with the subtilty of observations. We are now, perhaps, proceeding to the more open parts of Nature, which, however, are still more difficult; and, having got through the woods, are come to the bottom of the mountains.' [TF]

LXXXIII.

Excrevit autem mirum in modum istud malum ex opinione quadam, sive aestimatione inveterata, verum tumida et damnosa; minui nempe mentis humanae majestatem, si experimentis, et rebus particularibus sensui subjectis et in materia detriminatis, diu ac multum versetur: praesertim quum hujusmodi res ad inquirendum laboriosae, ad meditandum ignobiles, ad dicendum asperae, ad practicam illiberales, numero infinitae, et subtilitate tenues esse soleant [233]. Itaque jam tandem huc res rediit, ut via vera non tantum deserta, sed etiam interclusa et obstructa sit; fastidita experientia, nedum relicta, aut male administrata.

[233] In the Cogitata et Visa (Ellis and Spedding, Vol. III. pp. 600-1) Bacon makes the same reflexions, and then, adds: 'Quam opinionem sive animi dispositionem vires maximas sumpsisse ex ilia altera opinione elata et commentitia, qua veritas humanae mentis veluti indigena, nec aliunde commigrans; et sensus intellectum magis excitare quam informare asserebatur. Neque tamen errorem hunc, et mentis (si verum nomen quaeratur) alienationem, ab iis ulla ex parte correctam, qui sensui debitas, id est primas, partes tribuerunt. Quin et hos quoque exemplo et facto suo, relicta prorsiis Naturali historia et mundana perambulatione, omnia in Ingenii agitatione posuisse, et inter opacissima mentis Idola, sub specioso contemplationis nomine, perpetuo volutasse.' The student will not fail to notice the psychological interest attaching to the early part of this quotation. [TF]

LXXXIV.

Rursus vero homines a progressu in scientiis detinuit et fere incantavit reverentia antiquitatis, et virorum, qui in philosophia magni habiti sunt, authoritas, atque deinde consensus. Atque de consensu superius dictum est [234].

[234] Aphorism 77. CP. notes on that Aphorism, and also the passage in my Inductive Logic (4th ed., pp. 287-295) there referred to. To the instances of extravagant respect for authority given in those places, the reader may add the following taken from Galileo's 1st Dialogue (Sir Thomas Salusbury's Translation, pp. 91-93)

'SAGREDUS. I found one day, at home in his house, at Venice, a famous phisician, to whom some flockt for their studies, and others out of curiosity sometimes came thither to see certain anatomies dissected by the hand of a no lesse learned, than careful and experienced anatomist. It chanced upon that day, when I was there, that he was in search of the original and rise of the nerves, about which there is a famous controversie between the Galenists and Peripateticks; and the anatomist shewing, how that great number of nerves departing from the brain, as their root, and passing by the nape of the neck, distend themselves afterwards along by the back-bone, and branch themselves thorow all the body: and that a very small filament, as fine as a thred, went to the heart; he turned to a gentleman whom he knew to be a Peripatetick philosopher, and for whose sake he had, with extraordinary exactnesse, discovered and proved every thing, and demanded of him, if he was at length satisfied and perswaded that the original of the nerves proceeded from the brain, and not from the heart? To which the philosopher, after he had stood musing a while, answered; you have made me to see this business so plainly and sensibly, that did not the text of Aristotle assert the contrary, which positively affirmeth the nerves to proceed from the heart, I should be constrained to confesse your opinion to be true.'

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'SALVIATUS. And there are certain gentlemen yet living, and in health, Yvho were present, when a doctor, that was professor in a famous academy, hearing the description of the telescope, by him not seen as then, said that the invention was taken from Aristotle, and, causing his works to be fetch' t, he turned to a place where the philosopher gives the reason, whence it commeth, that from the bottom of a very deep well one may see the stars in heaven at noon day; and, addressing himself to the company, see here, saith he, the well, which representeth the tube, see here the gross vapours, from whence is taken the invention of the crystals, and see here lastly the sight fortified by the passage of the rays through a diaphonous, but more dense and obscure medium.'

On the immoderate reverence for Antiquity and Authority, CP. De Augmentis Scientiarum, Libro I. (Ellis and Spedding, Vol. I. pp. 456-459). This passage, though full of interest, is too long for quotation. [TF]

De antiquitate autem opinio, quam homines de ipsa fovent, negligens omnino est, et vix verbo ipsi congrua [235]. Mundi enim senium et gradævitas pro antiquitate vere

habenda sunt; quae temporibus nostris tribui debent, non juniori aetati mundi, qualis apud antiquos fuit. Illa enim aetas, respectu nostri, antiqua et major; respectu mundi ipsius, nova et minor fuit [236]. Atque revera quemadmodum majorem rerum humanarum notitiam et maturius judicium ab homine sene expectamus quam a juvene, propter experientiam et rerum, quas vidit, et audivit, et cogitavit, varietatem et copiam; eodem modo et a nostra aetate (si vires suas nosset, et experiri et intendere vellet) majora multo quam a priscis temporibus expectari par est; utpote aetate mundi grandiore, et infinitis experimentis et observationibus aucta et cumulata.

[235] The thought which Bacon here elaborates, is summed up in one short Aphorism in the parallel passage of De Augmentis Scientiarum, Libro i.: Sane, ut verum dicamus, Antiquitas saeculi juventus mundi.' For a discussion of the questions whether this Aphorism is due to Bacon himself, and what traces of it are to be found in earlier writers, see a note in my Inductive Logic, 4th ed., pp. 331-2, and also a note by Mr. Ellis to the De Augmentis Scientiarum, Libro I. (Ellis and Spedding, pp. 458-9). Both De Rémusat and Mr. Ellis cite very appositely 2 Esdras XIV. 10: 'For the world hath lost his youth, and the times begin to wax old.' [TF]

[236] Bentham in his Book of Fallacies, part I. Chapter 2, and Sydney Smith in his review of that work (Edinburgh Review, No. 84, reprinted in his Collected Works), follow up this argument in a striking and amusing manner. [TF]

M. Bouillet refers, for the same sentiment, to Pascal and Malebranche, but both his references are wrong. The right reference to Pascal is to a Fragment entitled 'Préface sur le Traité du Vide' or 'De l'autorité en matiére de philosophie.' The right reference to Malebranclie is to ' De la Recherche de la Vérite,' livre II. 2^{me} partie, Chapter 4. Both passages are interesting. [TF]

Neque pro nihilo aestimandum, quod per longinquas navigationes et peregrinationes (quae seculis nostris increbuerunt) plurima in natura patuerint, et reperta sint, quae novam philosophiae lucem immittere possint. Quin et turpe hominibus foret, si globi materialis tractus, terrarum videlicet, marium, astrorum, nostris temporibus immensum aperti et illustrati sint; globi autem intellectualis [237] finis inter veterum inventa et angustias cohibeantur.

[237] One of Bacon's minor works (reprinted in Ellis and Spedding's ed., Vol. III. pp. 727-768) is designated 'Descriptio Globi Intellectiialis.' To it is appended the 'Thema Coeli.' [TF]

Authores vero quod attinet, summae pusillanimitatis est authoribus infinita tribuere, authori autem authorum, atque adeo omnis authoritatis, Tempori, jus suum denegare. Recte enim Veritas Temporis filia dicitur, non Authoritatis [238]. Itaque mirum non est, si fascina ista antiquitatis et authorum et consensus, hominum virtutem ita ligaverint, ut cum rebus ipsis consuescere (tanquam maleficiati) non potuerint.

[238] See Aulus Gellius, Noctes Atticae, Libro xii. Cap. ii: Alius quidam veterum poetarum, cujus nomen mihi nunc memoriae non est, veritatem temporis filiam esse dixit.' I am indebted for this quotation to the Rev. E. Marshall. CP. Aeschylus, Prometheus Vinctus, 1. 981:

'Αλλ ἐκδιδάσκει πάνθ' ὁ γηράσκων χρόνος.

'Veritas temporis filia,' it has been pointed out to me, is the legend on the groats of Queen Mary, which must have been in use in Bacon's time. [TF]

LXXXV.

Neque solum admiratio antiquitatis, authoritatis, et consensus, hominum industriam in iis, quae jam inventa sunt, acquiescere compulit; verum etiam operum ipsorum admiratio, quorum copia jampridem facta est humano generi. Etenim quum quis rerum varietatem, et pulcherrimum apparatum qui per artes mechanicas ad cultum humanum congestus et introductus est, oculis subjecerit, eo certe inclinabit, ut potius ad opulentiae humanae admirationem, quam ad inopiae sensum accedat; minime advertens primitivas hominis observationes atque naturae operationes (quae ad omnem illam varietatem instar animae sunt, et primi motus) nec multas, nec alte petitas esse; caetera ad patientiam hominum tantum, et subtilem et ordinatum manus vel intrumentorum motum, pertinere [239]. Res enim (exempli gratia) subtilis est certe et accurata confectio horologiorum, talis scilicet, quae coelestia in rotis, pulsum animalium in motu successivo et ordinato, videatur imitari; quae tamen res ex uno aut altero naturae axiomate pendet.

[239] In the Cogitata et Visa (Ellis and Spedding, Vol. III. p. 593), the following sentence occurs after the words 'motum tantum pertinere:' 'atque in hac parte officinam cum Bibliotheca mire congruere, quae et ipsa tantam librorum varietatem ostentet, in qui bus si diligentius introspicias, nil aliud quam ejusdem rei infinitas repetitiones reperias, tractatu novas, invention praeoccupatas.' The substance of this sentence, though not in so neat a form, occurs in the next paragraph but one of this Aphorism. [TF]

Quod si quis rursus subtilitatem illam intueatur quae ad artes liberales pertinet; aut etiam eam quae ad corporum naturalium praeparationem per artes mechanicas spectat, et hujusmodi res suspiciat; veluti inventionem motuum coelestium in astronomia, concentuum in musica, literarum alphabeti (quae etiam adhuc in regno Sinarum in usu non sunt) in grammatica; aut rursus in mechanicis, factorum Bacchi et Cereris, hoc est, praeparationum vini et cervisiae, panificiorum, aut etiam mensae delitiarum, et distillationum, et similium: ille quoque, si secum cogitet, et animum advertat, per quantos temporum circuitus (cum haec omnia, praeter distillationes [240], antiqua fuerint) haec ad eam, quam nunc habemus, culturam perducta sint, et (ut jam de horologiis dictum est) quam parum habeant ex observationibus et axiomatibus naturae, atque quam facile, et tanquam per occasiones obvias et contemplationes incurrentes, ista inveniri potuerint: ille (inquam) ab omni admiratione se facile liberabit, et potius humanae conditionis miserebitur, quod per tot secula tanta fuerit rerum et inventorum penuria et sterilitas. Atque haec ipsa tamen, quorum nunc mentionem fecimus, inventa,

philosophia et artibus intellectus antiquiora fuerunt: adeo ut(si verum dicendum sit) cum hujusmodi scientiae rationales et dogmaticae inceperint, inventio operum utilium desierit [241].

[240] Distillation is generally supposed to have been introduced into Europe by the Moors about A.D. 1150, but as regards its earlier history there is considerable difficulty. Mr. Ellis refers to Dutens, Origine des Découvertes, etc., p. 187 of the London Edition, and Humboldt's Examen critique de l'Histoire de la Géographie, etc., Vol. II. p. 306. [TF]

[241] This is, of course, an exaggeration. It is true, however, that neither science nor philosophy came into existence, or could have come into existence, till the primary wants of life were satisfied. [TF]

Quod si quis ab officinis ad bibliothecas se converterit, et immensam, quam videmus, librorum varietatem in admiratione habuerit, is, examinatis et diligentius introspectis ipsorum librorum materiis et contentis, obstupescet certe in contrarium; et postquam nullum dari finem repetitionibus observaverit, quamque homines eadem agant et loquantur, ab admiratione varietatis transibit ad miraculum indigentiae et paucitatis earum rerum quae hominum mentes adhuc tenuerunt et occuparunt.

Quod si quis ad intuendum ea, quae magis curiosa habentur quam sana, animum submiserit, et alchymistarum aut magorum opera penitius introspexerit, is dubitabit forsitan utrum risu an lachrymis potius illa digna sint. Alchymista [242] enim spem alit aeternam, atque ubi res non succedit errores proprios reos substituit; secum accusatorie reputando, se aut artis aut authorum vocabula non satis intellexisse, unde ad traditiones et auriculares susurros animum applicat; aut in practicae suae scrupulis et momentis [243] aliquid titubatum esse, unde experimenta in infinitum repetit: ac interim quum inter experimentorum sortes in quaedam incidit aut ipsa facie nova aut utilitate non contemnenda; hujusmodi pignoribus animum pascit, eaque in majus ostentat et celebrat: reliqua spe sustentat. Neque tamen negandum est, alchymistas non pauca invenisse, et inventis utilibus homines donasse. Verum fabula illa [244] non male in illos quadrat de sene, qui filiis aurum in vinea defossum (sed locum se nescire simulans) legaverit; unde illi vineae fodiendae diligenter incubuerunt, et aurum quidem nullum repertum, sed vindemia ex ea cultura facta est uberior.

[242] CP. Aphorisms 54 and 73, and De Augmentis Scientiarum, lib, I. (Ellis and Spedding, Vol. I. pp. 456-7). [TF]

[243] He supposes that he has made some mistake either in weighing, or in selecting the proper moment for his manipulations. [TF]

[244] The Fable of the Father and his Sons, 'as inculcating Industry.' [TF]

At naturalis magiae [245] cultores, qui per rerum sympathias et antipathias omnia expediunt, ex conjecturis otiosis et supinissimis, rebus virtutes et operationes

admirabiles affinxerunt; atque si quando opera exhibuerint, ea illius sunt generis, ut ad admirationem et novitatem, non ad fructum et utilitatem, accommodata sint.

[245] See note 6 on Aphorism 5, and CP. Book II. Aphorism 9. [TF]

In superstitiosa autem magia [246] (si et de hac dicendum sit) illud inprimis animadvertendum est, esse tantummodo certi cujusdam et definiti generis subjecta, in quibus artes curiosae et superstitiosae, per omnes nationes atque aetates atque etiam religiones, aliquid potuerint aut luserint. Itaque ista missa faciamus. Interim nil mirum est, si opinio copiae causam inopiae dederit.

[246] 'Superstitious Magic' Bacon would, of course, altogether reject, though Natural Magic, in a purified form, he would admit as a branch of the 'Doctrina Operativa de Natura; Mechanics being the other branch. See De Augmentis Scientiarum, Libro III. Cap. 5. [TF]

LXXXVI.

Atque hominum admirationi, quoad doctrinas et artes, per se satis simplici et prope puerili, incrementum accessit ab eorum astu et artificio qui scientias tractaverunt et tradiderunt. Illi enim ea ambitione et affectatione eas proponunt, atque in eum modum efformatas ac veluti personatas in hominum conspectum producunt, ac si illae omni ex parte perfectae essent et ad exitum perductae. Si enim methodum aspicias et partitiones, illae prorsus omnia complecti et concludere videntur, quae in illud subjectum cadere possunt. Atque licet membra illa male impleta et veluti capsulae inanes sint; tamen apud intellectum vulgarem scientiae formam et rationem integrae prae se ferunt.

At primi et antiquissimi veritatis inquisitores, meliore fide et fato, cognitionem illam, quam ex rerum contemplatione decerpere, et in usum recondere statuebant, in aphorismos [247], sive breves easdemque sparsas nec methodo revinctas sententias, conjicere solebant; neque se artem universam complecti simulabant aut profitebantur. At eo quo nunc res agitur modo, minime mirum est, si homines in iis ulteriora non quaerant, quae pro perfectis et numeris suis jampridem absolutis traduntur.

[247] On the advantages of the Aphoristic over the Methodic treatment of a science which is still in its growth, CP. De Augmentis Scientiarum, Libro vi. Cap. 2 (Ellis and Spedding, pp. 665-6), where Bacon is still fuller and more explicit than in this passage. [TF]

In speaking of the 'primi et antiquissimi veritatis inquisitors,' he is probably thinking of Hippocrates, who;wrote in Aphorisms, as well as of the early Greek philosophers, whose wisdom was contained in γνῶμαι, sententiae, or maxims. [TF]

LXXXVII.

Etiam antiqua magnum existimationis et fidei incrementum acceperunt ex eorum vanitate et levitate, qui nova proposuerunt; praesertim in philosophiae naturalis parte activa et operativa [248]. Neque enim defuerunt homines vaniloqui et phantastici, qui partim ex credulitate, partim ex impostura, genus humanum promissis onerarunt: vitae prolongationem, senectutis retardationem, dolorum levationem, naturalium defectuum reparationem, sensuum deceptiones, affectuum ligationes et incitationes, intellectualium facultatum illuminationes et exaltationes, substantiarum transmutationes, et motuum ad libitum roborationes et multiplicationes, aëris impressiones et alterationes, coelestium influentiarum deductiones et procurationes, rerum futurarum divinationes, remotarum repraesentationes, occultarum revelationes, et alia complura pollicitando et ostentando. Verum de istis largitoribus non multum aberraverit, qui istiusmodi judicium fecerit, tantum nimirum in doctrinis philosophiae inter horum vanitates et veras artes interesse, quantum inter res gestas Julii Caesaris, aut Alexandri Magni, et res gestas Amadicii ex Gallia [249], aut Arthuri ex Britannia, in historiae narrationibus intersit. Inveniuntur enim clarissimi illi imperatores revera majora gessisse, quam umbratiles isti heroes etiam fecisse fingantur; sed modis et viis scilicet actionum minime fabulosis et prodigiosis. Neque propterea aequum est verae memoriae fidem derogari, quod a fabulis illa quandoque laesa sit et violata. Sed interim minime mirum est, si propositionibus novis (praesertim cum mentione operum) magnum sit factum praejudicium per istos impostores, qui similia tentaverunt; cum vanitatis excessus et fastidium etiam nunc omnem in ejusmodi conatibus magnanimitatem destruxerit.

[248] For a violent invective against the moderns, and especially Paracelsus and the Chemists, see Temporis Partus Masculus, E, and S., Vol. III. p. 531, Etc. The passage begins thus: ‘Nec non cape comites perfunctoriam Neotericorum turbam. Heus nomenclator, suggere. Atqui responded ne dignos esse quorum nomina teneat.’ The quacks of Bacon’s day were generally to be found amongst the professors of Alchemy and Magic. [TF]

[249] See Hallam’s Literature of Europe, part I. Chapter 4. § 70. [TF]

LXXXVIII.

At longe majora a pusillanimitate, et pensorum, quae humana industria sibi proposuit, parvitate et tenuitate, detrimenta in scientias invecta sunt. Et tamen (quod pessimum est) pusillanimitas ista non sine arrogantia et fastidio se offert.

Primum enim, omnium artium illa reperitur cautela jam facta familiaris, ut in qualibet arte authores artis suae infirmitatem in naturae calumniam vertant; et quod ars ipsorum non assequitur, id ex eadem arte impossibile in natura pronunciant. Neque certe damnari potest ars, si ipsa judicet. Etiam philosophia, quae nunc in manibus est, in sinu suo posita quaedam fovet, aut placita, quibus (si diligentius inquiratur) hoc hominibus omnino persuaderi volunt; nil ab arte, vel hominis opere, arduum, aut in naturam

imperiosum et validum, expectari debere; ut de heterogenia caloris astri et ignis, et mistione, superius dictum est [250]. Quae si notentur accuratius, omnino pertinent ad humanae potestatis circumscriptionem malitiosam, et ad quaesitam et artificiosam desperationem, quae non solum spei auguria turbet, sed etiam omnes industriae stimulos et nervos incidat, atque ipsius experientiae aleas abjiciat; dum de hoc tantum solliciti sint, ut ars eorum perfecta censeatur; gloriae vanissimae et perditissimae dantes operam, scilicet ut quicquid adhuc inventum et comprehensum non sit, id omnino nec inveniri, nec comprehendi posse in futurum credatur. At si quis rebus addere se [251] et novum aliquid reperire conetur, ille tamen omnino sibi proponet et destinabit unum aliquod inventum (nec ultra) perscrutari et eruere; ut magnetis naturam, maris fluxum et refluxum, thema coeli, et hujusmodi, quae secreti aliquid habere videntur, et hactenus parum feliciter tractata sint: quum summae sit imperitiae, rei alicujus naturam in se ipsa perscrutari; quandoquidem eadem natura, quae in aliis videtur latens et occulta, in aliis manifesta sit et quasi palpabilis, atque in illis admirationem, in his ne attentionem quidem moveat [252]; ut fit in natura consistentiae, quae in ligno vel lapide non notatur, sed solidi appellatione transmittitur, neque amplius de fuga separationis aut solutionis continuitatis inquiritur; at in aquarum bullis eadem res videtur subtilis et ingeniosa; quae bullae se conjiciunt in pelliculas quasdam, in hemisphaerii formam curiose effictas, ut ad momentum temporis evitetur solutio continuitatis.

[250] Aphorism 75. [TF]

[251] Mr. Spedding quotes from the Redargutio Philosophiarum: 'Quare missis istis philosophiis abstractis, , vos et ego, filii, rebus ipsis nos adjungamus.' [TF]

[252] On Ostensive or Glaring, and their opposite or Clandestine Instances, see Book II. Aphorisms 24, 25, and Herschel's Discourse on the Study of Natural Philosophy, §§ 192-3. [TF]

Atque prorsus illa ipsa, quae habentur pro secretis, in aliis habent naturam manifestam et communem; quae nunquam se dabit conspiciendam, si hominum experimenta aut contemplationes in illis ipsis tantum versentur. Generaliter autem et vulgo, in operibus mechanicis habentur pro novis inventis, si quis jampridem inventa subtilius poliat, vel ornet elegantius, vel simul uniat et componat, vel cum usu commodius copulet, aut opus majore, aut etiam minore, quam fieri consuevit, mole vel volumine exhibeat, et similia.

Itaque minime mirum est, si nobila et genere humano digna inventa in lucem extracta non sint, quum homines hujusmodi exiguis pensis et puerilibus contenti et delectati fuerint; quinetiam in iisdem se magnum aliquod sequutos, aut assequutos putaverint.

LXXXIX.

Neque illud praetermittendum est, quod nacta sit philosophia naturalis per omnes aetates adversarium molestum et difficilem; superstitionem nimirum, et zelum religionis

caecum et immoderatum [253]. Etenim videre est apud Graecos, eos, qui primum causas naturales fulminis et tempestatum insuetis adhuc hominum auribus proposuerunt, impietatis in deos eo nomine damnatos [254]: nec multo melius a nonnullis antiquorum patrum religionis Christianae exceptos fuisse eos, qui ex certissimis demonstrationibus (quibus nemo hodie sanus contradixerit) terram rotundam esse posuerunt, atque ex consequenti antipodas esse asseruerunt [255].

[253] CP. Aphorism 65. The notes on that Aphorism will also serve to illustrate this.

Though Bacon repudiated so vehemently the introduction of religious considerations into natural philosophy, there are many instances in his works of his deeply religious spirit. On his religious opinions generally, see Introduction, § 7. [TF]

[254] See Aristophanes' Clouds, l. 372, etc.:

ΣΤ. νὴ τὸν ᾽Απόλλω, τοῦτό γέ τοι δὴ τO νῦν λόγῳ εὖ προσέφυσας
καίτοι πρότερον τὸν Δί᾽ ἀληθῶς ᾠμην διὰ κοσκίνου οὐρεῖν.
ἀλλ᾽ ὅστις ὁ βροντῶν ἐστι φράσον" τοῦτό με ποιεῖ τετρεμαίνειν.
ΣΏ. αὖται βροντῶσι κυλινδόμεναι.
ΣΤ. τῷ τρόπῳ, ὦ πάντα σὺ τολμῶν;
ΣΩ, ὅταν ἐμπλησθῶσ᾽ ὕδατος πολλοῦ κἀναγκασθῶσι φέρεσθαι,
κατακρημνάμεναι πλήρεις ὄμβρου dv ἀνάγκην, εἶτα βαρεῖαι
εἰς ἀλλήλας ἐμπίπτουσαι ῥήγνυνται καὶ παταγοῦσιν.
ΣΤ. ὁ δ᾽ ἀναγκάζων ἐστὶ τίς αὐτάς, οὐχ ὁ Ζεύς, ὥστε φέρεσθαι ;
ΣΩ. ἥκιστ᾽, ἀλλ᾽ αἰθέριος δῖνος.
ΣΤ; Δῖνος ; τουτί μ᾽ ἐλελήθη,
ὁ Ζεὺς οὐκ ὢν, ἀλλ᾽ ἀντ᾽ αὐτοῦ Δῖνος νυνὶ βασιλεύων.

One of the articles in the indictment against Socrates was that he did not 'worship the Gods whom the city worships.' [TF]

[255] CP. Campanella, Metaphysics Libro I. Proem.: 'S. Augustinus et Lactantius negant esse Antipodas, quoniam ignorant XIathematicam, et vulgus solem putat esse pedalem,' etc. See Lactantius, Divinae Institutiones, Libro III. Cap. 24: 'Quid illi, qui esse contrarios vestigiis nostris Antipodas putant; num aliquid loquantur? aut est quisquam tarn ineptus, qui credat esse homines, quorum vestigia sint superiora quam capita? aut ibi quae apud nos jacent, inversa pendere? fruges et arbores deorsum versus crescere? pluvias, et nives, et grandinem sursum versus cadere in terram? Et niiratur aliquis hortos pensiles inter septem mira narrari; cum philosophi et agros, et maria, et urbes, et monies pensiles faciant?' He next proceeds to account for this strange opinion and that of the rotundity
of the earth by what appeared to him false inferences from the motion of the stars, and then continues: 'Quod si quaeras ab iis, qui haec portenta defendant, quomodo non cadunt omnia in inferiorem illam coeli partem: respondent, hanc rerum esse natiiram, iit pondera in medium ferantur; et ad medium connexa sunt omnia, sicut radios videmus in

rota: quae autem levia sunt, ut nebula, fumus, ignis, a medio deferantur, ut coelum petant.' St. Augustine (De Civitate Dei, Libro XVI. Cap. 9) argues that, even if the world be round, it does not follow that there is land on the other side, or, even if there be such land, that it is inhabited. He then absolutely rejects the supposition of Antipodes nulla ratione credendum est') on the ground that it is inconsistent with the Scriptural account of the origin of the human race. 'Quoniam nullo modo Scriptura ista mentitui', quae narratis praeteritis facit hdem, eo quod ejus praedicta complentur; nimisque absurdum est ut dicatur, aliquos homines ex hac in illam partem, Oceani immensitate trajecta, navigate ac pervenire potuisse, ut etiam illis ex uno illo primo homine genus instituerétur humanum.'

The following quotation from one of Jeremy Taylor's Sermons (Heber's Edition, revised by Eden, Vol. VIII. p, 536) is so appropriate, and, moreover, so interesting in itself, that I cannot refrain from adding it: 'If any man; have a revelation or a discovery of which thou knowest nothing but by his preaching, be not too quick to condemn it; not only lest thou discourage his labour and stricter enquiries in the search of truth, but lest thou also be a fool upon record; for so is every man that hastily judges what he slowly understands. Is it not a monument of a lasting reproach, that one of the popes of Rome condemned the bishop of Salzburg for saying that there were antipodes f and is not pope Nicholas deserted by his own party for correcting the sermons of Berengarius, and making him recant into a worse error? and posterity will certainly make themselves very merry with the wise sentences made lately at Rome against Galileo and the Jansenists. To condemn one truth is more shameful than to broach two errors: for he that in an honest and diligent enquiry misses something of the mark, will have the apologies of human infirmity, and the praise of doing his best; but he that condemns a truth when it is told him, is an envious fool, and is a murderer of his brother's fame, and his brother s reason.'

Mr. Mill discusses the incapacity of conceiving the existence of Antipodes in two places of his Logic, namely, Book II. Chapter 5. § 6, and Book V. Chapter 3. § 3. It is, perhaps, superfluous to remark, with reference to these passages, that Mr. Mill's views as to the relation of inconceivability to impossibility are combated by Mr. Herbert Spencer. [TF]

Quinetiam, ut nunc sunt res, conditio sermonum de natura facta est durior et magis cum periculo, propter theologorum scholasticorum summas et methodos; qui cum theologiam (satis pro potestate) in ordinem redegerint, et in artis formam effinxerint, hoc insuper effecerunt, ut pugnax et spinosa Aristotelis philosophia [256] corpori religionis, plus quam par erat, immisceretur.

[256] In the corresponding passage of the Cogitata et Visa (Ellis and Spedding, p. 596), he says: 'hoc insuper ausi sunt, ut contentiosam et tumultuariam Aristotelis philosophiam corpori religionis inseruerint.'

It has often been remarked that the distinguishing characteristic of the scholastic theology was the union of theological matter with a dialectical form, the theological

matter being derived from the Scriptures and the Fathers, and the dialectical form from the Logic of Aristotle. But with the form, no inconsiderable portion of the matter of the Aristotelian philosophy, especially in the domains of psychology and metaphysics, frequently effected an entrance, and thus, to a certain extent, determined both the terminology and the doctrines of the Mediaeval Church. In illustration of this statement, see. Bishop Hampden's Bampton Lectures, a work which well deserves the attention both of the theological and of the philosophical student. [TF]

Eodem etiam spectant (licet diverso modo) eorum commentationes, qui veritatem Christianae religionis ex principiis ex authoritatibus philosophorum deducere et confirmare haud veriti sunt; fidei et sensus conjugium tanquam legitimum multa pompa et solennitate celebrates, et grata rerum varietate animos hominum permulcentes; sed interim divina humanis, impari conditione, permiscentes. At in hujusmodi misturis theologiae cum philosophia, ea tantum, quae nunc in philosophia recepta sunt, comprehenduntur; sed nova, licet in melius mutata, tantum non summoventur et exterminantur [257].

[257] This is one of Bacon's shrewdest remarks. It is abundantly illustrated in the history of science both before and since his time. A new discovery in science is at first decried as contrary or even fatal to faith; then, after a time, it is grudgingly admitted, and incorporated into the received doctrine, till at last no one dreams of calling it in question. But the process soon begins afresh with some more recent discovery, so that a constant warfare is going on between the unwise theologian and the scientific investigator. And this warfare is wholly unnecessary, and can have only one issue. For the scientific theory must ultimately stand or fall on scientific grounds, and, should it be ultimately admitted, the theologian, whether he acquiesces in the result or not, must, with the rest of mankind, bow to the decision of competent judges. No thoughtful man, of course, can avoid comparing the results of science with his religious beliefs, but the results of science, to be worth anything at all, must be arrived at by a purely independent process, employing only scientific data and submitting only to scientific tests. The man of science has a right to demand that his investigations shall not be hampered by theological prepossessions; but the results at which he arrives become the common property of all, and it is for the theologian to co-ordinate these results with his religious beliefs, or, if need be, to adapt his religious beliefs to the new facts or newly established generalisations which are presented to him. [TF]

Denique invenias, ex quorundam theologorum imperitia, aditum alicui philosophiae, quamvis emendatae, pene interclusum esse. Alii siquidem simplicius subverentur, ne forte altior in naturam inquisitio ultra concessum sobrietatis terminum penetret; traducentes et perperam torquentes ea, quae de divinis mysteriis in Scripturis sacris adversus rimantes secreta divina dicuntur, ad occulta naturae, quae nullo interdicto prohibentur. Alii callidus conjiciunt et animo versant, si media ignorentur, singula ad manum et virgulam divinam (quod religionis, ut putant, maxime intersit) facilius posse referri: quod nihil aliud est, quam Deo per mendacium gratificari [258] velle. Alii ab exemplo metuunt, ne motus et mutationes circa philosophiam in religionem incurrant

ac desinant. Alii denique solliciti videntur, ne in naturae inquisitione aliquid inveniri possit, quod religionem (praesertim apud indoctos) subvertat, aut saltem labefactet. At isti duo posteriores metus nobis videntur omnino sapientiam animalem sapere; ac si homines, in mentis suae recessibus et secretis cogitationibus de firmitudine religionis, et fidei in sensum imperio diffiderent ac dubitarent; et propterea ab inquisitione veritatis in naturalibus periculum illis impendere metuerent. At vere rem reputanti, philosophia naturalis, post verbum Dei, certissima superstitionis medicina est; eademque probatissimum fidei alimentum. Itaque merito religioni donatur tanquam fidissima ancilla: cum altera voluntatem Dei, altera potestatem manifestet [259]. Neque enim erravit Ille, quit dixit; erratis, nescientes Scripturas et potestatem Dei [260]: informationem de voluntate et meditationem de potestate nexu individuo commiscens et copulans. Interim minus mirum est, si naturalis philosophiae incrementa cohibita sint; cum religio, quae plurimum apud animos hominum pollet, per quorundam imperitiam et zelum incautum in partem contrariam transierit et abrepta fuerit.

[258] CP. De Augmentis Scientiarum, Libro I. (Ellis and Spedding, Vol. I. p. 436): 'Namque eos qui autumant nimiam scientiam inclinare mentem in atheismum, ignorantiamque secundarum causarum pietati erga primam, obstetricari, libenter compeilarem Jobi quaestione, *An oporteaf ftmiUri pro Deo, et ej us gratia doluin loqui conveniat, tit ipsi gratipcemur?* The passage in Job, here referred to, is Chapter, XIII. Ver. 7. [HJ] [TF]

[HJ] Job 13:7 is as follows: "Will you speak wickedly on God's behalf? Will you speak deceitfully for him?"

[259] In the Advancement of Learning (Ellis and Spedding, Vol. lii, p. 478) and in the Ninth Book of the De Augmentis Scientiarum, it is the *glory* of God, as revealed by Nature, which is opposed to the will of God, as revealed by Scripture. 'Wherefore we conclude that sacred Theology (which in our idiom we call Divinity) is grounded only upon the word and oracle of God, and not upon the light of nature: for it is, written, Coeli enarrant gloriam Dei, but it is not written, Coeli enarrant voiuntatem Dei, but of that it is said, Ad legem et testimonium.' [TF]

[260] Matt. XXII. 29. [260.1] [TF]

[260.1] Matthew 22:29 is as follows: "Jesus replied, 'You are in error because you do not know the Scriptures or the power of God.' " [HJ]

XC.

Rursus in moribus et institutis scholarum, academiarum, collegiorum, et similium conventuum, quae doctorum hominum sedibus et eruditionis culturae destinata sunt, omnia progressui scientiarum adversa inveniuntur [261]. Lectiones enim et exercitia ita sunt disposita, ut aliud a consuetis haud facile cuiquam in mentem veniat cogitare aut contemplari. Si vero unus aut alter fortasse judicii libertate uti sustinuerit, is sibi soli hanc operam imponere possit; ab aliorum autem consortio nihil capiet utilitatis. Sin et hoc

toleraverit, tamen in capessenda fortuna industriam hanc et magnanimitatem sibi non levi impedimento fore experietur. Studia enim hominum in ejusmodi locis in quorundam authorum scripta, veluti in carceres, conclusa sunt; a quibus si quis dissentiat, continuo ut homo turbidus et rerum novarum cupidus corripitur. At magnum certe discrimen inter res civiles et artes [262]: non enim idem periculum a novo motu et a nova luce. Verum in rebus civilibus mutatio etiam in melius suspecta est ob perturbationem; cum civilia authoritate, consensu, fama, et opinione, non demonstratione [263], nitantur. In artibus autem et scientiis, tanquam in metalli fodinis, omnia novis operibus et ulterioribus progressibus circumstrepere debent. Atque secundum rectam rationem res ita se habet, sed interim non ita vivtur: sed ista, quam diximus, doctrinarum administratio et politia scientiarum augmenta durius premere consuevit.

[261] The main business of the Universities at this time was the 'disputations.' Their chief interests were either literary or theological, and, so far as the physical sciences were cultivated at all, it was, at least in the English Universities, mainly in the old tracks. As late as the foundation of Sir William Sediey's Professorship of Natural Philosophy in 1621, it was prescribed that the Professor should lecture in the works of Aristotle. In the statute regulating the duties of the Chair, there is not a hint of any independent treatment of the subject. The statutes of the Savilian Professor of Astronomy, however, which date from 1619, direct the Professor, on occasion, to refer to the theories or discoveries of recent writers: 'Astronomiae Professor ad suum munus sciat necessario pertinere interpretationem totius Mathematicae Constructionis Ptolemaei (Almagestum vocant), adhibitis, sue loco, Copernici, Gebri, et aliorum Recentiorum inventis.'

Bacon pursues this complaint at greater length in the Introduction to the Second Book of the De Augmentis Scientiarum (Ellis and Spedding, Vol. I. pp. 487-492), His own idea of an institution for the advancement of science is given in the New Atlantis.

The letters written by Bacon to the Universities of Oxford and Cambridge, and to Trinity College, Cambridge, on sending them copies of his works, are interesting in connexion with this Aphorism. The following is the letter inscribed in the copy of the De Augmentis Scientiarum, sent to the University of Oxford:

'Franciscus Baro de Veruiamio, Vicecomes S^{eti} Abani, inclytae Academiae Oxoniensi S.

Cum Almae matri meae incl. Academiae Cantabrigiensi scripserim, deessem sane officio, si simile amoris pignus sorori ejus non deferrem. Sicut autem eos hortatus sum, ita et vos hortor; ut Scientiarum Augmentis strenue incumbatis, et yeterum labores neque nihil neqiie omnia esseputetis, sed, vires etiam propriasmodeste perpendentes, subinde tamen experiamini. Omnia cedent quam optime, si arma non alii in alios vertatis, sed junctis copiis in Naturara rerum impressionem faciatis. Sufficiet quippe ilia honori et victoriae. Valete.' [TF]

[262] CP. Aristotle's Politics, Book II, Chapter 8. sects, 18, 24: Ψεῦδος δὲ καὶ τὸ παράδειγμα τὸ περὶ τῶν τεχνῶν᾽ Ον γὰρ ὅμοιον τὸ κινεῖν τέχνην Kal νόμον. ὁ γὰρ νόμος

ἰσχὺν οὐδεμίαν ἔχει πρὸς τὸ πείθεσθαι πλὴν παρὰ τὸ ἔθος, τοῦτο δ᾽ οὐ γίνεται εἰ μὴ διὰ χρόνου πλῆθος, κ.τ.λ. [TF]

[263] These remarks are not inconsistent with what Bacon says in Aphorism 127, where he appears to contemplate the possibility of a political science, established by induction. AH that he means here is that the stability of a government depends not on the reasons which can be assigned in its favour, but on authority, usage, assent, etc. [TF]

XCI.

Atque insuper licet ista invidia cessaverit; tamen satis est ad cohibendum augmentum scientiarum, quod hujusmodi conatus et industriae praemiis careant. Non enim penes eosdem est cultura scientiarum et praemium. Scientiarum enim augmenta a magnis utique ingeniis proveniunt; at pretia et praemia scientiarum sunt penes vulgus aut principes viros, qui (nisi raro admodum) vix mediocriter docti sunt. Quinetiam hujusmodi progressus non solum praemiis et beneficentia hominum, verum etiam ipsa populari laude destituti sunt. Sunt enim illi supra captum maximae partis hominum, et ab opinionum vulgarium ventis facile obruuntur et extinguuntur. Itaque nil mirum, si res illa non foeliciter successerit, quae in honore non fuit.

XCII.

Sed longe maximum progressibus scientiarum, et novis pensis ac provinciis in iisdem suscipiendis, obstaculum deprehenditur in desperatione hominum, et suppositione impossibilis. Solent enim viri prudentes et severi in hujusmodi rebus plane diffidere: naturae obscuritatem, vitae brevitatem, sensuum fallacias, judicii infirmitatem, experimentorum difficultates, et similia secum reputantes. Itaque existimant, esse quosdam scientiarum, per temporum et aetatum mundi revolutiones, fluxus et refluxus; cum aliis temporibus crescant et floreant, aliis declinent et jaceant: ita tamen, ut cum ad certum quendam gradum et statum pervenerint, nil ulterius possint [264].

[264] On the idea of Cycles, as applied to the phenomena of human society, see Mill's Logic, Book vi. Chapter lo. § 3. For the celebrated cycle of Plato, see the beginning of the eighth book of the Republic, and for Aristotle's criticism on it, Politics, VIII. (v.) 12, The idea of cycles and of periodical crises, at which the accumulated property, inventions, institutions, etc. of mankind are swept away, is to be found also in the third book of the Laws. [TF]

Itaque si quis majora credat aut spondeat, id putant esse cujusdam impotentis et immaturi animi; atque hujusmodi conatus initia scilicet laeta, media ardua, extrema confusa habere. Atque cum hujusmodi cogitationes eae sint, quae in viros graves et judicio praestantes facile cadant, currandum revera est, ne rei optimae et pulcherrimae amore capti severitatem judicii relaxemus, aut minuamus; et sedulo videndum, quid spei

affulgeat, et ex qua parte se ostendat; atque auris levioribus spei rejectis, eae, quae plus firmitudinis habere videntur, omnino discutiendae sunt et pensitandae. Quinetiam prudentia civilis ad consilium vocanda est et adhibenda, quae ex praescripto diffidit, et de rebus humanis in deterius conjicit. Itaque jam et de spe dicendum est; praesertim cum nos promissores non simus, nec vim aut insidias hominum judiciis faciamus aut struamus, sed homines manu et sponte ducamus. Atque licet longe potentissimum futurum sit remedium ad spem imprimendam, quando homines ad particularia, praesertim in tabulis nostris inveniendi digesta et disposita (quae partim ad secundam, sed multo magis ad quartam *Instaurationis* [265] nostrae partem pertinent), adducemus; cum hoc ipsum sit non spes tantum, sed tanquam res ipsa: tamen ut omnia clementius fiant, pergendum est in instituto nostro de praeparandis hominum mentibus; cujus praeparationis ista ostensio spei pars est non exigua. Nam absque ea, reliqua faciunt magis ad contristationem hominum (scilicet, ut deteriorem et viliorem habeant de iis, quae jam in usu sunt, opinionem, quam nunc habent, et suae conditionis infortunium plus sentiant et pernoscant), quam ad alacritatem aliquam inducendam, aut industriam experiendi acuendam. Itaque conjecturae nostrae, quae spem in hac re faciunt probabilem, aperiendae sunt et proponendae: sicut Columbus fecit [266], ante navigationem illam suam mirabilem maris Atlantici: cum rationes adduxerit, cur ipse novas terras et continentes praeter eas, quae ante cognitae fuerunt, inveniri posse confideret: quae rationes, licet primo rejectae, postea tamen experimento probatae sunt, et rerum maximarum causae et initia fuerunt.

[265] The fourth part of the Instauration was to be the Scala Intellectus, the second is, of course, the Novum Organum. For Bacon's conception of the fourth part, see the Distributio Operis, pp. 178, 179. At the end of his account, he says: 'Itaque hujusmodi exemplis' (namely, such as shall present the whole process of discovery) 'quartam partem nostri operis attribuimus; quae revera nil aliud est, quam secundae partis application particularis et explicate.' [TF]

[266] For many years before Columbus was enabled to start on his voyage of discovery, it had become a fixed idea in his mind that land was to be found to the West. For the reasons of this belief, depending partly on general geographical considerations, partly on the stories of mariners, partly on the fact that pieces of pine, cane, and the like, had been found washed ashore on the coast of Portugal, the Azores, etc., see Washington Irving's Life and Voyages of Columbus, Chapter 3. [TF]

XCIII.

Principium autem [267] sumendum a Deo: hoc nimirum quod agitur, propter excellentem in ipso boni naturam, manifeste a Deo esse, qui author boni, et pater luminum est. In operationibus autem divinis, initia quaeque tenuissima exitum certo trahunt. Atque quod de spiritualibus dictum est, *Regnum Dei non venit cum observatione* [268], id etiam in omni majore opere Providentiae evenire reperitur; ut omnia sine strepitu et sonitu placide labantur, atque res plane agatur priusquam homines eam agi putent aut advertant. Neque omittenda est prophetia Danielis de ultimis mundi

temporibus; *Multi pertransibunt, et multiplex erit scientia* [269]: manifeste innuens et significans, esse in fatis, id est, in Providentia, ut pertransitus mundi (qui per tot longinquas navigationes impletus plane aut jam in opere esse videtur) et augmenta scientiarum in eandem aetatem incidant.

[267] Here begins the enumeration of the Grounds of Hope, which are twenty-one in all. The enumeration is completed in the 114th Aphorism. [TF]

[268] Luke xvii. 20. [268.1] [TF]

[26.1] Luke 17:20 is as follows: “Once, on being asked by the Pharisees when the kingdom of God would come, Jesus replied, “The coming of the kingdom of God is not something that can be observed’”. [HJ]

[269] Daniel XII. 4 [269.1]. This text forms the motto to the frontispiece prefixed to the First Edition of the Novum Organum. [TF]

[269.1] Daniel 12:4 is as follows: “But you, Daniel, roll up and seal the words of the scroll until the time of the end. Many will go here and there to increase knowledge.’” [HJ]

XCIV.

Sequitur ratio omnium maxima ad faciendam spem; nempe ex erroribus temporis praeteriti et viarum adhuc tentatarum. Optima enim est ea reprehensio, quam de statu civili haud prudenter administrato quispiam his verbis complexus est [270]: *Quod ad praeterita pessimum est, id ad futura optimum videri debet. Si enim vos omnia, quae ad officium vestrum spectant, praestitissetis, neque tamen res vestrae in meliore loco essent; ne spes quidem ulla reliqua foret, eas in melius provehi posse. Sed cum rerum vestrarum status, non a vi ipsa rerum, sed ab erroribus vestris male se habeat; sperandum est, illis erroribus missis aut correctis, magnam rerum in melius mutationem fieri posse*. Simili modo, si homines per tanta annorum spatia viam veram inveniendi et colendi scientias tenuissent, nec tamen ulterius progredi potuissent; audax proculdubio et temeraria foret opinio, posse rem in ulterius provehi. Quod si in via ipsa erratum sit, atque hominum opera in iis consumpta, in quibus minime oportebat; sequitur ex eo, non in rebus ipsis difficultatem oriri, quae potestatis nostrae non sunt, sed in intellectu humano ejusque usu et applicatione; quae res remedium et medicinam suscipit. Itaque optimum fuerit illos ipsos errores proponere: quot enim fuerint errorum impedimenta in praeterito, tot sunt spei argumenta in futurum. Ea vero licet in his, quae superius dicta sunt, non intacta omnino fuerint; tamen ea etiam nunc breviter, verbis nudis ac simplicibus, repraesentare visum est.

[270] Demosthenes. Phil. III. pp. 111, 112., CP. Phil. I. p. 40. [270.1] [TF]

[270.1] These must be the First and the Third Philippic speeches of Demosthenes. [HJ]

XCV.

Qui tractaverunt scientias aut empirici aut dogmatici [271] fuerunt. Empirici, formicae more, congerunt tantum, et utuntur: rationales, aranearum more, telas ex se conficiunt: apis vero ratio media est, quae materiam ex floribus horti et agri elicit; sed tamen eam propria facultate vertit et digerit. Neque absimile philosophiae verum opificium est; quod nec mentis viribus tantum aut praecipue nititur, neque ex historia naturali et mechanicis experimentis praebitam materiam, in memoria integram, sed in intellectu mutatam et subactam, reponit. Itaque ex harum facultatum (experimentalis scilicet et rationalis) arctiore et sanctiore foedere (quod adhuc factum non est) bene sperandum est.

[271] See the Preface to the Novum Organum, and Aphorisms 62, 64, 67.

This is one of the best known, and most happily expressed, of Bacon's Aphorisms. But, after the explanations already given, it does not appear to require any annotation. The last sentence shews how far Bacon was from recommending a merely empirical philosophy. [TF]

XCVI.

Naturalis philosophia adhuc sincera non invenitur, sed infecta et corrupta: in Aristotelis schola, per logicam [272], in Platonis schola, per theologiam naturalem [273]; in secunda schola [274] Platonis, Procli, et aliorum, per mathematicam; quae philosophiam naturalem terminare, non generare aut procreare debet [275]. At ex philosophia naturali pura et impermista meliora speranda sunt.

[272] See Aphorisms 54, 63, with my notes on them. [TF]

[273] See Aphorism 65, with my notes. CP. also Aphorism 48, so far as it bears on Final Causes. [TF]

[274] Bacon is alluding to the Neoplatonists, though, properly speaking, the 'secunda schola Platonis' is the New Academy. On the philosophy of the Neoplatonists, see Zeller or Ueberweg. The slightest knowledge of their system will shew the justice of Bacon's criticism. [TF]

[275] CP. De Augmentis Scientiarum, Libro III. Cap. 6, which the student should read carefully in connexion with this Aphorism. I am inclined to think that Bacon had conceived, though, perhaps, not very clearly, the true relation between Physics and Mathematics. The most general axioms of Natural Philosophy were to be carefully established by induction; then, when they had been stated in a quantitative form, they were to be combined with each other, and worked out deductively, by means of mathematical calculations, into all their ramifications and applications. It is needless to

add that the magnificent achievements of modern science (witness, for instanc, the Principia or Optics of Newton, or the Méchanique Analytique of Lagrange) have been due at least as much to mathematical calculation as to inductive generalisation. The more advanced sciences, in fact, become, in their later stages, mainly mathematical. But, while a science remains in its earlier, or inductive, stage, it is only capable of mathematical treatment, if at all, to a very slight degree. This, for instance, is still the case with the sciences of chemistry and physiology.

The parallel passage in Book II. Aphorism 8 ('Optime autem cedit inquisition naturalis, quando physicum terminatur in mathematico') appears to apply specially to the enumeration and mensuration of the ultimate particles of matter, as conceived by Bacon. Hence, it might be contended that his view of the functions of Mathematics in the present Aphorism is equally limited. But I am inclined to think that here the remark has a much wider bearing, and that the office of Mathematics, as contemplated in II. 8, would be only a special exemplification of the functions here ascribed to them.

In the Parasceve, Aphorism. 7, the relation of physics and mathematics is felicitously, though vaguely, stated as follows: 'Physica autem et mathematica bene commistae generant practicam.' [TF]

XCVII.

Nemo adhuc tanta mentis constantia et rigore inventus est, ut decreverit et sibi imposuerit theorias et notiones communes penitus abolere, et intellectum abrasum et aequum ad particularia de integro applicare [276]. Itaque ratio illa humana, quam habemus, ex multa fide, et multo etiam casu, nec non ex puerilibus, quas primo hausimus, notionibus, farrago quaedam est et congeries.

[276] These remarks remind us of Descartes, who may possibly have been influenced by reading this passage and the Aphorisms on the Idola. For an account of the process by which he attempted to clear his mind of preconceived notions, see the First Meditation, or the beginning of the First Part of the Principia, or the earlier portion of the Dissertatio de Methodo. The completeness with which he attempted to carry out his purpose may be judged of by the following brief passage, taken from the De Methodo: 'Sed quod ad eas opiniones attinet, quas ego ipse in eum usque diem fueram amplexus, nihil melius facere me posse arbitrabar, quam si omnes simul et semel e mente mea delerem, ut deinde vel alias meliores vel certe easdem, sed postquam maturae rationis examen subiissent, admitterem: credebamque hoc pacto longe melius me ad vitam regendam posse informari, quam, si veteris aedificii fundamenta retinerem, iisque tantum principiis inniterer, quibus olim juvenilis aetas mea, nullo unquam adhibito examine an veritati congruerent, credulitatem suam addixerat.' [TF]

Quod si quis aetate matura, et sensibus integris, et mente repurgata, se ad experientiam et ad particularia de integro applicet, de eo melius sperandum est. Atque hac in parte

nobis spondemus fortunam Alexandri Magni: neque quis nos vanitatis arguat, antequam exitum rei audiat, quae ad exuendam omnem vanitatem spectat.

Etenim de Alexandro et ejus rebus gestis Aeschines ita loquutus est: *Nos certe vitam mortalem non vivimus; sed in hoc nati sumus, ut posteritas de nobis portenta narret et praedicet* [277]: perinde ac si Alexandri res gestas pro miraculo habuisset.

[277] Aeschines in Ctesiphontem, p. 72. § 132: Τοιγάρτοι τι τῶν ἀνελπίστων καὶ ἀπροσδοκήτων ep ἡμῶν οὐ γέγονεν; Οὐ yap βίον γ᾽ ἡμεῖς ἀνθρώπινον βεβιώκαμεν, ἀλλ᾽ εἰς παραδοξολογίαν τοῖς ἐσομένοις μεθ᾽ ἡμᾶς ἔφυμεν. [TF]

At aevis sequentibus Titus Livius melius rem advertit et introspexit, atque de Alexandro hujusmodi quippiam dixit [278]: *Eum non aliud quam bene ausum vana contemnere*. Atque simile etiam de nobis judicium futuris temporibus factum iri existimamus: *Nos nil magni fecisse*; sed tantum ea, quae pro magnis habentur, minoris fecisse. Sed interim (quod jam diximus) non est spes nisi in regeneratione scientiarum; ut eae scilicet ab experientia certo ordine excitentur et rursus condantur: quod adhuc factum esse aut cogitatum nemo (ut arbitramur) affirmaverit.

[278] Livy, ix ad fin. [TF]

XCVIII.

Atque experientiae fundamenta [279] (quando ad hanc omnino deveniendum est) aut nulla, aut admodum infirma adhuc fuerunt; nec particularium sylva et materies, vel numero, vel genere, vel certitudine, informando intellectui competens, aut ullo modo sufficiens, adhuc quaesita est et congesta. Sed contra homines docti (supini sane et faciles) rumores quosdam experientiae, et quasi famas et auras ejus, ad philosophiam suam vel constituendam vel confirmandam exceperunt, atque illis nihilominus pondus legitimi testimonii attribuerunt. Ac veluti si regnum aliquod aut status non ex literis et relationibus a legatis et nuntiis fide dignis missis, sed ex urbanorum sermunculis et ex triviis consilia sua et negotia gubernaret; omnino talis in philosophiam administratio, quatenus ad experientiam, introducta est. Nil debitis modis exquisitum, nil verificatum, nil numeratum, nil appensum, nil dimensum in naturali historia reperitur [280]. At quod in observatione indefinitum et vagum, id in informatione fallax et infidum est. Quod si cui haec mira dictu videantur, et querelae minus justae propiora, cum Aristoteles tantus ipse vir, et tanti regis opibus subnixus, tam accuratam de animalibus historiam confecerit, atque alii nonnulli majore diligentia (licet strepitu minore) multe adjecerint, et rursus alii de plantis, de metallis, et fossilibus, historias et narrationes copiosas conscripserint; is sane non satis attendere et perspicere videtur, quid agatur in praesentia. Alia enim est ratio naturalis historiae, quae propter se confecta est; alia ejus, quae collecta est ad informandum intellectum in ordine ad condendam philosophiam [281]. Atque hae duae historiae tum aliis rebus, tum praecipue in hoc differunt; quod prima ex illis specierum naturalium varietatem, non artium mechanicarum experimenta contineat. Quemadmodum enim in civilibus ingenium cujusque, et occultus animi

affectuumque sensus, melius elicitur, cum quis in perturbatione ponitur, quam alias: simili modo, et occulta naturae magis se produnt per vexationes artium, quam cum cursu suo meant [282]. Itaque tum demum bene sperandum est de naturali philosophia, postquam historia naturalis (quae ejus basis est et fundamentum) melius instructa fuerit; antea vero minime.

[279] This, the sixth, is one of the most important of the 'Grounds of Hope.' It is taken from the future construction of a Natural History, specially adapted to the wants of Natural Philosophy ('collecta ad informandum intellectum in ordine ad condendam philosophiam and containing a record of experiments as well as observations. This 'Natural History' was to be supplied in the third part of the Instauratio Magna, which was to be entitled 'Phaenomena Universi, sive Historia Naturalis et Experimentalis ad condendam Philosophiam.' Towards constructing this third part of the Instauratio several attempts were made by Bacon, as in the Historia Ventorum, Historia Vitae et Mortis, Historia Densi et Rari, Sylva Sylvarum, etc. These works are collected in the third volume of Ellis and Spedding's Edition, pp. 1-680. It must be confessed, however, of these pieces, that they 'answer but very imperfectly to Bacon's conception of a natural history' as delineated in this Aphorism. Far the most successful, perhaps the only successful, part of Liebig's attack on Bacon is directed against this class of his writings.

On the supreme importance attached by Bacon to the collection of observations and experiments which it was his intention to make, see Mr. Spedding's Preface to the Parasceve, given in Vol. I. of the Collected Works, pp. 369-390. I cannot, however, but think that Mr. Spedding slightly exaggerates the importance which Bacon attached to this part of his reform. Surely 'the novelty, from which the most important results were to be expected,' if we are to select any one part of the scheme as such, was his Inductive Method. 'Spes est una in inductione vera.' 'In hac crete inductione' (namely, induction as reformed by himself) 'spes maxima sita est.'

It may be remarked, however, as a proof of the great importance which Bacon attached to his Natural History, that, when he published the Novum Organum in its fragmentary form, passing over all the 'auxilia intellectus' (see Libro II. Aphorism 21) between the first and eighth, he thought it desirable to append an account of the latter, as furnishing a description of the plan on which his Natural History was to be constructed. The title of this Appendix is 'Parasceve ad Historiam Naturalem et Experimentalem,' or 'Descriptio Historiae Naturalis et Experimentalis, Qualis sufficiat et sit in ordine ad Basin et Fundamenta Philosophiae Verae.' It is followed by a 'Catalogus Historiarum Particularium,' on which he designed, at his leisure, to draw up a list of questions, illustrating the true method of enquiry. We are informed, moreover, by Dr. Rawley that the Sylva Sylvarum was the last work on which Bacon was engaged. In that case, he must have suspended the composition of the Novum Organum, in order to carry on his Natural History. [TF]

[280] CP. Parasceve, Aphorism 7. On the necessity of accurately weighing, measuring, and counting in conducting observations or experiments, it is now needless to insist. The

student will find a brief and excellent account of 'Methods of Observation' in Whewell's Novum Organum Renovatum, Book III. Chapter 2. If he wishes to pursue the subject at greater length, he may read with advantage the Third Book of Professor Jevons' Principles of Science, entituled 'Methods of Measurement.' [TF]

[281] Bacon constantly insists on the subordination of Natural History to Natural Philosophy. But it is difficult to conceive any philosophical writer collecting natural facts for any other purpose than that of basing on them philosophical generalisations. Aristotle, certainly, is not chargeable with this fault.

It was not on any difference in the objects for which they were collected, but on the number, variety, accuracy, and pertinency of the observations, and on the distinctive character of the inductive method which was to be applied to them, when collected, that Bacon should have insisted as distinguishing the Natural History which he designed to inaugurate from that of his predecessors. [TF]

[282] Nature best discovers her secrets, when tortured by Art. This is an excellent illustration of the advantage which Experiment, at least in many cases, possesses over Observation. For the differences between the two my Inductive Logic, Chapter 2. [TF]

XCIX.

Atque rursus in ipsa experimentorum mechanicorum copia, summa eorum, quae ad intellectus informationem maxime faciunt et juvant, detegitur inopia. Mechanicus enim, de veritatis inquisitione nullo modo sollicitus, non ad alia quam quae operi suo subserviunt aut animum erigit aut manum porrigit. Tum vero de scientiarum ulteriore progressu spes bene fundabitur, quum in Historiam Naturalem recipientur et aggregabuntur complura experimenta, quae in se nullius sunt usus, se ad inventionem causarum et axiomatum tantum faciunt; quae nos lucifera experimenta, ad differentiam fructiferorum, appellare consuevimus [283]. Illa autem miram habent in se virtutem et conditionem; hanc videlicet, quod nunquam fallant aut frustrentur. Cum enim ad hoc adhibeantur, non ut opus aliquod efficiant sed ut causam naturalem in aliquo revelent, quaquaversum cadunt, intentioni aeque satisfaciunt; cum quaestionem terminent.

[283] See Aphorism 70, with note 80. [TF]

C.

At non solum copia major experimentorum quaerenda est et procuranda, atque etiam alterius generis, quam adhuc factum est; sed etiam methodus [284] plane alia et ordo et processus continuande et provehendae Experientiae introducenda. Vaga enim Experientia et se tantum sequens (ut superius dictum est [285]) mera palpatio est, et homines potius stupefacit quam informat. At cum Experientia lege certa procedet, seriatim et continenter, de scientiis aliquid melius sperari poterit.

[284] What follows is a mere repetition of what has already been said in the preceding Aphorism. [TF]

[285] Aphorism 82. [TF]

CI.

Postquam vero copia et materies Historiae Naturalis et Experientiae, talis qualis ad opus intellectus sive ad opus philosophicum requiritur, praesto jam sit et parata; tamen nullo modo sufficit intellectus, ut in illam materiem agat sponte et memoriter; non magis, quam si quis computationem alicujus ephemeridis memoriter se tenere et superare posse speret. Atque hactenus tamen potiores meditationis partes quam scriptionis in inveniendo fuerunt; neque adhuc Experientia literata [286] facta est: atqui nulla nisi de scripto inventio probanda est. Illa vero in usum inveniente, ab Experientia facta demum literata melius sperandum.

[286] He is speaking here of experience, that is, observations and experiments, committed to writing. But in Aphorisms 103, 110 the expression ‘experientia literata' is used in the same sense as in the passage already quoted from the De Augmentis Scientiarum, lib. v. Cap. 2, namely, to denote a method of consulting experience intermediate between ‘mera palpatio' and the ‘novum organum.' See note 76 on Aphorism 70. [TF]

CII.

Atque insuper cum tantus sit particularium numerus et quasi exercitus, isque ita sparsus et diffusus, ut intellectum disgreget et confundat, de velitationibus et levibus motibus et transcursibus intellectus non bene sperandum est; nisi fiat instructio et coordinatio, per tabulas inveniendi [287] idoneas et bene dispositas et tanquam vivas, eorum quae pertinent ad subjectum in quo versatur inquisitio, atque ad harum tabularum auxilia praeparata et digesta mens applicetur.

[287] He is alluding to Tables, such as those which are given in the early part of the Second Book. [TF]

CIII.

Verum post copiam particularium rite et ordine veluti sub oculos positorum, non statim transeundum est ad inquisitionem et inventionem novorum particularium aut operum; aut saltem, si hoc fiat, in eo non acquiescendum. Neque enim negamus, postquam omnia omnium artium experimenta collecta et digesta fuerint atque ad unius hominis notitam et judicium pervenerint, quin ex ipsa traductione experimentorum unius artis in

alias multa nova inveniri possint ad humanam vitam et statum utilia, per istam Experientiam quam vocamus Literatam [288]: sed tamen minora de ea speranda sunt; majora vero a nova luce Axiomatum [289] ex particularibus illis certa via et regula eductorum, quae rursus nova particularia indicent et designent. Neque enim in plano via sita est [290], sed ascendendo et descendendo; ascendendo primo ad Axiomata, descendendo ad Opera.

[288] See note 86 on Aphorism 101. We must recollect that the distinction between 'Experientia Literata' and 'Interpretatio Naturae sive Novum Organum ' is that the former proceeds 'ab experimentis ad experimenta,' the latter ' ab experimentis ad axiomata, quae et ipsa nova experimenta designent.' For a fall account of Experientia Literata and the various modes of experimenting which it includes, see the long passage at the end of De Augmentis Scientiarum, Libro II. Cap. 5 (Ellis and Spedding, Vol. I. pp. 622-633). Of various modes of experimenting, Traductio or Translatio is only one, and the 'traductio experimentorum unius artis in alias,' again, is only one variety of this. The student will find the passage in the De Augmentis Scientiarum above referred to, notwithstanding its length, of great interest. [TF]

[289] CP. De Augmentis Scientiarum, 1. c.: 'Nam lumen ipsum ab Interpretatione Naturae, sive Novo Organo, petendum est.' [TF]

[290] Examples of the upward process were to be given in the Scala Intellectus, or fourth part of the Instauratio Magna, while the downward process, or application to practice, was reserved for the sixth and last part. [TF]

CIV.

Neque tamen permittendum est, ut intellectus a particularibus ad axiomata remota et quasi generalissima (qualia sunt principia, quae vocant, artium et rerum) saliat et volet; et ad eorum immotam veritatem axiomata media probet et expediat [291]: quod adhuc factum est, prono ad hoc impetu naturali intellectus, atque etiam ad hoc ipsum, per demonstrationes quae fiunt per syllogismum, jampridem edocto et assuefacto [292]. Sed de scientiis tum demum bene sperandum est, quando per scalam veram, et per gradus continuos et non intermissos aut hiulcos, a particularibus ascendetur ad axiomata minora, et deinde ad media, alia aliis superiora, et postremo demum ad generalissima. Etenim axiomata infirma non multum ab experientia nuda discrepant. Suprema vero illa et generalissima (quae habentur) notionalia [293] sunt et abstracta, et nil habent solidi. At media sunt axiomata illa vera et solida et viva, in quibus humanae res et fortunae sitae sunt [294]; et supra haec quoque, tandem ipsa illa generalissima; talia scilicet quae non abstracta sint, sed per haec media vere limitantur [295].

[291] CP. Aphorism 19 and note 22. [TF]

[292] CP. Aphorism 20. [TF]

[293] That is, founded in the notions of the human mind, instead of in the realities of nature. [TF]

[294] CP. the last paragraph of Aphorism 66, and note 57. [TF]

[295] That is, such as may be shown to include the axiomata media; laws, in fact, of which the axiomata media are particular cases, admitting of verification. The laws of motion, as now stated, or the law of gravity, or the law of definite proportions in Chemistry, would be instances of the kind of 'axiomata generalissima' which Bacon had in view. With them we may compare such 'abstract and notional' first principles, as 'Every body seeks its own place,' or 'The celestial motions are circular,' or 'Nature does nothing in vain.' It was not the generality of the old 'axiomata generalissima,' but their vagueness and the slight extent to which they rested on ascertained facts, and the unwillingness of men to submit them to verification, which caused them to be so serious an obstacle to the advance of science. No laws, of which we can at present form any conception, can be more general than the Laws of Motion, but, at the same time, no generalisations can be more precisely stated, and none can rest on a wider basis of evidence or account for a larger number of facts. [TF]

Itaque hominum intellectui non plumae addendae, sed plumbum potius et pondera [296]; ut cohibeant omnem saltum et volatum. Atque hoc adhuc factum non est; quum vero factum fuerit, melius de scientiis sperare licebit.

[296] The truth is that men require both wings and ballast. A man cannot have too fertile an imagination, but his imaginative powers should be combined with a keen perception of the requirements of evidence and with corresponding critical acumen. Bacon has really hit the mark in Aphorism 57. [TF]

CV.

In constituendo autem axiomate, forma inductionis alia quam adhuc in usu fuit excogitanda est; eaque non ad principia tantum (quae vocant) probanda et invenienda, sed etiam ad axiomata minora et media, denique omnia. Inductio enim quae procedit per enumerationem simplicem [297] res puerilis est, et precario [298] concludit, et periculo exponitur ab instantia contradictoria [299], et plerumque secundum pauciora quam par est, et ex his tantummodo quae praesto sunt [301], pronunciat. At inductio, quae ad inventionem et demonstrationem scientiarum et artium erit utilis [302], naturam separare debet, per rejectiones et exclusiones debitas; ac deinde, post negativas tot quot sufficiunt, super affirmativas concludere [303]; quod adhuc factum non est, nec tentatum certe, nisi tantummodo a Platone [304], qui ad excutiendas [305] definitiones et ideas [306] hac certe forma inductionis aliquatenus utitur. Verum ad hujus inductionis, sive demonstrationis [307], instructionem bonam et legitimam quamplurima adhibenda sunt, quae adhuc nullius mortalium cogitationem subiere; adeo ut in ea major sit consumenda opera, quam adhuc consumpta est in syllogismo [308]. Atque hujus inductionis auxilio, non solum ad axiomata invenienda, verum etiam ad

notiones terminandas [309], utendum est. Atque in hac certe inductione spes maxima sita est.

[297] On the Inductio per Enumerationem Simplicem, and the distinction between it and Scientific Induction ('quae ad inventionem et demonstrationem scientiarum et artium est utilis'), see my Inductive Logic, 4th ed., pp. 7-9, 122-124, 215-222, 276-295. In reading these passages, the student must distinguish between the legitimate and illegitimate, as well as between the necessary and unnecessary, employment of the Inductio per Enumerationem Simplicem. [TF]

[298] That is, on no certain grounds. [TF]

[299] A single contradictory instance is generally sufficient to overthrow an induction based on simple enumeration, but, where an induction is based on elimination and seems to establish a causal connection, the strong presumption is that any exception is apparent only and is really due to some counteracting cause. CP. Cogitata et Visa (Ellis and Spedding, Vol. III. p. 618); 'Visum est ei talem inductionis formam inveniendam, quae ex aliquibus generaliter concludat; ita ut instantiam contradictoiiam inveniri non posse demonstretur.' [TF]

[301] Thus, a man living in one part of the globe might infer from the men whom he had seen that all men are white, a man living in another part that all men are black, and so on. [TF]

[302] This is Scientific Induction, as distinguished from Inductio per Enumerationem Simplicem. But, though Bacon had formed the idea of a Scientific Induction, or a process of elimination by means of which causes might be detected, his own account of the process and of the rules by which it should be conducted is, for the most part, vague and not sufficiently adapted to practice. Subsequent writers, especially Sir John Herschel, Dr. Whewell, and Mr. Mill have rendered these rules at once more precise and better adapted to practice. See notes on Book II. Aphorisms 11-18, and Introduction, §§ 9, 15. [TF]

[303] There can be no question that Bacon is here alluding to the Method of Exclusions, of which he gives an instance in Book II. Aphorism 18. See note 70 on the ambiguous passage in Book I. Aphorism 69. The second of the alternative explanations, which were there proposed, is, of course, the one which is applicable here.

The defects of Bacon's Method of Exclusion (for a further account of which see § 9 of the Introduction to this edition and Mr. Ellis's Preface to Bacon's Philosophical Works, Ellis and Spedding, Vol. I. pp. 22-39) are tolerably obvious. There is, first, the difficulty, amounting, in most cases, almost to impossibility, of ascertaining that all the possible explanations or causes of the given phenomenon have been passed in review. Then, again, we not only require rules to exclude false theories, but also tests to satisfy ourselves of the truth of the theory which we ultimately adopt. These, however, Bacon

might have maintained, are, at least, suggested in II. 15, and, to a certain extent, supplied in some of the Praerogativae Instantiarum. [TF]

[304] But in the Temporis Partus Masculus (Ellis and Spedding, Vol. III. p. 530) he abuses Plato, amongst other things, for his Induction, and apostrophizes him thus: '. . . . . animosque vagis inductionibus tentares et exsolveres.' By the Platonic Induction in that and the present passage, he probably means two different things. In the Temporis Partus Masculus, he is alluding probably to what is usually understood by the Platonic or Socratic Induction, the ἐπακτικοὶ λόγοι, or παραβολή, which (except in the fact that it generally argues from a number of instances, instead of generally arguing from' a single instance) answers to the Example (παράδειγμα) of Aristotle. For an account of this mode of reasoning, see the Introduction to Mansel's Edition of Aldrich, 4th ed., p. xx. But the 'forma inductionis' to which Bacon alludes in this Aphorism is undoubtedly the Method of Exclusion, as practised by Plato. When he wishes to settle the meaning of a term, his usual method (of which we may see an excellent instance, with regard to δικαιοσύνη, in the 1st book of the Republic) is to bring forward a number of interlocutors, who, one after the other, make the attempt; each, in his turn, is refuted, generally by an application of the Socratic παραβολή, or induction in the sense just described; then, the question is either left unsettled (as in the Euthyphron), or Socrates himself proposes a definition, which is accepted as final. But, if the affirmative Socrates stands his ground, it is only because, as Mr. Grote says, there is no negative Socrates to cross-question him. In fact, this allusion to the Platonic Method of Rejection brings into prominence the objections to the method generally. How can we be certain that all the possible definitions have been started, and what guarantee have we of the correctness of the one which is ultimately adopted? [TF]

[305] This word implies both discussion and determination. [TF]

[306] The word, I think, here stands for the ἰδέαι of Plato. Its use as notiones [306.1], was, before the time of David Buchanan and Descartes, exceedingly rare. See Hamilton on Reid, Appendix, Note G, where the student will find a most interesting account of the history of the word. In Aphorism 23 and elsewhere, Bacon uses it in its scholastic sense, as appropriated to the forms of the Divine Mind, 'divinae mentis ideae.' See note 29 on Aphorism 23. [TF]

[306.1] The word "notiones" appears as "=notiones" in Fowler. It could also be "notions"! [HJ]

[307] Bacon probably uses this term, usually appropriated to mathematical proof, of set purpose. He conceived, and conceived, I think, rightly, that Induction, if properly conducted, is capable of affording evidence positively certain. CP. the Distributio Operis, p. 172, 'Inductionem enim censemus earn esse demonstrandi formam,' etc. [TF]

[308] Any one acquainted with the subsequent history of scientific discovery and scientific method will admire the wonderful foresight displayed by Bacon in this sentence. [TF]

[309] Thus, for instance, if we arrive at -a true axiom on the nature of heat, we shall be better able to define the term or notion. CP. Aphorism 14 and note 17. [TF]

CVI.

At in axiomatibus constituendis per hanc inductionem, examinatio et probatio etiam facienda est, utrum quod constituitur axioma aptatum sit tantum et ad mensuram factum eorum particularium ex quibus extrahitur; an vero sit amplius et latius [310]. Quod si sit amplius aut latius, videndum an eam suam amplitudinem et latitudinem per novorum particularium designationem, quasi fide-jussione quadam, firmet [311]; ne vel in jam notis tantum haereamus, vel laxiore fortasse complexu umbras et formas abstractas, non solida et determinata in materia, prensemus. Haec vero cum in usum venerint, solida tum demum spes merito affulserit.

[310] CP. Aphorism 70 and note 74. We here again come across the distinction since expressed by the terms 'Empirical Law' and 'Law of Nature.' [TF]

[311] Mr. Adamson (Encyclopaedia Britannica, Vol. III. p. 217) is quite right in saying that this Aphorism appears to introduce the idea of hypothesis. He might also have added that it introduces the idea of verification, including prediction. As to the nature of the 'fidejussio,' I may remark that the circumstance of a scientific generalisation enabling us to predict the future affords a strong confirmation of its truth, though it does not positively prove it. See my Inductive Logic, 4th ed., pp. 113-119.

Mr. Spedding very appositely quotes the following passage from Valerius Terminus (Ellis and Spedding, Vol. III. p.243): 'That the discovery of new works and active directions not known before, is the only trial to be accepted of; and yet not that neither, in case where one particular giveth light to another; but where particulars induce an axiom or observation, which axiom found out discovereth and designeth new particulars. That the nature of this trial is not only upon the point, whether the knowledge be profitable or no, but even upon the point whether the knowledge be true or no; not because you may always conclude that the Axiom which discovereth new instances is true, but contrariwise you may safely conclude that if it discover not any new instance it is in vain and untrue.' [TF]

CVII.

Atque hic etiam resumendum est, quod superius dictum est [312] de Naturali Philosophia producta et scientiis particularibus ad eam reductis, ut non fiat scissio et truncatio scientiarum; nam etiam absque hoc minus de progressu sperandum est.

[312] See Aphorisms 79, 80, with the notes upon them. Here, as in those Aphorisms, there seems to be some confusion between Natural Philosophy and the Philosophia Prima. The metaphors 'scissio et truncatio' certainly apply to the Philosophia Prima, as described in De Augmentis Scientiarum, Libro III. Cap. i, rather than to Natural Philosophy, as described in the subsequent chapters of the same Book.

Of the justice, however, of Bacon's remark, and of its supreme importance, there can be no doubt. The results of the labours of specialists require to be gathered together into one science, and the various sciences themselves to be compared and brought into harmony, if human knowledge is to progress as a whole and we are to command a real insight into the ways of nature. [TF]

CVIII.

Atque de desperatione tollenda et spe facienda, ex praeteriti temporis erroribus valere jussis aut rectificatis, jam dictum est. Videndum autem et si quae alia sint quae spem faciant. Illud vero occurrit; si hominibus non quaerentibus, et aliud agentibus, multa utilia, tanquam casu quodam aut per occasionem, inventa sint; nemini dubium esse posse, quin iisdem quaerentibus et hoc agentibus, idque via et ordine, non impetu et desultorie, longe plura detegi necesse sit. Licet enim semel aut iterum accidere possit, ut quispiam in id forte fortuna incidat, quod magno conatu et de industria scrutantem antea fugit; tamen in summa rerum proculdubio contrarium invenitur. Itaque longe plura et meliora, atque per minora intervalla, a ratione et industria et directione et intentione hominum speranda sunt, quam a casu et instinctu animalium et hujusmodi, quae hactenus principium inventis dederunt.

CIX.

Etiam illud ad spem trahi possit, quod nonnulla ex his quae jam inventa sunt ejus sint generis ut antequam invenirentur haud facile cuiquam in mentem venisset de iis aliquid suspicari; sed plane quis illa ut impossibilia contempsisset. Solent enim homines de rebus novis ad exemplum veterum, et secundum phantasiam ex iis praeceptam et inquinatam, hariolari; quod genus opinandi fallacissimum est, quandoquidem multa ex his quae ex fontibus rerum petuntur per rivulos consuetos non fluant.

Veluti si quis, ante tormentorum igneorum [313] inventionem, rem per effectus descripsisset, atque in hunc modum dixisset: inventum quoddam detectum esse, per quod muri et munitiones quaeque maximae ex longo intervallo concuti et dejici possint; homines sane de viribus tormentorum et machinarum per pondera et rotas et hujusmodi arietationes et impulsus multiplicandis, multa et varia secum cogitaturi fuissent; de vento autem igneo [314], tam subito et violenter se expandente et exsufflante, vix unquam aliquid alicujus imaginationi aut phantasiae occursurum fuisset; utpote cujus

exemplum in proximo non vidisset, nisi forte in terrae motu aut fulmine, quae, ut magnalia naturae et non imitabilia ab homine, homines statim rejecturi fuissent.

[313] Cannon, 'Large pieces, which were conveyed on cars or carriages, were called karrenbüchse, but soon after also canna, cannon.' 'These karrenbüchsen with a wheel were invented in Germany in the beginning of the sixteenth century.' 'Martin Bellay, speaking of the league formed between the emperor Charles V and pope Leo X against France, and the siege of Parma undertaken in the year 1521, says, "De ceste heure lá furent inventées les harcquebouzes qu'on tiroit sur une fourchette."' — Beckmann's History of Inventions. [TF]

[314] Beckmann 'is inclined to accede to the opinion of those who believe that gunpowder was invented in India, and brought by the Saracens from Africa to the Europeans, who however improved the preparation of it, and found out different ways of employing it in war.' 'The preparation of gunpowder,' he thinks, 'became known in Europe in the thirteenth century, about the same time that the use of the Greek fire, of which there were many kinds, began to be lost.' [TF]

Eodem modo si, ante fili bombycini [315] inventionem, quispiam hujusmodi sermonem injecisset: esse quoddam fili genus inventum ad vestium et supellectilis usum, quod filum linteum aut laneum tenuitate, et nihilominus tenacitate, ac etiam splendore et mollitie, longe superaret; homines statim aut de serico aliquo vegetabili, aut de animalis alicujus pilis delicatioribus, aut de avium plumis et lanugine, aliquid opinaturi fuissent; verum de vermis pusilli textura, eaque tam copiosa et se renovante et anniversaria, nil fuissent certe commenturi. Quod si quis etiam de vermi verbum aliquod injecisset, ludibrio certe futurus fuisset, ut qui novas aranearum operas somniaret.

[315] Silk (sericum) was so called as coming from the country of the Seres or Chinese, where its cultivation appears to go back to the highest antiquity. It was known both to the Greeks and Romans. [TF]

Similiter, si ante inventionem acus nauticae [316] quispiam hujusmodi sermonem intulisset: inventum esse quoddam instrumentum, per quod cardines et puncta coeli exacte capi et dignosci possint; homines statim de magis exquisita fabricatione instrumentorum astronomicorum ad multa et varia, per agitationem phantasiae, discursuri fuissent; quod vero aliquid inveniri possit, cujus motus cum coelestibus tam bene conveniret, atque ipsum tamen ex coelestibus non esset, sed tantum substantia lapidea aut metallica [317], omnino incredibile visum fuisset. Atque haec tamen et similia per tot mundi aetates homines latuerunt, nec per philosophiam aut artes rationales inventa sunt, sed casu et per occasionem; suntque illius (ut diximus) generis, ut ab iis quae antea cognita fuerunt plane heterogenea et remotissima sint, ut praenotio aliqua nihil prorsus ad illa conducere potuisset.

[316] The Mariner's Compass. 'The directive power of the magnet seems to have been unknown in Europe till late in the twelfth century. It appears, however, on very good

authority, that it was known in China, and throughout the East generally, at a very remote period. * * * * * At first, the Chinese would appear to have used it exclusively for guidance in travelling by land. The earliest date at which we hear of their using it at sea is somewhere about 300 A.D.' Chambers' Encyclopaedia. It is sometimes stated that Marco Polo brought the Compass with him from China to Italy in 1260, but there is evidence of its use in Europe in the previous century.

[317] In Book II. Aphorism 36, an 'Instantia crucis' is proposed for the purpose of determining the cause of the Polarity of the Needle. [TF]

Itaque sperandum omnino est, esse adhuc in naturae sinu multa excellentis usus recondita, quae nullam cum jam inventis cognationem habent aut parallelismum, sed omnino sita sunt extra vias phantasiae; quae tamen adhuc inventa non sunt; quae proculdubio per multos saeculorum circuitus et ambages et ipsa quandoque prodibunt, sicut illa superiora prodierunt; sed per viam, quam nunc tractamus, propere et subito et simul repraesentari [318] et anticipari possunt.

[318] 'Be presented at once,' without any delay. This word, besides its ordinary meaning, has two others: (α) to pay on the spot; to pay in ready money: (β) to perform an act immediately, without delay. [TF]

CX.

Attamen conspiciuntur et alia inventa ejus generis, quae fidem faciant, posse genus humanum nobilia inventa, etiam ante pedes posita, praeterire et transilire. Utcunque enim pulveris tormentarii vel fili bombycini vel acus nauticae vel sacchari vel papyri vel similium inventa quibusdam rerum et naturae proprietatibus niti videantur, at certe imprimendi artificium nil habet quod non sit apertum et fere obvium. Et nihilominus homines, non advertentes literarum modulos difficilius scilicet collocari quam literae per motum manus scribantur, sed hoc interesse, quod literarum moduli semel collocati infinitis impressionibus, literae autem per manum exaratae unicae tantum scriptioni, sufficiant; aut fortasse iterum non advertentes atramentum ita inspissari posse, ut tingat, non fluat; praesertim [319] literis resupinatis et impressione facta desuper; hoc pulcherrimo invento (quod ad doctrinarum propagationem tantum facit) per tot saecula caruerunt [320].

[319] This is given as a reason why ink was needed, which should stain without running. [TF]

[320] The honour of the invention of printing from moveable types has been much disputed, it is generally ascribed to John Guttemberg [320.1] of Mainz. All that we can say with certainty is that it is due to the middle of the fifteenth century. In order to carry the art to any perfection, it was necessary to invent not only moveable types, but also an ink more viscous and tenacious than the ordinary ink. It may be added that the Chinese had from time immemorial been acquainted with the art of printing from blocks

of wood. What constituted the novelty of European printing was the displacement of block-books by the use of moveable types. [TF]

[320.1] Unusual spelling of Johann Guttenberg! This is most probably a type-setting mistake. [HJ]

Solet autem mens humana, in hoc inventionis curriculo, tam laeva saepenumero et male composita esse, ut primo diffidat, et paulo post se contemnat; atque primo incredibile ei videatur aliquid tale inveniri posse, postquam autem inventum sit, incredibile rursus videatur id homines tamdiu fugere potuisse. Atque hoc ipsum ad spem rite trahitur; superesse nimirum adhuc magnum inventorum cumulum, qui non solum ex operationibus incognitis eruendis, sed et ex jam cognitis transferendis et componendis et applicandis, per eam quam diximus Experientiam Literatam [321], deduci possit.

[321] This expression is here used in the same sense as in Aphorism 103 and the De Augmentis Scientiarum. [TF]

CXI.

Neque illud omittendum ad faciendam spem: reputent (si placet) homines infinitas ingenii, temporis, facultatum expensas, quas homines in rebus et studiis longe minoris usus et pretii collocant; quorum pars quota si ad sana et solida verteretur, nulla non difficultas superari possit. Quod idcirco adjungere visum est, quia plane fatemur Historiae Naturalis et Experimentalis collectionem, qualem animo metimur et qualis esse debet, opus esse magnum, et quasi regium, et multae operae atque impensae.

CXII.

Interim particularium multitudinem nemo reformidet, quin potius hoc ipsum ad spem revocet. Sunt enim artium et naturae particularia Phaenomena manipuli instar ad ingenii commenta, postquam ab evidentia rerum disjuncta et abstracta fuerint. Atque hujus viae exitus in aperto est, et fere in propinquo; alterius exitus nullus, sed implicatio infinita. Homines enim adhuc parvam in Experientia moram fecerunt, et eam leviter perstrinxerunt, sed in meditationibus et commentationibus ingenii infinitum tempus contriverunt. Apud nos vero si esset praesto quispiam qui de facto naturae [322] ad interrogata responderet, paucorum annorum esset inventio causarum et scientiarum omnium.

[322] The great difficulty, Bacon seems to have thought, was to ascertain the facts of nature, rather than to draw the right inferences from them. Here, again, we see the importance which he attached to a properly and adequately constituted Natural History. [TF]

CXIII.

Etiam nonnihil hominibus spei fieri posse putamus ab exemplo nostro proprio; neque jactantiae causa hoc dicimus sed quod utile dictu sit. Si qui diffidant, me videant, hominem inter homines aetatis meae civilibus negotiis occupatissimum [323], nec firma admodum valetudine (quod magnum habet temporis dispendium), atque in hac re plane protopirum [324], et vestigia nullius sequutum, neque haec ipsa cum ullo mortalium communicantem, et tamen veram viam constanter ingressum et ingenium rebus submittentem, haec ipsa aliquatenus (ut existimamus) provexisse: et deinceps videant, quid ab hominibus otio abundantibus, atque a laboribus consociatis, atque a temporum successione, post haec indicia nostra expectandum sit; praesertim in via quae non singulis solummodo pervia est (ut fit in via illa rationali), sed ubi hominum labores et operae (praesertim quantum ad experientiae collectam) optime distribui et deinde componi possint. Tum enim homines vires suas nosse incipient, cum non eadem infiniti, sed alia alii praestabunt [325].

[323] In the Cogitata et Visa (Ellis and Spedding, Vol. III. p. 619), he speaks of himself as ‘rebus civilibus plus quam vellet immistus.’ The union of scientific and civil employments, to which Bacon here alludes, reminds us of Cowley’s celebrated lines:

‘Bacon, at last, a mighty man, arose,
Whom a wise King and Nature chose
Lord-Chancellor of both their law's.’ [TF]

[324] Πρωτόπειρος, the first man to make the trial. The account, given in the Introduction, § 13, of authors contemporary with or earlier than Bacon, who had anticipated portions of his teaching, will shew that there is some exaggeration in this statement Perhaps, however, he is referring only to the Inductive Method delineated in Book II. [TF]

[325] This sentence would form a good motto for Adam Smith’s chapters on the Division of Labour. [TF]

CXIV.

Postremo, etiamsi multo infirmior et obscurior aura spei ab ista Nova Continente spiraverit [326], tamen omnino experiendum esse (nisi velimus animi esse plane abjecti) statuimus. Non enim res pari periculo non tentatur, et non succedit; cum in illo ingentis boni, in hoc exiguae humanae operae, jactura vertatur. Verum ex dictis, atque etiam ex non dictis, visum est nobis spei abunde subesse, non tantum homini strenuo ad experiendum, sed etiam prudenti et sobrio ad credendum.

[326] ‘Bacon refers to what Peter Martyr Anghiera has related, that Columbus observing the west winds which blow at certain times of the year on the coast of Portugal came to the conclusion that there must be land to generate them.’ Mr. Ellis’ note. [TF]

CXV.

Atque de desperatione tollenda, quae inter causas potentissimas ad progressum scientiarum remorandum et inhibendum fuit, jam dictum est. Atque simul sermo de signis et causis errorum, et inertiae et ignorantiae quae invaluit, absolutus est; praesertim cum subtiliores causae, et quae in judicium populare aut observationem non incurrunt, ad ea quae de Idolis animi humani dicta sunt referri debeant.

Atque hic simul pars destruens Instaurationis nostrae claudi debet, quae perficitur tribus redargutionibus: redargutione nimirum *Humanae Rationis Nativae* et sibi permissae; redargutione *Demonstrationum*; et redargutione *Theoriarum*, sive philosophiarum et doctrinarum quae receptae sunt [327]. Redargutio vero earum talis fuit qualis esse potuit; videlicet per signa, et evidentiam causarum; cum confutatio alia nulla a nobis (qui et de principiis et de demonstrationibus ab aliis dissentimus) adhiberi potuerit.

[327] See notes on Aphorisms 38, 39, with the passages in Ellis and Spedding's Edition there referred to. In a note on the Distributio Operis, Mr. Spedding remarks that there the three Redargutiones are enumerated in the reverse order to that in which they are enumerated in this Aphorism, and in which they are treated in the Novum Organum. ‘This shows,’ he says, ‘that the Distributio Operis was written before Bacon had decided upon the arrangement of the Novum Organum.’ The enumeration in the Partis Secundae Delineatio (Ellis and Spedding, Vol. III. p. 548) corresponds with that in the Distributio Operis.

The ‘Redargutio Humanae Rationis Nativae et sibi permissae’ includes, of course, the doctrine of the Idola Tribus, Idola Specus, and Idola Fori. [TF]

Quocirca tempus est, ut ad ipsam artem et normam *Interpretandi Naturam* veniamus; et tamen nonnihil restat quod praevertendum est. Quum enim in hoc primo Aphorismorum libro illud nobis propositum sit, ut tam ad intelligendum quam ad recipiendum ea quae sequuntur mentes hominum praeparentur; expurgata jam et abrasa et aequata mentis area, sequitur ut mens sistatur in positione bona, et tanquam aspectu benevolo, ad ea quae proponemus [328]. Valet enim in re nova ad praejudicium, non solum praeoccupatio fortis opinionis veteris, sed et praeceptio sive praefiguratio falsa rei quae affertur. Itaque conabimur efficere ut habeantur bonae et verae de iis quae adducimus opiniones, licet ad tempus tantummodo, et tanquam usurariae, donec res ipsa pernoscatur.

[328] The mirror being now polished, it must be, placed in such a position as to catch the sun’s rays. [TF]

CXVI.

Primo itaque [329] postulandum videtur, ne existiment homines nos, more antiquorum Graecorum, aut quorundam novorum hominum, Telesii, Patricii, Severini [330], sectam aliquam in philosophia condere velle. Neque enim hoc agimus; neque etiam multum interesse putamus ad hominum fortunas quales quis opiniones abstractas de natura et rerum principiis habeat; neque dubium est, quin multa hujusmodi et vetera revocari et nova introduci possint; quemadmodum et complura themata coeli supponi possunt, quae cum phaenomenis sat bene conveniunt, inter se tamen dissentiunt.

[329] In this, and the two next Aphorisms, we have three cautions or warnings. The first is, that the author does not wish to found a sect, or even to propound a complete theory; the second, that particular effects ought not to be expected at first; the third, that mistakes will be sure to occur in the history and tables of discovery. [TF]

[330] CP. De Augmentis Scientiarum, Libro III. Cap. 4 (Ellis and Spedding, Vol. I. p. 564): 'Neque vero ex hoc *Placitorum Philosophiae Kalendario* nuperas theorias et dogmata excludo; sicut illam Theophrasti Paracelsi, eloquenter in corpus quoddam et harmoniam philosophiae redactam a Severino Dano; aut Telesii Consent ini, qui Parmenidis philosophiam instaurans arma Peripateticoriim in illos ipsos vertit; aut Patricii Veneti, qui Platonicorum fumos sublimavit; aut Gilberti popularis nostri, qui Philolai dogmata reposuit; aut alterius cujuscunque, si modo dignus sit.' To Telesius, whom he calls 'the best of the Novellists,' Bacon refers, perhaps, more than to any other modern writer. The Severinus, alluded to in this Aphorism, is probably the same as 'Severinus the Dane' (b. 1543, d. 1602), who must be distinguished from his more celebrated namesake, Marcus Aurelius Severinus, the Calabrian. Both these authors, as well as Telesius and Patricius, are referred to in the Introduction to this Edition.

It is curious that in the Temporis Partus Masculus, where Bacon's judgments are usually extremely severe, Severinus the Dane should be specially selected for commendation: 'Invideo tibi (Paracelsae) e sectatoribus tuis unum Petrum Severinum, virum non dignum qui istis ineptiis immoriatur' (Ellis and Spedding, Vol. III. p. 533.) [TF]

At nos de hujusmodi rebus opinabilibus, et simul inutilibus, non laboramus. At contra nobis constitutum est experiri, an revera potentiae et amplitudinis humanae firmiora fundamenta jacere ac fines in latius proferre possimus [331]. Atque licet sparsim, et in aliquibus subjectis specialibus, longe veriora habeamus et certiora (ut arbitramur) atque etiam magis fructuosa quam quibus homines adhuc utuntur (quae in quintam [332] Instaurationis nostrae partem congessimus), tamen theoriam nullam universalem aut integram proponimus. Neque enim huic rei tempus adhuc adesse videtur. Quin nec spem habemus vitae producendae ad sextam [333]. Instaurationis partem (quae philosophiae per legitimam Naturae Interpretationem inventae destinata est) absolvendam; sed satis habemus si in mediis sobrie et utiliter nos geramus, atque interim semina veritatis sincerioris in poteros spargamus, atque initiis rerum magnarum non desimus.

[331] CP. the title of the Novum Organum, 'Aphorismi de Interpretatione Naturae et Regno Hominis.' [TF]

[332] This part was to be entitled 'Prodromi sive Anticipationes Philosophiae Secundae.' The Preface to it is published at the end of Ellis and Spedding's second volume. [TF]

[333] This part was to be entitled 'Philosophia Secunda, sive Scientia Activa.' There is a fine description of it in the Distributio Operis. See p. 180. [TF]

CXVII.

Atque quemadmodum sectae conditores non sumus, ita nec operum particularium largitores aut promissores. Attamen possit aliquis hoc modo occurrere; quod nos, qui tam saepe operum mentionem faciamus et omnia eo trahamus, etiam operum aliquorum pignora exhibeamus. Verum via nostra et ratio (ut saepe perspicue diximus et adhuc dicere juvat) ea est; ut non opera ex operibus sive experimenta ex experimentis (ut empirici), sed ex operibus et experimentis causas et axiomata, atque ex causis et axiomatibus rursus nova opera et experimenta (ut legitimi Naturae Interpretes), extrahamus.

Atque licet in tabulis nostris inveniendi (ex quibus quarta pars [334] Instaurationis consistit), atque etiam exemplis particularium (quae in secunda parte adduximus), atque insuper in observationibus nostris super historiam (quae in tertia parte [335] operis descripta est), quivis vel mediocris perspicaciae et solertiae complurium operum nobilium indicationes et designationes ubique notabit; ingenue tamen fatemur, historiam naturalem quam adhuc habemus, aut ex libris aut ex inquisitione propria, non tam copiosam esse et verificatam, ut legitimae Interpretationi satisfacere aut ministrare possit [336].

[334] The 'Scala Intellectus.' CP. note 65 on Aphorism 92. [TF]

[335] The 'Phaenomena Universi, sive Historia Naturalis et Experimentails ad condendam Philosophiam.' CP. note 79 on Aphorism 98. [TF]

[336] This 'candid confession' of Bacon should be taken in excuse of the many shortcomings of the part of his work here referred to, and in deprecation of the hostile criticisms of Liebig and others. CP. the next Aphorism, and Introduction, p. 144. [TF]

Itaque si quis ad mechanica sit magis aptus et paratus, atque sagax ad venanda opera ex conversatione sola cum experimentis, ei permittimus et relinquimus illam industriam, ut ex historia nostra et tabulis multa tanquam in via decerpat et applicet ad opera, ac veluti foenus recipiat ad tempus, donec sors haberi possit. Nos vero, cum ad majora contendamus, moram omnem praeproperam et praematuram in istiusmodi rebus tanquam Atalantae pilas (ut saepius solemus dicere) damnamus. Neque enim aurea poma pueriliter affectamus, sed omnia in victoria cursus artis super naturam [337]

ponimus; neque muscum aut segetem herbidam demetere festinamus, sed messem tempestivam expectamus.

[337] That is, the 'regnum hominis.' But then this victory over nature can only be acquired by patient observation of her ways. 'Natura enim non nisi parendo vincitur.' [TF]

CXVIII.

Occurret etiam alicui proculdubio, postquam ipsam historiam nostram et inventionis tabulas perlegerit, aliquid in ipsis experimentis minus certum, vel omnino falsum; atque propterea secum fortasse reputabit, fundamentis et principiis falsis et dubiis inventa nostra niti. Verum hoc nihil est; necesse enim est talia sub initiis evenire. Simile enim est ac si in scriptione aut impressione una forte litera aut altera perperam posita aut collocata sit; id enim legentem non multum impedire solet, quandoquidem errata ab ipso sensu facile corriguntur. Ita etiam cogitent homines, multa in historia naturali experimenta falso credi et recipi posse, quae paulo post a causis et axiomatibus inventis facile expunguntur et rejiciuntur. Sed tamen verum est, si in historia naturali et experimentis magna et crebra et continua fuerint errata, illa nulla ingenii aut artis foelicitate corrigi aut emendari posse. Itaque si in historia nostra naturali, quae tanta diligentia et severitate et fere religione probata et collecta est, aliquid in particularibus quandoque subsit falsitatis aut erroris, quid tandem de naturali historia vulgari, quae prae nostra tam negligens est et facilis, dicendum erit? aut de philosophia et scientiis super hujusmodi arenas (vel syrtes potius) aedificatis? Itaque hoc quod diximus neminem moveat.

CXIX.

Occurrent etiam in historia nostra et experimentis plurimae res, primo leves et vulgatae, deinde viles et illiberales, postremo nimis subtiles ac mere speculativae, et quasi nullius usus: quod genus rerum hominum studia avertere et alienare possit [338].

[338] In this and the two next Aphorisms, we have three apologies, namely, for the occurrence in the Natural History of common things, of base things, and of subtle things. [TF]

Atque de istis rebus, quae videntur vulgatae, illud homines cogitent; solere sane eos adhuc nihil aliud agere, quam ut eorum quae rara sunt causas ad ea quae frequenter fiunt referant et accommodent, at ipsorum quae frequenter eveniunt nullas causas inquirant, sed ea ipsa recipiant tanquam concessa et admissa.

Itaque non ponderis, non rotationis coelestium [339], non caloris, non frigoris, non luminis, non duri, non mollis, non tenuis, non densi, non liquidi, non consistentis, non animati, non inanimati, non similaris, non dissimilaris, nec demum organici, causas

quaerunt; sed illis, tanquam pro evidentibus et manifestis, receptis, de ceteris rebus, quae non tam frequenter et familiariter occurrunt, disputant et judicant.

[339] To have asked this question should surely be put down to Bacon's credit. The cause of the celestial motions was first discovered by Newton. [TF]

Nos vero, qui satis scimus nullum de rebus raris aut notabilibus judicium fieri posse, multo minus res novas in lucem protrahi, absque vulgarium rerum causis et causarum causis rite examinatis et repertis, necessario ad res vulgarissimas in historiam nostram recipiendas compellimur. Quinetiam nil magis philosophiae offecisse deprehendimus quam quod res, quae familiares sunt et frequenter occurrunt, contemplationem hominum non morentur et detineant, sed recipiantur obiter, neque earum causae quaeri soleant: ut non saepius requiratur informatio de rebus ignotis, quam attentio in notis.

CXX.

Quod vero ad rerum vilitatem attinet, vel etiam turpitudinem, quibus (ut ait Plinius [340]) honos praefandus est; eae res, non minus quam lautissimae et pretiosissimae, in historiam naturalem recipiendae sunt. Neque propterea polluitur naturalis historia: sol enim aeque palatia et cloacas ingreditur, neque tamen polluitur. Nos autem non Capitolium aliquod aut Pyramidem hominum superbiae dedicamus aut condimus, sed templum sanctum ad exemplar mundi in intellectu humano fundamus. Itaque exemplar sequimur. Nam quicquid essentia dignum est, id etiam scientia dignum, quae est essentiae imago [341]. At vilia aeque subsistunt ac lauta. Quinetiam, ut e quibusdam putridis materiis, veluti musco et zibetho [342], aliquando optimi odores generantur; ita et ab instantiis vilibus et sordidis quandoque eximia lux et informatio emanat. Verum de hoc nimis multa; cum hoc genus fastidii sit plane puerile et effoeminatum.

[340] 'Rerum natura, hoc est, vita narratur, et haec sordidissima sui parte, ut plurimarum rerum aut mysticis vocabulis aut externis, immo barbaris, etiam cum honoris praefatione ponendis.' Nat. Hist., Libro I. ad init [340.1]. The expression 'honorem praefari' means 'to apologise.' 'to ask permission' in using an indelicate phrase. CP. Cicero, Epistolae ad Diversos, Libro IX. ep. 22: 'Si dicimus, ille patrem strangulavit, honorem non praefamur. Sin de Aurelia aliquid, aut Lollia; bonos praefandus est.' [TF]

[340.1] This quotation comes from Pliny the Elder's *Natural History* (Naturalis Historia), Book I, not Bacon's *Parasceve*. The term "honoris praefatio" is used to justify writing about things that might seem vulgar or unpleasant. [HJ]

[341] With the various questions, as to the correspondence or relation of knowledge to being, which were to occupy so much of the attention of subsequent philosophers, Bacon did not concern himself. That knowledge would correspond with being, if we were once to dispel the phantoms which beset us and lay our minds alongside of facts, he took for granted. [TF]

[342] Musk and civet. [TF]

CXXI.

At de illo omnino magis accurate dispiciendum; quod plurima in historia nostra captui vulgari, aut etiam cuivis intellectui (rebus praesentibus assuefacto), videbuntur curiosae cujusdam et inutilis subtilitatis. Itaque de hoc ante omnia et dictum et dicendum est: hoc scilicet; nos jam sub initiis et ad tempus, tantum *lucifera* experimenta, non *fructifera* quaerere; ad exemplum creationis divinae, quod saepius diximus, quae primo die lucem tantum produxit, eique soli unum integrum diem attribuit, neque illo die quicquam materiati operis immiscuit.

Itaque si quis istiusmodi res nullius esse usus putet, idem cogitat ac si nullum etiam lucis esse usum censeat, quia res scilicet solida aut materiata non sit. Atque revera dicendum est, simplicum naturarum [343] cognitionem bene examinatam et definitam instar lucis esse; quae ad universa operum penetralia aditum praebet, atque tota agmina operum et turmas, et axiomatum nobilissimorum fontes, potestate quadam complectitur et post se trahit; in se tamen non ita magni usus est. Quin et literarum elementa per se et separatim nihil significant nec alicujus usus sunt, sed tamen ad omnis sermonis compositionem et apparatum instar materiae primae sunt. Etiam semina rerum potestate valida, usu (nisi in processu suo) nihili sunt. Atque lucis ipsius radii dispersi, nisi coeant, beneficium suum non impertiuntur.

[343] This passage is important as throwing light both on Bacon's theory of Forms and on his theory of Induction. He seems to have thought it possible to discover the ultimate elements (simplices naturae), out of which all the manifold and intricate effects in Nature are compounded, just as all words and sentences, however numerous and complex they may be, are compounded out of the letters of the alphabet. When these 'simple natures' were discovered, it would be easy, he conceived, by rejecting first one and then another, to ascertain, through the method of Exclusion, the Form or Cause of any given phenomenon. See Introduction, § 9, and Mr. Ellis' General Preface to Bacon's Philosophical Works, pp. 25-39. [TF]

Quod si quis subtilitatibus speculativis offendatur, quid de scholasticis viris dicendum erit, qui subtilitatibus immensum indulserunt? quae tamen subtilitates in verbis, aut saltem vulgaribus notionibus (quod tantundem valet), non in rebus aut natura consumptae fuerunt, atque utilitatis expertes erant, non tantum in origine, sed etiam in consequentiis; tales autem non fuerunt, ut haberent in praesens utilitatem nullam, sed per consequens infinitam; quales sunt eae de quibus loquimur. Hoc vero sciant homines pro certo, omnem subtilitatem disputationum et discursuum mentis, si adhibeatur tantum post axiomata inventa, seram esse et praeposteram; et subtilitatis tempus verum ac proprium, aut saltem praecipuum, versari in pensitanda experientia et inde constituendis axiomatibus: nam illa altera subtilitas naturam prensat et captat, sed nunquam apprehendit aut capit [344]. Et verissimum certe est quod de occasione sive

fortuna dici solet, si transferatur ad naturam: videlicet, *eam a fronte comatam, ab occipitio calvam esse* [345].

[344] For it is 'subtilitati naturae longe impar.' 'Assensum itaque constringit, non res.' CP. Aphorisms 10-14. [TF]

[345] See Phaedrus' Fables, Libro V. fab, 8:

'Occasio Depicta.
Cursu volucri pendens in novacula,
Calvus, comosa fronte, nudo corpore,
Oiiem si occuparis, teneas: elapsum semel
Non ipse possit Jupiter reprehendere;
Occasionem rerum significat brevem.
Effectus impediret ne segnis mora,
Finxere antiqui talem effigiem temporis,'

Dr. Kitchin quotes also a hexameter found in Dionysius Cato, Distich, de Moribus, II. 26 (circ. A.D, 400):

'Fronte capillata, post est Occasio calva.'

Cp. our proverb, 'Taking Time by the forelock.' [TF]

Denique de contemptu in naturali historia rerum aut vulgarium, aut vilium, aut nimis subtilium et in originibus suis inutilium, illa vox mulierculae ad tumidum principem, qui petitionem ejus ut rem indignam et majestate sua inferiorem abjecisset, pro oraculo sit; *Desine ergo rex esse* [346]: quia certissimum est, imperium in naturam, si quis hujusmodi rebus ut nimis exilibus et minutis vacare nolit, nec obtineri nec geri posse.

[346] This story is told of Philip of Macedon by Plutarch, Apophthegmata, p. 179. 25-29, ed. Reiske, Vol. vi: Πρεσβύτιδος δὲ πενιχρᾶς ἀξιούσης én' αὐτοῦ κριθῆναι, καὶ πολλάκις ἐνοχλούσης, ἔφη, μὴ σχολάζειν. ἡ δὲ πρεσβῦτις ἐγκραγοῦσα, Καὶ μὴ βασίλευε, εἶπεν. ὁ δὲ θαυμάσας τὸ ῥηθέν, οὐ μόνον ἐκείνης, ἀλλὰ καὶ τῶν ἄλλων, εὐθὺς διήκουσεν. [TF]

CXXII.

Occurrit [347] etiam et illud; mirabile quiddam esse et durum, quod nos omnes scientias atque omnes authores simul ac veluti uno ictu et impetu summoveamus: idque non assumpto aliquo ex antiquis in auxilium et praesidium nostrum, sed quasi viribus propriis.

[347] Mr. Spedding suggests that 'occurrit' is a misprint for 'occurret.' Aphorisms 122-126 contain the answers to four objections, Aphorism 127 is the answer to a doubt rather than to an objection. [TF]

Nos autem scimus, si minus sincera fide agere voluissemus, non difficile fuisse nobis, ista quae afferuntur vel ad antiqua saecula ante Graecorum tempora (cum scientiae de

natura magis fortasse sed tamen majore cum silentio floruerint, neque in Graecorum tubas et fistulas adhuc incidissent), vel etiam (per partes certe) ad aliquos ex Graecis ipsis referre, atque astipulationem et honorem inde petere: more novorum hominum, qui nobilitatem sibi ex antiqua aliqua prosapia, per genealogiarum favores, astruunt et affingunt. Nos vero rerum evidentia freti, omnem commenti et imposturae conditionem rejicimus; neque ad id quod agitur plus interesse putamus, utrum quae jam invenientur antiquis olim cognita, et per rerum vicissitudines et saecula occidentia et orientia sint, quam hominibus curae esse debere, utrum Novus Orbis fuerit insula illa Atlantis [348] et veteri mundo cognita, an nunc primum reperta. Rerum enim inventio a naturae luce petenda, non ab antiquitatis tenebris repetenda est.

[348] See Plato's Timaeus, 24 E-25 D. [TF]

Quod vero ad universalem istam reprehensionem attinet, certissimum est vere rem reputanti, eam et magis probabilem esse et magis modestam, quam si facta fuisset ex parte. Si enim in primis notionibus errores radicati non fuissent, fieri non potuisset quin nonnulla recte inventa alia perperam inventa correxissent. Sed cum errores fundamentales fuerint, atque ejusmodi, ut homines potius res neglexerint ac praeterierint, quam de illis pravum aut falsum judicium fecerint; minime mirum est, si homines id non obtinuerint quod non egerint, nec ad metam pervenerint quam non posuerint aut collocarint, neque viam emensi sint quam non ingressi sint aut tenuerint [349].

[349] CP. Aphorism 32. [TF]

Atque insolentiam rei quod attinet; certe si quis manus constantia atque oculi vigore lineam magis rectam aut circulum magis perfectum se describere posse quam alium quempiam sibi assumat, inducitur scilicet facultatis comparatio: quod si quis asserat se adhibita regula aut circumducto circino lineam magis rectam aut circulum magis perfectum posse describere, quam aliquem alium vi sola oculi et manus, is certe non admodum jactator fuerit. Quin hoc, quod dicimus, non solum in hoc nostro conatu primo et incoeptivo locum habet; sed etiam pertinet ad eos qui huic rei posthac incumbent. Nostra enim via inveniendi scientias exaequat fere ingenia [350], et non multum excellentiae eorum relinquit: cum omnia per certissimas regulas et demonstrationes transigat. Itaque haec nostra (ut saepe diximus) foelicitatis cujusdam sunt potius quam facultatis, et potius temporis partus quam ingenii. Est enim certe casus aliquis non minus in cogitationibus humanis, quam in operibus et factis.

[350] CP. Aphorism 61 and note 13. This anticipation of Bacon never has been, and never can be, realised. There is not, and there never can be, a mechanical method of invention, furnishing rules whereby men of average abilities may invent arts or make discoveries with the same facility and certainty with which they use a pair of compasses. The reason of this impossibility is to be sought not only in the complexity and 'subtlety' of nature (which Bacon thought to be much simpler than it is) and in the laborious and complicated character of many of the processes of reasoning, but also in the important and, indeed,

indispensable share which imagination has in all scientific discovery. Now for the stimulation and exercise of the imagination no rules can be given, though the habitual observation of the ordinary rules of logic, and especially of hypothesis, may be useful in diverting it from improper, and directing it into proper channels.

Bacon's confidence in the ease and certainty with which his method might be applied was a direct consequence of his theory of 'simple natures,' 'This method of exclusion' (says Mr. Ellis, Ellis and Spedding, Vol. I. pp. 33-36) 'requires only an attentive consideration of each "instantia," in order first to analyse it into its simple natures, and secondly to see which of the latter are to be excluded — processes which require no higher faculties than ordinary acuteness and patient diligence. There is clearly no room in this mechanical procedure for the display of subtlety or of inventive genius. Bacon's method therefore' (as he conceived) 'leads to certainty, and may be employed with nearly equal success by all men who are equally diligent.' [TF]

CXXIII.

Itaque dicendum de nobis ipsis quod ille [351] per jocum dixit, praesertim cum tam bene rem secet: *fieri non potest ut idem sentiant, qui aquam et qui vinum bibant*. At caeteri homines, tam veteres quam novi, liquorem biberunt crudum in scientiis, tanquam aquam vel sponte ex intellectu manantem, vel per dialecticam, tanquam per rotas ex puteo, haustam. At nos liquorem bibimus et propinamus ex infinitis confectam uvis, iisque maturis et tempestivis, et per racemos quosdam collectis ac decerptis, et subinde in torculari pressis, ac postremo in vase repurgatis et clarificatis. Itaque nil mirum si nobis cum aliis non conveniat.

[351] Said by Philocrates of Demosthenes: ἐπαναστὰς δ᾽ ὁ Φιλοκράτης μάλα ὑβριστικῶς οὐδέν, ἔφη, θαυμαστόν, ὦ ἄνδρες ᾽Αθηναῖοι, μὴ ταὐτὰ ἐμοὶ Kai Δημοσθένει δοκεῖν" οὗτος μὲν γὰρ ὕδωρ, ἐγὼ ᾽δὲ οἶνον πίνω. καὶ ὑμεῖς ἐγελᾶτε. Demosth. De Falsa Legatione, p. 355. [TF]

CXXIV.

Occurret proculdubio et illud: nec metam aut scopum scientiarum a nobis ipsis (id quod in aliis reprehendimus) verum et optimum praefixum esse. Esse enim contemplationem veritatis omni operum utilitate et magnitudine digniorem et celsiorem: longam vero istam et sollicitam moram in experientia et materia et rerum particularium fluctibus mentem veluti humo affigere, vel potius in Tartarum quoddam confusionis et perturbationis dejicere; atque ab abstractae sapientiae serenitate et tranquillitate (tanquam a statu multo diviniore) arcere et summovere. Nos vero huic rationi libenter assentimur; et hoc ipsum, quod innuunt ac praeoptant, praecipue atque ante omnia agimus. Etenim verum exemplar mundi in intellectu humano fundamus; quale invenitur, non quale cuipiam sua propria ratio dictaverit. Hoc autem perfici non potest, nisi facta mundi dissectione atque anatomia diligentissima. Modulos vero ineptos mundorum et

tanquam simiolas [352], quas in philosophiis phantasiae hominum extruxerunt, omnino dissipandas edicimus. Sciant itaque homines (id quod superius [353] diximus) quantum intersit inter humanae mentis idola et divinae mentis ideas. Illa enim nihil aliud sunt quam abstractiones ad placitum: hae autem sunt vera signacula Creatoris super creaturas, prout in materia per lineas veras et exquisitas imprimuntur et terminantur. Itaque ipsissimae res [354] sunt (in hoc genere) veritas et utilitas: atque opera ipsa pluris facienda sunt, quatenus sunt veritatis pignora, quam propter vitae commoda [355].

[352] 'Apings,' 'mimicries.' The word is not classical, though simiolus is. [TF]

[353] Aphorism 23. [TF]

[354] Therefore, the very things themselves (that is, the facts of nature) are, in this kind of enquiry, both truth and utility.' He means that, if we know the facts of nature, as they really are, we shall both attain truth and gain rules for practice. Mr. Spedding thinks that, if this were the true interpretation, we ought to have *et* before *veritas* as well as before *utilitas*. He proposes the translation, 'truth 'and utility are (in this kind) the very same things,' though lie acknowledges that this use of *ipsissimae* cannot be justified. To me there appears less difficulty in taking the passage as I have done above. Ellis proposes to render it thus: 'Truth and utility are in this kind the very things we seek for.' Dr. Kitchin, to the same effect, translates: 'And so the chief things of all are, in this kind, Truth and Usefulness.' This gives an excellent sense; but will the words bear it? [TF]

[355] We have here an important modification of the point of view which is prominent in Aphorism 81. 'Veritas et utilitas.' and 'veritas' rather than 'utilitas' is, in this Aphorism, described as the proper and adequate object of the Baconian method. CP. Aphorism 129, where Bacon repeats, perhaps still more unequivocally, the same sentiment.

The following passages, which are quoted by Mr. Spedding, appear to me to be less in accordance with the spirit of this Aphorism than with that of Aphorism Si, which, it must be acknowledged, is, notwithstanding many expressions to the contrary, representative of Bacon's general attitude on this subject:

'Ista autem duo pronuntiata, Activum et Contemplativum, res eadem sunt; et quod in operando utilissimum, id in sciendo verissimum.' Novum Org, II. 4.

'Si quis autem sit, cui in contemplationis amorem et venerationem effuso, ista operum frequens et cum tanto honore mentio quiddam asperum et ingratum sonet, is pro certo sciat, se propriis desideriis adversari; etenim in natura, opera non tantum vitae beneficia, sed et vcritatis pignora esse. Et quod in religione verissime requiritur, ut fidem quis ex operibus monstret; idem in natural! pbilosophia competere, ut scientia similiter ex operibus monstretur, Veritatem enim per operum indicationem, magis quam ex argumentatione aut etiam ex sensu, et patefieri et probari. Quare imam eandemque rationem et conditionis humanae et mentis dotandae esse.'—Cogitata et Visa, Ellis and Spedding, Vol. III. p. 612.

‘Ouinetiam illis quibus in contemplationis amorem effusis frequens apud nos operum mentio asperum quiddaixi atque ingratum et mechanicuin sonat, monstrabimus quantum illi desideriis suis propriis adversentur; cum puritas contemplationum atque substructio et inventio operum prorsus eisdem rebus nitantur, ac simui perficiantur.’ — Partis Secundae Delineatio, Ellis and Spedding, Vol. III. p. 549.

To these passages might be added Novum Organum II. 49: ‘Etenim ipsum Posse et ipsum *Scire* naturam humanam amplificant, non beant. Itaque decerpenda sunt ex universitate rerum ea quae ad usus vitae maxima faciunt’

In my notes on Aphorism 81, I have already stated my reasons for regarding Bacon’s conception of the ends of knowledge, or, at least, that which is most prominent in his works, as partial and insufficient. In a few places, however, as in the present Aphorism, he rises above the merely practical view, to which he usually attaches himself. [TF]

CXXV.

Occurret fortasse et illud: nos tanquam actum agere, atque antiquos ipsos eandem quam nos viam tenuisse [356]. Itaque verisimile putabit quispiam etiam nos, post tantum motum et molitionem, deventuros tandem ad aliquam ex illis philosophiis quae apud antiquos valuerunt. Nam et illos in meditationum suarum principiis vim et copiam magnam exemplorum et particularium paravisse, atque in commentarios per locos et titulos digessisse, atque inde philosophias suas et artes confecisse, et postea, re comperta, pronuntiasse, et exempla ad fidem et docendi lumen sparsim addidisse; sed particularium notas et codicillos ac commentarios suos in lucem edere supervacuum et molestum putasse: ideoque fecisse quod in aedificando fieri solet, nempe post aedificii structuram machinas et scalas a conspectu amovisse. Neque aliter factum esse credere certe oportet. Verum nisi quis omnino oblitus fuerit eorum quae superius dicta sunt, huic objectioni (aut scrupulo potius) facile respondebit. Formam enim inquirendi et inveniendi apud antiquos et ipsi profitemur [357], et scripta eorum prae se ferunt. Ea autem non alia fuit [358], quam ut ab exemplis quibusdam et particularibus (additis notionibus communibus, et fortasse portione nonnulla ex opinionibus receptis, quae maxime placuerunt) ad conclusiones maxime generales sive principia scientiarum advolarent, ad quorum veritatem immotam et fixam conclusiones inferiores per media educerent ac probarent; ex quibus artem constituebant. Tum demum si nova particularia et exempla mota essent et adducta quae placitis suis refragarentur, illa aut per distinctiones aut per regularum suarum explanationes in ordinem subtiliter redigebant, aut demum per exceptiones grosso modo summovebant: at rerum particularium non refragantium causas ad illa principia sua laboriose et pertinaciter accommodabant. Verum nec historia naturalis et experientia illa erat, quam fuisse oportebat (longe certe abest), et ista advolatio ad generalissima omnia perdidit.

[356] CP. Filum Labyrinthi, sive Inquisitio Legitima de Motu, Ellis and Spedding, Vol. III. pp. 637-8. [TF]

[357] There can be no question that we ought to adopt Mr. Ellis' correction, 'profitentur'. [TF]

[358] The remainder of the Aphorism sums up and brings together what has already been said separately in many of the preceding Aphorisms. [TF]

CXXVI.

Occurret et illud: nos, propter inhibitionem quandam pronuntiandi et principia certa ponendi donec per medios gradus ad generalissima rite perventum sit, suspensionem quandam judicii tueri, atque ad Acatalepsiam rem deducere. Nos vero non Acatalepsiam, sed Eucatalepsiam [359] meditamur et proponimus: sensui enim non derogamus, sed ministramus; et intellectum non contemnimus, sed regimus. Atque melius est scire quantum opus sit, et tamen nos non penitus scire putare, quam penitus scire nos putare, et tamen nil eorum quae opus est scire.

[359] Dr. Kitchin appositely quotes the well-known passage from the Advancement of Learning: 'If a man will begin with certainties, he shall end in doubts; but if he will be content to begin with doubts, he shall end in certainties,' See Book I., Ellis and Spedding, Vol. III. p. 293. CP., Aphorism 37. [TF]

CXXVII.

Etiam dubitabit quispiam potius quam objiciet, utrum nos de Naturali tantum Philosophia [360], an etiam de scientiis reliquis, Logicis, Ethicis, Politicis, secundum viam nostram perficiendis loquamur [361]. At nos certe de universis haec quae dicta sunt intelligimus: atque quemadmodum vulgaris logica, quae regit res per syllogismum, non tantum ad naturales, sed ad omnes scientias pertinet; ita et nostra, quae procedit per inductionem, omnia complectitur. Tam enim historiam et tabulas [362] inveniendi conficimus de ira, metu, et verecundia, et similibus; ac etiam de exemplis rerum civilium: nec minus de motibus mentalibus memoriae, compositionis et divisionis [363], judicii, et reliquorum, quam de calido et frigido, aut luce, aut vegetatione, aut similibus. Sed tamen cum nostra ratio interpretandi, post historiam praeparatam et ordinatam, non mentis tantum motus et discursus (ut logica vulgaris), sed et rerum naturam intueatur; ita mentem regimus, ut ad rerum naturam se, aptis per omnia modis, applicare possit [364]. Atque propterea multa et diversa in doctrina interpretationis praecipimus, quae ad subjecti, de quo inquirimus, qualitatem et conditionem, modum inveniendi nonnulla ex parte applicent.

[360] It will be noticed that Natural Philosophy is here used in its restricted sense, as opposed to 'scientiae logicae, ethicae,' not as including the consideration of 'affectus, et prehensiones intellectuals,' CP. Aphorisms 79, 80, where it is used in the wider sense. [TF]

[361] CP. Newton's Optics, Book II. ad fin.: And if Natural Philosophy in all its parts, by pursuing this method, should at length be perfected, the bounds, of Moral Philosophy will be also enlarged. For, so far as we, can know by Natural Philosophy what is the First Cause, what powder he has over us, and what benefits we receive from him; so far our duty towards him, as well as that towards one another, will appear to us by the light of Nature.'

This Aphorism, notwithstanding certain passages in the Novum Organum which apparently point to the opposite conclusion, as, for instance, in the Preface, p. 187, and in Aphorisms 29, 77, 12S, affords conclusive evidence that Bacon contemplated the application of his method to the mental and moral, as well as the natural sciences. The extended meaning of the term 'Natural Philosophy' (including 'affectus, et preliensiones intellectuales'), as employed in Aphorism 80, appears to imply the same intention. And, though, perhaps, there is nothing in Bacon's works strictly corresponding with the 'historia et tabulae inveniendi de ira, metu,' die., of which he speaks below, there are many places where he seems to assume that such enquiries fall within the scope of his philosophy. Besides the numerous passages in the later books of the De Augmentis Scientiarum, the student may refer to the Novum Organum, Book II. Aphorisms 26, 27, 35 ad fin., Historia Vitae et Mortis (Ellis and Spedding, Vol. II. pp. 170-174), Filum Labyrinthi, sive Inquisitio Legitima de Motu, ad fin, (Ellis and Spedding, Vol. III. pp. 639-40), Sylva Sylvarum, Exp. 795 and several of the 'experiments' in the tenth century. But, without multiplying references, I may state that it appears to me unquestionable that Bacon, while he regarded his method as primarily, and, perhaps, most easily applicable to the natural sciences, contemplated its ultimate extension to all branches of knowledge alike. The passages which seem to point in the opposite direction are, I conceive, as I have already stated, ironical, and refer not to science, or knowledge in the true sense, at all, but to rhetoric and disputation.

On the justness of Bacon's view and on the sense or senses in which Induction Is applicable to the moral and mental sciences, this is not the place to speak. It may suffice to say that, in my opinion, certainty can only be attained in these sciences by the employment, at all events in the first instance, of the Inductive Method. Speculations, in these as in all other subjects, unless based on the patient study of facts, 'variantur, non augentur' The enormous extension which the method of Induction has received in recent times by the application of a historical treatment to the subjects of law, institutions, language, art, morals, religion, etc, has really laid the basis of a scientific study of man, which may at some future time rival in inspect of certainty, while it will even transcend in interest, the scientific study of nature. The student who may wish to see successful examples of this mode of treatment, the historical method, as it has been called, is referred to the works of Sir Maine, Professor Max Muller, Sir J. Lubbock, Dr. Tylor, and (though here, perhaps, he will be treading on less firm ground) to the Psychology and Sociology of Mr. Herbert Spencer. For an analysis of the historical method, he may consult the Editors Inductive Logic, 4th ed., pp. 201-203, and Mill's

Logic, Book vi. Chapter 10. The whole of the sixth book of Mr. Mill's Logic bears on the methods of the moral and mental sciences.

The word 'logicis' in the above sentence should probably be taken as including what we call 'psychology' as well as logic proper. But even logic, in the strictest sense of the term, rests ultimately on an inductive basis. It is only through having observed what processes of reasoning lead to a sound, and what to an unsound conclusion, that is, to a conclusion agreeing or disagreeing with facts, that men have been able to frame with any certainty even the rules of logic itself. [TF]

[362] See last note. [TF]

[363] Affirmation and Negation, not, as Mr. Ellis suggests, Synthesis and Analysis. See Aldrich's Logic, ad init.: 'Est enim Judicium aliud *Affirmativum*, quod vocatur etiam *Compositio*; aliud *Negativum*) quod et *Divisio*.' This terminology is derived from Aristotle. Cp., for instance, De Interpretatione, Chapter i: περὶ yap σύνθεσιν καὶ διαίρεσίν ἐστι τὸ ψεῦδός τε καὶ τὸ ἀληθές. τὰ μὲν οὖν ὀνόματα αὐτὰ καὶ τὰ ῥήματα ἔοικε τῷ ἄνευ συνθέσεως καὶ διαιρέσεως νοήματι, οἷον τὸ ἄνθρωπος ἢ τὸ λευκόν, ὅταν μὴ προστεθῇ τι" οὔτε γὰρ ψεῦδος οὔτε ἀληθές πω. [TF]

[364] The object of this remark is to distinguish bis own from the vulgar logic. The common logic is concerned only with the operations of the mind, regarded in and for themselves, but the Baconian logic has for its aim. to interpret the ways of external nature as well as the processes of the human mind, and hence it must adapt and accommodate itself to the quality and condition of the various objects which it investigates. This is a far-seeing description of the office and peculiarities of the Inductive Logic. Thus, for example, one method or combination of methods is applicable to mechanical problems, another to the problems of chemistry, a third to those of physiology, and so on. Bacon's own 'Praerogativae Instantiarum' in the 2nd Book would afford a good instance of what he means. [TF]

CXXVIII.

At illud de nobis ne dubitare quidem fas sit; utrum nos philosophiam et artes et scientias quibus utimur destruere et demoliri cupiamus: contra enim, earum et usum et cultum et honores libenter amplectimur. Neque enim ullo modo officimus, quin istae, quae invaluerunt, et disputationes alant, et sermones ornent, et ad professoria munera ac vitae civilis compendia adhibeantur et valeant; denique, tanquam numismata quaedam, consensu inter homines recipiantur. Quinetiam significamus aperte, ea quae nos adducimus ad istas res non multum idonea futura; cum ad vulgi captum deduci omnino non possint, nisi per effecta et opera tantum [365]. At hoc ipsum, quod de affectu nostro et bona voluntate erga scientias receptas dicimus, quam vere profiteamur, scripta nostra in publicum edita (praesertim libri De Progressu Scientiarum [366]) fidem faciant. Itaque id verbis amplius vincere non conabimur. Illud interim constanter et diserte monemus;

his modis, qui in usu sunt, nec magnos in scientiarum doctrinis et contemplatione progressus fieri, nec illas ad amplitudinem operum deduci posse.

[365] See notes on the last Aphorism and on Aphorism 29. In favour of my interpretation of this and similar passages as ironical, I may adduce the argument that Bacon could hardly have contradicted himself on so important a matter in two consecutive Aphorisms. [TF]

[366] 'The Twoo Bookes of Francis Bacon of the Proficience and Advancement of Learning Divine and Humane,' first published in 1605. The De Augmentis Scientiarum, of course, was not yet published. [TF]

CXXIX.

Superest ut de Finis excellentia pauca dicamus. Ea si prius dicta fuissent, votis similia videri potuissent: sed spe jam facta, et iniquis praejudiciis sublatis, plus fortasse ponderis habebunt. Quod si nos omnia perfecissemus et plane absolvissemus, nec alios in partem et consortium laborum subinde vocaremus, etiam ab hujusmodi verbis abstinuissemus, ne acciperentur in praedicationem meriti nostri. Cum vero aliorum industria acuenda sit et animi excitandi atque accendendi, consentaneum est ut quaedam hominibus in mentem redigamus.

Primo itaque, videtur inventorum nobilium introductio inter actiones humanas longe primas partes tenere: id quod antiqua saecula judicaverunt. Ea enim rerum inventoribus divinos honores tribuerunt [367]; iis autem qui in rebus civilibus merebantur (quales erant urbium et imperiorum conditores, legislatores, patriarum a diuturnis malis liberatores, tyrannidum debellatores, et his similes), heroum tantum honores decreverunt. Atque certe si quis ea recte conferat, justum hoc prisci saeculi judicium reperiet. Etenim inventorum beneficia ad universum genus humanum pertinere possunt, civilia ad certas tantummodo hominum sedes: haec etiam non ultra paucas aetates durant, illa quasi perpetuis temporibus. Atque status emendatio in civilibus non sine vi et perturbatione plerumque procedit: at inventa beant, et beneficium deferunt absque alicujus injuria aut tristitia.

[367] CP. De Augmentis Scientiarum, Libro I, Ellis and Spedding, Vol. I. p. 470: 'Quippe supra humanos honores, heroici numerabantur et divini; in quorum distributione hunc ordinem tenuere veteres. Rerumpublicarum conditores, legisiatores, tyrannicidae, patres patriae, quique in rebus civilibus optime meruerunt, insign iti sunt titulo Heroum tantum, aut Semideorum; quales fuere Theseus, Minos, Romulus, ceterique. Ex altera parte inventores et authores novarum artium, quique vitam humanam novis comniodis et accessionibus dotarunt, semper consecrati sunt inter Deos ipsos Majores; quod Cereri, Baccho, Mercurio, Apollini, et aliis contigit. Quod certe jure et sano cum judicio factum est. Nam priorum benemerita intra unius aetatis aut nationis limites fere coercentur; nec absimilia sunt imbribus tempestivis et benignis, qui quamvis frugiferi sint atque optabiles, tainen pro ilia tempestate tantum qua decidunt, atque pro

amplitudine tractus terrae quam irrigant, utiles sunt; posted orum vero beneficia, ut ipsius solis et coelestium munera, temporibus perpetua, locis infinita sunt. Ilia rursus cum contentione et perturbatione ut plurimum conjimcta sunt; haec habent verum characterem Divinae Praesentiae, veniuntque in aura lem, absque tumuitu aut strepitu.' [TF]

Etiam inventa quasi novae creationes sunt, et divinorum operum imitamenta; ut bene cecinit ille:

> 'Primum frugiferos foetus mortalibus aegris
> Dididerant quondam praestanti nomine Athenae;
> Et RECREAVERUNT vitam, legesque rogarunt [368].'

[368] Lucretius, vi. 1-3. Bacon, in quoting these lines, probably from memory, has altered 'primae' into 'primum,' 'dididerunt' into 'dididerant, and 'praeclaro ' into ' praestanti.' [TF]

Atque videtur notatu dignum in Solomone; quod cum imperio, auro, magnificentia operum, satellitio, famulitio, classe insuper, et nominis claritate, ac summa hominum admiratione floreret, tamen nihil horum delegerit sibi ad gloriam sed ita pronuntiaverit: *Gloriam Dei esse, celare rem; gloriam regis, investigare rem* [369].

[369] Proverbs XXV. 2. [369.1] [TF]

[369.1] Proverbs 25:2: "It is the glory of God to conceal a matter; to search out a matter is the glory of kings." [HJ]

Rursus (si placet) reputet quipiam, quantum intersit inter hominum vitam in excultissima quapiam Europae provincia, et in regione aliqua Novae Indiae [370] maxime fera et barbara: ea [371] tantum differre existimabit, ut merito *hominem homini Deum esse* [372], non solum propter auxilium et beneficium, sed etiam per status comparationem, recte dici possit. Atque hoc non solum, non coelum, non corpora, sed artes praestant.

[370] The name given to the Western Continent and Islands, when first discovered by Columbus, who imagined them to be a part of India. We still have traces of this nomenclature in the 'West Indies.' the 'Red Indians,' 'Indiana,' etc. [TF]

[371] Ought not this word to be corrected to eas, which is the reading in the edition published at Leyden in 1645? [TF]

[372] '"Homo homini Deus, si suum officium sciat." An Aphorism of Caecilius Comicus apud Symmach. Epist. x. 104 (al. 114).' (?ix. 108.) 'Bacon has expanded the meaning of the saying (according to his wont) beyond its original extent. See also Zenobius, Cent. I. 91 in Gaisford's Paroemiographi Graeci, where the proverb is 'Ανθρώπος ἀνθρώπου δαιμόνιον.' Dr. Kitchin's note. Of the two authors here cited, Caecilius Statius, the comic

poet, died B.c. 168, being an immediate predecessor of Terence; Zenobius lived in the time of Hadrian. It has been pointed out to me that the same proverb is referred to in Hooker's Ecclesiastical Polity, Book I. Chapter X. sect. 12. See an interesting note on the passage in Dean Church's edition of Book I. (Clarendon Press), p. 128, and CP. Jeremy Taylor's Works (ed. Heber and Eden), Vol. IV., p. 315. [TF]

Rursus, vim et virtutem et consequentias rerum inventarum notare juvat; quae non in aliis manifestius occurrunt, quam in illis tribus quae antiquis incognitae, et quarum primordia, licet recentia, obscura et ingloria sunt: Artis nimirum Imprimendi, Pulveris Tormentarii, et Acus Nauticae [373]. Haec enim tria rerum faciem et statum in orbe terrarum mutaverunt: primum, in re literaria; secundum, in re bellica; tertium, in navigationibus: unde innumerae rerum mutationes sequutae sunt; ut non imperium aliquod, non secta, non stella, majorem efficaciam et quasi influxum super res humanas exercuisse videatur, quam ista mechanica exercuerunt.

[373] CP. Aphorism 109. [TF]

Praeterea non abs re fuerit, tria hominum ambitionis genera et quasi gradus distinguere. Primum eorum, qui propriam potentiam in patria sua amplificare cupiunt; quod genus vulgare est et degener. Secundum eorum, qui patriae potentiam et imperium inter humanum genus amplificare nituntur; illud plus certe habet dignitatis, cupiditatis haud minus. Quod si quis humani generis ipsius potentiam et imperium in rerum universitatem instaurare et amplificare conetur, ea proculdubio ambitio (si modo ita vocanda sit) reliquis et sanior est et augustior. Hominis autem imperium in res, in solis artibus et scientiis ponitur. Naturae enim non imperatur, nisi parendo [374].

[374] CP. Aphorism 3, Dr. Kitchin quotes Livy, xxL 4, where, in describing Hannibal, he says: 'Nunquam ingenium idem ad res diversissimas, parendum atque imperandum, habilius fuit,' I may add Aristotle's description of the good citizen, Pol. III. 4 (14): δεῖ δὲ τὸν πολίτην τὸν ἀγαθὸν ἐπίστασθαι καὶ δύνασθαι καὶ ἄρχεσθαι καὶ ἄρχειν, Kal αὕτη ἀρετὴ πολίτου, τὸ τήν τών ἐλευθέρων ἀρχὴν ἐπίστασθαι ἐπ᾽ ἀμφότερα. [TF]

Praeterea, si unius alicujus particularis inventi utilitas ita homines affecerit, ut eum qui genus humanum universum beneficio aliquo devincire potuerit homine majorem putaverint; quanto celsius videbitur tale aliquid invenire, per quod alia omnia expedite inveniri possint? Et tamen (ut verum omnino dicamus) quemadmodum luci magnam habemus gratiam, quod per eam vias inire, artes exercere, legere, nos invicem dignoscere possimus; et nihilominus ipsa visio lucis res praestantior est et pulchrior, quam multiplex ejus usus: ita certe ipsa contemplatio rerum prout sunt, sine superstitione aut impostura, errore aut confusione, in seipsa magis digna est, quam universus inventorum fructus [375].

[375] CP. Aphorism 124 ad fin. and note 55. This passage, like that, furnishes a happy exception to the manner in which Bacon, when speaking of the ends of knowledge, usually subordinates truth to practice. [TF]

Postremo, siquis depravationem scientiarum et artium ad malitiam et luxuriam et similia objecerit; id neminem moveat. Illud enim de omnibus mundanis bonis dici potest, ingenio, fortitudine, viribus, forma, divitiis, luce ipsa, et reliquis. Recuperet modo genus humanum jus suum in naturam quod ei ex dotatione divina competit, et detur ei copia: usum vero recta ratio et sana religio gubernabit.

CXXX.

Jam vero tempus est ut artem ipsam Interpretandi Naturam proponamus: in qua licet nos utilissima et verissima praecepisse arbitremur, tamen necessitatem ei absolutam (ac si absque ea nil agi possit) aut etiam perfectionem non attribuimus. Etenim in ea opinione sumus: si justam Naturae et Experientiae Historiam [376] praesto haberent homines, atque in ea sedulo versarentur, sibique duas res imperare possent; unam, ut receptas opiniones et notiones deponerent; alteram, ut mentem a generalissimis et proximis ab illis ad tempus cohiberent; fore ut etiam vi propria et genuina mentis [377], absque alia arte, in formam nostram Interpretandi incidere possent. Est enim *Interpretatio* verum et naturale opus mentis, demptis iis quae obstant [378]: sed tamen omnia certe per nostra praecepta erunt magis in procinctu, et multo firmiora.

[376] Bacon again takes the opportunity of shewing the importance which he attaches to his Natural History. CP. Aphorism 98 and my notes on it. [TF]

[377] But the mind would, in that case, employ unconsciously the rules "which Bacon and his successors have prescribed for its conscious use. ‘Natural Logic’ is only artificial logic, employed unconsciously, and artificial logic is only the formal expression of Natural Logic. [TF]

[378] Mr. Spedding compares the following parallel passages: — Valerius Terminus, Chapter 22: — ‘That it is true that interpretation is the very natural and direct intention, action, and progression of the understanding, delivered from impediments; and that all anticipation is but a deflexion or declination by accident.’ Adv. of Learn. (2nd book): — ‘ For he that shall attentively observe how the mind doth gather this excellent dew of knowledge, like unto that which the poet speaketh of, *Aërii mellis coelestia dona*, distilling and contriving it out of particulars natural and artificial, as the flowers of the field and garden, shall find that the mind of herself by nature doth manage and act an induction much better than they describe it.’ [TF]

Neque tamen illis nihil addi posse affirmamus: sed contra, nos, qui mentem respicimus non tantum in facultate propria, sed quatenus copulatur cum rebus, Artem inveniendi cum Inventis adolescere posse, statuere debemus [379].

[379] In the Cogitata et Visa (Ellis and Spedding, Vol. III. p. 610), there is a fine passage on the relation, between particular discoveries and, the Art of Discovery itself:

‘Quod si particularis alicujus inventi utilitas ita homines affecerit, ut eum qui universum genus humanum unico aliquo beneficlo complecti posset homine majorem putarent; at multo celsius inventum esse, quod alia omnia inventa particularia potentia quadam in se contineat. ac animae humanae vias aperiat, ut ad nova et ulteriora quaeque ductu certo et recto penetrare possit. Quemadmodum enim saeculis prioribus, cum homines in navigando per stellanim tantum observationes cuirsum dirigebant, eos veteris sane continentis oras legisse, aut maria aliqua minora et mediterranea trajecisse; necesse autem fuisse usum acus nauticae, ut ducem viae magis fidum, innotuisse, antequam Oceanus trajiceretur, et Novi Orbis regiones detegerentur: simili prorsus ratione, quae huciisque in artibus et scientiis hominum inventa sunt, potuisse instinctii, usu, observatione, meditatione, aperiri, utpote sensiii propiora; antequam vero ad remotiora et occultiora naturae appellere liceat, necessario praecedere, ut melior et perfectior mentis humanae usus et adoperatio inveniatur. Quare hujuscemodi Inventum proculdubio Temporis partum nobiiissimum, et vere masculum esse.’

M. Bouillet calls attention to the following passage in the Filum Labyrinthi, sive Inquisitio Legitima de Motu (Ellis and Spedding, Vol. III. pp. 635-636): ‘Nam et ipsi statuinius, artem inveniendi adolescere cum inventis; neque ad aliquid iinmotum et inviolabile inveniendi artihcium hominum industriam et felicitatem astringendam. Artis enim perfectionem artis usum remorari, nihil est necesse.’

Properly speaking, there is no such art as an ‘Art of Invention,’ for ‘invention’ depends on the exercise of the imaginative faculty, which has not hitherto been amenable, and is never likely to be amenable, to rules. But, at the same time, as we have seen in a note on a previous aphorism (Aphorism 122), by the cultivation of logical habits of mind, and the habitual observation of certain rules, even the imagination may be diverted from improper, and directed into proper channels. Moreover, when imagination has played its part, its products must be submitted to and tested by reason, and here it becomes necessary to employ the rules of logic, whether such rules be stated formally, or, as is more frequently the case, applied unconsciously. At this point, then, arises the question (suggested by this and the latter part of the 127th Aphorism, q. v. [379.1]), whether there is any advance in the analyses and rules of logic in any way corresponding with the advance which is constantly taking place- in the individual sciences? On the whole, I think, it maybe' answered that there is. For what, is Logic but the analysis of the most correct modes of reasoning in each department of human thought, and the construction of rules based on such analysis? Now reasoning is constantly being- applied to new subjects or to new branches of old subjects complicated cases of reasoning, too, are constantly being unravelled and referred to simple principles. Hence, though we are never likely to discover any new laws of thought or to add to the simple formulae to which all reasoning may be reduced in the last resort, yet we may be constantly gaining a wider knowledge of the applications, and possibly of the necessary modifications, of our rules, increased practical skill in weighing arguments and detecting fallacies, and a juster view of the special characteristics which distinguish the reasoning and method of each particular science. And that logic (in the largest sense of the term) has, as a matter

of fact, advanced, as the particular arts and 'sciences have advanced, though not, perhaps, always in the same proportion, hardly admits, I conceive, of any doubt.

[379.1] ”q. v.” = “quod vide” = ”for more information see”. [HJ]

The dependence of Logic on the condition of the several sciences is put in a striking, though undoubtedly an exaggerated, form by Condillac (Histoire Moderne, livre xx. ch, 12): ‘Je n’ai pas le courage de vous parler de ceux qui, avant le renouvellement des sciences, ont tentd d’enseigner Fart de raisonner. Si des Tartares voulaient faire une poetique, vous pensez bien qu’elle serait mauvaise, parce quits n’ont pas de bons poetes. li en est de meme des logiques qui ont dte faites avant le dixseptieme siécle.’ [TF]

Finis Libri Primus Novi Organi.

SUMMARY OF BOOK II.

From the prefatory remarks of Book I, Bacon passes in Book lI to a more formal and positive exposition of his method. The first ten Aphorisms consist mainly of general reflexions, for the most part very obscurely worded, on the ends of science, on the necessity of enquiring into Forms, and on the connexion between the speculative and practical branches of knowledge. He then proceeds to give a specimen of the investigation of a Form, taking as his example the Form of Heat. The first step in the investigation is to draw up certain Tables, the ultimate purpose of which is to enable him to eliminate those qualities which might be supposed to be, but which are not really, of the required Form. When the Tables are completed, and the false explanations have, so far as possible, been rejected, he proceeds, according to his own metaphor, to reap the 'Vindemiatio Prima de forma Calidi,' and, in order to reap this vintage, he gives free play to the Imagination, that is, in spite of his warnings to the contrary in Book I, he frames Hypotheses. This process is called 'permissio intellectus.' 'Atque haec sit prima vindemiatio, sive interpretatio inchoata de forma Calidi, facta per permissionem intellectus' (see Aphorism 20). In Aphorism 21 he announces that, having completed the 'Tabulae' and 'Vindemiatio Prima,' he will proceed 'ad reliqua auxilia intellectus circa Interpretationem Naturae et Inductionem veram ac perfectam.' Of these 'auxilia' he enumerates nine (Aphorism 21), but of the nine one only, the 'Praerogativae Instantiarum (of which here are twenty-seven varieties), is discussed in the Fragment of the Novum Organum which Bacon published. He is on the point of passing on to the 'adminicula inductionis,' when the work abruptly ends.

LIBER SECUNDUS

APHORISMORUM

DE INTERPRETATIONE
NATURAE
SIVE
DE REGNO
HOMINIS.

APHORISMUS.

I.

Super datum corpus novam naturam [1] sive novas naturas generare et superinducere, opus et intentio est humanae potentiae [2]. Datae autem naturae Formam, sive differentiam veram [3], sive naturam naturantem [4], sive fontem emanationis (ista enim vocabula habemus, quae ad indicationem rei proxime accedunt) invenire, opus et intentio est humanae scientiae [5]. Atque his operibus primariis subordinantur alia opera duo secundaria et inferioris notae; priori, transformatio corporum concretorum de alio in aliud, intra terminos Possibilis [6]; posteriori, inventio in omni generatione et motu latentis processus [7], continuati ab efficiente manifesto et materia manifesta usque ad Formam inditam; et inventio similiter latentis schematismi [8] corporum quiescentium et non in motu.

[1] Mr. Ellis remarks that, throughout this Aphorism, Bacon maintains the antithesis between 'corpus,' the concrete body, and 'natura,' the abstract quality. Of each 'corpus' various 'naturae' are predicable. [TF]

[2] Bacon seems to have thought that, if we could once discover the 'form,' we could superinduce the corresponding 'nature' on any given body, but this consequence by no means necessarily follows. Suppose we knew the exact 'form' of the 'natures' which are predicable of and constitute gold, could we superinduce these on silver, or could we eliminate the 'natures' which characterise silver and substitute those which characterise gold? [TF]

[3] Its distinguishing characteristics, or, more precisely, its essence, or inmost constitution, or fundamental attributes. [TF]

[4] In the most general meaning of the words, Natura Naturans and Natura Naturata may be described as related to each other in the following manner. Natura Naturata is the actual condition of a given object or quality, or of the aggregate of all objects and qualities, the Universe, at any given time; Natura Naturans is the immanent cause of this condition, or aggregate of conditions, and is regarded as producing it by a continuous process. Thus, when we say 'how wonderfully Nature works,' we are speaking of 'Natura Naturans;' when we say 'how beautiful is Nature,' we are speaking of Natura Naturata. Hence, Natura Naturans is related to Natura Naturata as cause to effect. Or, again, we may say that Natura Naturans is the active or dynamical, Natura Naturata the passive or statical aspect of Nature. It will be easily understood from this account how Natura Naturans, in some systems of philosophy, as, for instance, in that of Spinoza, came to denote God as the immanent cause of the Universe.

In employing 'natura naturans' and 'fons emanationis' as the equivalents of 'form,' Bacon seems to be adopting a point of view slightly different from that which he takes, where he describes it as 'vera differentia.' But, perhaps, we may exhibit the identity of these various expressions, by saying that the 'data natura' results from the 'form' in the same way that the secondary properties flow from the primary ('differentia vera') or the attributes from the substance, or effects in nature from the indwelling cause. I am, however, inclined to think that in this passage the word 'form' is really employed, though, of course, unconsciously, with two different shades of meaning, namely, as the equivalent of 'essence' ('differentia vera') and of 'cause' ('natura naturans, sive fons emanationis'). For an explanation of these two meanings, and an attempt at reconciling them, see Introduction, § 8. [TF]

[5] For the connexion between 'scientia et potentia humana,' CP. Book i, Aphorism 3. [TF]

[6] The idea of the transmutation of one body into another, and specially of metals, is of frequent occurrence in Bacon's works, and is specially insisted on in Liebig's invective against the Baconian philosophy. 'The possibility' says Mr. Ellis, 'of transmutation, long and strenuously denied, though certainly on no sufficient grounds, is now generally admitted. "There was a time when this fundamental doctrine of the alchemists was opposed to known analogies. It is now no longer so opposed to them, only some stages beyond their present development," Faraday, Lectures on Non-Metallic Elements, p. 106.'

On Bacon's ideas as to the transmutability of the elements and of metals, the student may refer to the Introduction, pp. 26-28. [TF]

[7] See Aphorism 6 [VI] and Book I: 51 [LI]. [TF]

[8] See Aphorism 7 [VII] and Book I: 51 [LI]. [TF]

II.

Quam infeliciter se habeat scientia humana, quae in usu est, etiam ex illis liquet quae vulgo asseruntur. Recte ponitur; *Vere scire, esse per causas scire* [9]. Etiam non male constituuntur causae quatuor; Materia, Forma, Efficiens, et Finis [10]. At ex his causa finalis tantum abest ut prosit, ut etiam scientias corrumpat, nisi in hominis actionibus [11]. Formae inventio habetur pro desperata [12]. Efficiens vero, et materia (quales quaeruntur et recipiuntur, remotae scilicet [13], absque *latenti processu* ad formam) res perfunctoriae sunt, et superficiales, et nihili fere ad scientiam veram et activam. Neque tamen obliti sumus nos superius notasse et correxisse errorem mentis humanae, in deferendo formis primas essentiae [14]. Licet enim in natura nihil vere existat praeter corpora individua [15], edentia actus puros individuos ex lege; in doctrinis tamen, illa ipsa lex, ejusque inquisitio et inventio atque explicatio, pro fundamento est tam ad sciendum, quam ad operandum. Eam autem legem, ejusque *paragraphos* [16], formarum nomine intelligimus; praesertim cum hoc vocabulum invaluerit, et familiariter occurrat.

[9] Ἐπίστασθαι οἰόμεθα ὅταν τήν τ᾽ αἰτίαν οἰώμεθα γινώσκειν, δι᾽ ἣν τὸ πρᾶγμά ἐστιν, ὅτι ἐκείνου αἰτία ἐστί, καὶ μὴ ἐνδέχεσθαι τοῦτ᾽ ἄλλως ἔχειν. Aristotle, An. Post. I. 2 ad init. [TF]

Whatever may be our opinion as to the nature of Causation, or the ultimate analysis of the idea of Cause, this maxim is undoubtedly true; we cannot truly know a thing, unless we know its antecedents and conditions.

[10] On the Four Causes of Aristotle, see Introduction, § 8, n. 34. [TF]

[11] In the actions of men, we must, of course, take account of Final Causes. We know by experience that men always or generally act, consciously or unconsciously, with some end in view. Hence, to understand their acts, we must enquire into their aims. It is from supposing that Nature always, in like manner, has some end in view, from an analogy, in fact, between man and nature, that the theory of Final Causes has been extended to Physics.

On the subject of Final Causes generally, and Bacon's criticism of the doctrine, see Introduction, § 10. [TF]

[12] CP. Book I. Aphorism 75. [TF]

[13] He is probably alluding here to the ὕλη, or shapeless matter, potentially all things and actually nothing, of the Aristotelians, and to the habit of referring natural events and processes to God or Nature as the First Cause, instead of seeking to ascertain the second and proximate Efficient Causes. The proximate efficient cause with Bacon would be the latens processus, and the proximate material cause the latens schematismus. A knowledge of such causes, he thought, would increase our power over nature, whereas the various speculations about the more remote causes appertained, he conceived, not to physics, but to theology and (so far as he recognised any such science) metaphysics.

The causes which he condemns as ‘remote’ and ‘superficial’ may, however, simply be the material and efficient causes, as popularly assigned. Thus, for instance, we might say that vegetable matter was the material cause of coal, and continued pressure its efficient cause. But Bacon would insist on knowing its inmost structure and the secret process by which it had passed from its original condition into its present state. [TF]

[14] Sc. primas partes. The passage to which he alludes is undoubtedly Book I. Aphorism 51, where the ‘forms’ which he condemns are apparently the ἰδέαι of Plato (cp. Book I. Aphorism 65), and where he insists on the investigation of the matter rather than the form. ‘Materia potius considerari debet, et ejus schematismi, et metaschematismi, atque actus purus, et lex actus sive motus; formae enim commenta animi humani sunt, nisi libeat leges iilas actus formas appellare.’ Forms (in the sense of the Platonists and some of the Schoolmen), as abstracted from matter, Bacon rejected altogether; instead of being the principal constituents of being (‘primae partes essentiae’), he denied that they had any existence at all. His own ‘forms,' whatever their precise character may have been, were to be arrived at only by an investigation of matter, and had no existence apart from matter. Hence, the opposition between form and matter had no place in his philosophy, and ‘to assign to forms the principal share in being ' became an unmeaning phrase. [TF]

[15] He is here again combating the Platonic and Scholastic Realism. Strictly speaking, there exist only individual bodies, with their individual manifestations. We may translate the next clause, ‘giving forth individual manifestations (ἐνέργειαι) according to law.' The laws according to which individual bodies exhibit their various manifestations are the proper object of knowledge, and such knowledge is the only guide to practice.

This sentence, combined with Book I. Aphorism 1, affords, perhaps, one of the best statements we have of the Nominalist, as opposed to the Realist, theory of the nature and objects of knowledge. [TF]

[16] ‘Clauses' or ‘sections.' I think that Mr. Ellis (see General Preface, p. 31) interprets this term rightly, in referring it to the ‘simple natures' into which Bacon (see Book II. Aphorism 17) regarded the forms of substances as admitting of resolution. A ‘forma copulata' (as of lion, gold, etc,) is a ‘conjugium naturarum simplicium,’ and hence the ‘simple natures’ may be regarded as ‘clauses' of the forma copulata.

There would, however, be no difficulty in interpreting 'paragraphos' with reference to the ‘forms’ of the ‘simple natures’ themselves. The allusion would then be to the several differentiae which constitute, or the several conditions out of which is produced, the given nature, such, for instance, as those enumerated in Aphorism 20.

It will be noticed that Bacon here employs the word in a different sense (namely, the signification appropriated to it by himself) from that in which he employed it in the last sentence but one, where he condemned the position assigned to Forms. [TF]

III.

Qui causam alicujus naturae (veluti albedinis aut caloris) in certis [17] tantum subjectis novit; ejus scientia imperfecta est: et qui effectum super certas tantum materias (inter eas, quae sunt susceptibiles) inducere potest; ejus potentia pariter imperfecta est. At qui efficientem et materialem causam [18] tantummodo novit (quae causae fluxae sunt, et nihil aliud quam vehicula et causae formam deferentes in aliquibus [19]), is ad nova inventa, in materia aliquatenus simili et praeparata, pervenire potest; sed rerum terminos altius fixos non movet. At qui formas novit, is naturae unitatem in materiis dissimillimis complectitur [20]; itaque quae adhuc facta non sunt, qualia nec naturae vicissitudines, neque experimentales industriae, neque casus ipse, in actum unquam perduxissent, neque cogitationem humanam subitura fuissent, detegere et producere potest. Quare ex formarum inventione sequitur contemplatio vera, et operatio libera [21].

[17] 'Certain' in the sense of 'particular.' [TF]

[18] The Efficient and Material Causes seem here to be spoken of only in reference to concrete substances, while the Forms which Bacon has in view in this Aphorism are those of 'simple natures,' such as heat or whiteness. Now he who knows the material and efficient causes of any given substance may be able to produce or modify other substances of a similar character, but his power will extend no further. But he, on the other hand, who is acquainted with the form, law, or cause of a 'simple nature,' such as heat or whiteness, will be able to produce it in substances of the most dissimilar kind. [TF]

[19] In particular substances only. The meaning is that the Efficient and Material Causes vary as we pass from one substance to another (fluxae sunt), and convey or embody the form in certain cases only. In other cases, a different efficient cause might be necessary to convey, or a different material cause to embody, the same form. For the sense in which the word 'fluxae' is used, CP. Book I. Aphorisms 16, 51, and note on Book I. Aphorism. 11. [TF]

[20] Thus, if we knew the Law of the development of Heat, we should be able to produce heat in any substance whatever. This scientific knowledge of law is here contrasted with the merely empirical knowledge of the artisan, who, being acquainted with certain substances only, can produce changes in them, or like substances, but who, not being acquainted with the Laws of Nature, cannot extend his operations beyond the range of his experience. [TF]

[21] That is, unrestricted to this or that object-matter. CP. again Book I. Aphorism 3. [TF]

IV.

Licet viae ad potentiam atque ad scientiam humanam conjunctissimae sint et fere eaedem, tamen propter perniciosam et inveteratam consuetudinem versandi in abstractis, tutius omnino est ordiri et excitare scientias ab iis fundamentis quae in ordine sunt ad partem activam, atque ut illa ipsa partem contemplativam signet et determinet. Videndum itaque est, ad aliquam naturam super corpus datum generandam et superinducendam, quale quis praeceptum aut qualem quis directionem aut deductionem maxime optaret; idque sermone simplici et minime abstruso.

Exempli gratia; si quis argento cupiat superinducere flavum colorem auri aut augmentum ponderis (servatis legibus materiae [22]), aut lapidi alicui non diaphano diaphaneitatem, aut vitro tenacitatem, aut corpori alicui non vegetabili vegetationem; videndum (inquam) est, quale quis praeceptum aut deductionem potissimum sibi dari exoptet. Atque primo, exoptabit aliquis proculdubio sibi monstrari aliquid hujusmodi, quod opere non frustret neque experimento fallat. Secundo, exoptabit quis aliquid sibi praescribi, quod ipsum non astringat et coerceat ad media quaedam et modos quosdam operandi particulares. Fortasse enim destituetur, nec habebit facultatem et commoditatem talia media comparandi et procurandi. Quod si sint et alia media et alii modi (praeter illud praeceptum) progignendae talis naturae, ea fortasse ex iis erunt quae sunt in operantis potestate; a quibus nihilominus per angustias praecepti excludetur, nec fructum capiet. Tertio, optabit aliquid sibi monstrari, quod non sit aeque difficile ac illa ipsa operatio de qua inquiritur, sed propius accedat ad praxin.

[22] Are not these words inserted in order to intimate that the process must be regarded as purely physical, and to exclude Superstitious Magic? Mr. Ellis explains: 'That is, with a corresponding decrease of volume.' [TF]

Itaque de praecepto vero et perfecto operandi, pronuntiatum erit tale; *ut sit certum, liberum, et disponens* [23] *sive in ordine ad actionem*. Atque hoc ipsum idem est cum inventione formae verae. Etenim forma naturae alicujus talis est ut, ea posita, natura data infallibiliter [24] sequatur. Itaque adest perpetuo, quando natura illa adest [25], atque eam universaliter affirmat, atque inest omni [25.5]. Eadem forma talis est ut, ea amota, natura data infallibiliter fugiat [26]. Itaque abest perpetuo, quando natura illa abest, eamque perpetuo abnegat, atque inest soli [27]. Postremo [28], forma vera talis est, ut naturam datam ex fonte aliquo essentiae deducat quae inest pluribus, et notior est naturae [29] (ut loquuntur) quam ipsa forma. Itaque de axiomate vero et perfecto sciendi pronuntiatum et praeceptum tale est; *ut inveniatur natura alia, quae sit cum natura data convertibilis* [30], *et tamen sit limitatio naturae notioris, instar generis veri* [31]. Ista autem duo pronuntiata, activum et contemplativum, res eadem sunt; et quod in operando utilissimum, id in sciendo verissimum [32].

[23] 'Auxiliary.' [TF]

[24] So far as 'Forma' here = cause, 'infallibiliter' must be taken with the qualification, unless there are counteracting circumstances.' [TF]

[25] So far as 'Forma' = cause, and 'natura ilia' = effect, Bacon is open to the charge, made against him by Mill, of having neglected to take into consideration the fact of plurality of causes. The same cause (unless there are counteracting circumstances) always produces the same effect, but the same effect may be due to different causes, as, for instance, death to disease, poison, or a shot-wound. See Mill's Logic, Book III. Chapter 10; Book V. Chapter 3. § 7. See also my Inductive Logic, 4th ed., pp. 6, 125-131, where I have attempted to restate this doctrine with greater precision. [TF]

[25.5] The two phrases "inest omni" (it is present in every (thing) and "inest soli" (it is present in the sole (thing)) may appear as "inest omnibus" and "inest solis" in some reproductions of Fowler's work. Here, I have reproduced the text as in the original first (1878) and second (1889) editions of the Fowler's work. [HJ]

[26] See last note. The effect, in any particular instance, might be due to a different cause, and would, therefore, not disappear. [TF]

[27] 'Therefore, the form is always absent, when the given nature is absent' (this statement is true), 'and its absence always involves the absence of the given nature (this is inaccurate; see above), 'and it is to be found in the given nature only ' (this is true). My criticism, contained in the above parentheses, applies, of course, only to the case in which Form = cause. [TF]

[28] Here 'form' seems to be taken in the sense of 'vera differentia' (see Aphorism I). The 'fons essentiae' spoken of below is regarded as the genus, and the 'natura data' as the species or tota essentia. The last is supposed to be deduced from the fons essentiae by means of (or by the addition of) the form.

This passage is interesting, because it illustrates both the ambiguity of the word 'Form,' and the close approximation or even ultimate identity of its two meanings, as noticed in the Introduction, § 8. The 'Fons Essentiae' may be regarded as the original substance capable of differentiation, the 'natura data' as the new substance produced from it, and the 'form' either as the law governing the development of the one from the other or as the sum of the attributes which, added to the original 'essentia,' constitute the 'natura data.' Thus, let us suppose, for the sake of example, that it would be possible to find a menstruum, or common substance, capable, by the addition of various differentiae, of becoming gold, silver, copper, etc. The menstruum or common substance would represent the fons essentiae, and gold, silver, etc. the naturae datae. Then, we might describe the 'form' either as the *attributes* which, added to the menstruum, constitute the natura data, or as the *conditions* under which the natura data is developed from the menstruum, or, which is only another way of speaking, as the *law* of the process by which the menstruum is converted into the natura data. [TF]

[29] That is, more general. See note 27 on Book I. Aphorism 22. The proper expression is natura notior. [TF]

[30] This expression requires qualification. See notes 25, 26 above. [TF]

[31] 'As of a true genus.' The 'genus verum' is the same as the 'natura notius' or 'fons essentiae.' [TF]

[32] See Book I. Aphorisms 81, 129, with the notes. [TF]

V.

At praeceptum sive axioma de transformatione corporum duplicis est generis [33]. Primum intuetur corpus, ut turmam sive conjugationem naturarum simplicium: ut in auro haec conveniunt; quod sit flavum; quod sit ponderosum, ad pondus tale; quod sit malleabile aut ductile, ad extensionem talem; quod non fiat volatile, nec deperdat de quanto suo per ignem; quod fluat fluore tali; quod separetur et solvatur modis talibus; et similiter de caeteris naturis, quae in auro concurrunt. Itaque hujusmodi axioma rem deducit ex formis naturarum simplicium. Nam qui formas et modos novit superinducendi flavi, ponderis, ductilis, fixi, fluoris, solutionum, et sic de reliquis, et eorum graduationes et modos, videbit et curabit ut ista conjungi possint in aliquo corpore, unde sequatur transformatio in aurum. Atque hoc genus operandi pertinet ad actionem primariam. Eadem enim est ratio generandi naturam unam aliquam simplicem, et plures; nisi quod arctetur magis restringatur homo in operando, si plures requirantur, propter difficultatem tot naturas coadunandi; quae non facile conveniunt, nisi per vias naturae tritas et ordinarias. Utcunque tamen dicendum est, quod iste modus operandi (qui naturas intuetur simplices, licet in corpore concreto) procedat ex iis [34], quae in natura sunt constantia et aeterna et catholica, et latas praebeat potentiae humanae vias, quales (ut nunc sunt res) cogitatio humana vix capere aut repraesentare possit.

[33] One of these modes of transformation proceeds by discovering the various simple natures or qualities which determine the character of the body, and then superinducing them one by one, till the body is constituted (cp. Sylva Sylvarum, Exp. 328); the other watches the latent process by which the body is produced according to the ordinary way of nature, and then attempts to repeat it artificially. The artificial production of marble by fusion under pressure would be a good instance of the latter mode of transformation, as well as the various attempts, more or less successful, to produce artificial diamonds. For Bacon's sanguine expectations as to the former mode, I cannot offer a better apology than that suggested by Mr. Mill (Logic, Book v, Chapter 3. § 7); 'Why should it not be possible to make gold? Each of the characteristic properties of gold has its *forma*, its essence, its set of conditions, which if we could discover, and learn how to realise, we could superinduce that particular property upon any other substance, upon wood, or iron, or lime, or clay. If, then, we could effect this with respect to every one of the essential properties of the precious metal, we should have converted the other substance into gold. Nor did this, if once the premises were granted, appear to transcend

the real powers of mankind- For daily expenence showed that almost every one of the distinctive sensible properties of any object, its consistence, its colour, its taste, its smell, its shape, admitted of being totally changed by fire, or water, or some other chemical agent. The *formae* of all those qualities seeming, therefore, to be within human power either to produce or to annihilate, not only did, the transmutation of substances appear abstractedly possible, but the employment of the power, at our choice, for practical ends, seemed by no means hopeless.' [TF]

[34] Sc. naturae simplices. [TF]

At secundum genus axiomatis (quod a *latentis processus* inventione pendet) non per naturas simplices procedit, sed per concreta corpora, quemadmodum in natura inveniuntur, cursu ordinario. Exempli gratia; in casu ubi fit inquisitio, ex quibus initiis, et quo modo, et quo processu, aurum aut aliud quodvis metallum aut lapis generetur, a primis menstruis aut rudimentis suis usque ad mineram perfectam; aut similiter, quo processu herbae generentur, a primis concretionibus succorum in terra, aut a seminibus, usque ad plantam formatam, cum universa illa successione motus, et diversis et continuatis naturae nixibus; similiter, de generatione ordinatim explicata animalium, ab initu ad partum; et similiter de corporibus aliis.

Enimvero neque ad generationes corporum tantum spectat haec inquisitio, sed etiam ad alios motus et opificia naturae. Exempli gratia; in casu ubi fit inquisitio de universa serie et continuatis actionibus alimentandi, a prima receptione alimenti ad assimilationem perfectam; aut similiter de motu voluntario in animalibus, a prima impressione imaginationis et continuatis nixibus spiritus usque ad flexiones et motus artuum; aut de explicato motu linguae et labiorum et instrumentorum reliquorum usque ad editionem vocum articulatarum. Nam haec quoque spectant ad naturas concretas, sive collegiatas et in fabrica; et intuentur veluti consuetudines naturae particulares et speciales, non leges fundamentales et communes, quae constituunt formas [35]. Veruntamen omnino fatendum est, rationem istam videri expeditiorem et magis sitam in propinquo, et spem injicere magis, quam illam primariam.

[35] In attempting to determine the meaning which Bacon attached to the word Form, this language is of some importance. The 'fundamental and common laws' seem to be distinguished from the 'forms' which they 'constitute,' and thus one 'law' or 'form' to be regarded as more generic than another. See Introduction, pp. 61, 62. [TF]

At pars Operativa similiter, quae huic parti Contemplativae respondet, operationem extendit et promovet ab iis quae ordinario in natura inveniuntur ad quaedam proxima, aut a proximis non admodum remota; sed altiores et radicales operationes super naturam pendent utique ab axiomatibus primariis. Quinetiam ubi non datur homini facultas operandi, sed tantum sciendi, ut in coelestibus (neque enim ceditur homini operari in coelestia, aut ea immutare aut transformare), tamen inquisitio facti ipsius sive veritatis rei, non minus quam cognitio causarum et consensuum, ad primaria illa et catholica axiomata de naturis simplicibus (veluti de natura rotationis spontaneae [36],

attractionis sive virtutis magneticae, et aliorum complurium quae magis communia sunt quam ipsa coelestia) refertur. Neque enim speret aliquis terminare quaestionem, utrum in motu diurno revera terra aut coelum rotet, nisi naturam rotationis spontaneae prius comprehenderit.

[36] See II. 36 (2) and 48 (17), with notes. [TF]

VI.

Latens autem *Processus* [37], de quo loquimur, longe alia res est quam animis hominum (qualiter nunc obsidentur) facile possit occurrere. Neque enim intelligimus mensuras quasdam, aut signa, aut scalas processus in corporibus spectabiles; sed plane processum continuatum, qui maxima ex parte sensum fugit.

[37] See Playfair's Preliminary Dissertation to the Encyclopaedia Britannica. Remarks on the Novum Organum: 'Latent Process is the secret and invisible progress by which sensible changes are brought about, and seems, in Bacon's acceptation, to involve the principle, since called the *law of continuity* according to which, no change, however small, can be effected but in *time*. To know the relation between the time and the change effected in it, would be to have a perfect knowledge of the latent process. In the firing of a cannon, for example, the succession of events during the short interval between the application of the match and the expulsion of the ball constitutes a latent process of a very remarkable and complicated nature, which, however, we can now trace with some degree of accuracy. In mechanical operations, we can often follow this process still more completely. When motion is communicated from any body to another, it is distributed through all the parts of that other, by a law quite beyond the reach of sense to perceive directly, but yet subject to investigation, and determined by a principle which, though late in being discovered, is now generally recognised. The applications of this mechanical principle, are perhaps the instances in which a latent, and, indeed, a very recondite process has been most completely analysed.' [TF]

Exempli gratia; in omni generatione et transformatione corporum, inquirendum quid deperdatur et evolet, quid maneat, quid accedat; quid dilatetur, quid contrahatur; quid uniatur, quid separetur; quid continuetur, quid abscindatur; quid impellat, quid impediat; quid dominetur, quid succumbat; et alia complura.

Neque hic rursus, haec tantum in generatione aut transformatione corporum quaerenda sunt; sed et in omnibus aliis alterationibus et motibus similiter inquirendum quid antecedat, quid succedat; quid sit incitatius, quid remissius; quid motum praebeat, quid regat; et hujusmodi. Ista vero omnia scientiis (quae nunc pinguissima Minerva et prorsus inhabili contexuntur) incognita sunt et intacta. Cum enim omnis actio naturalis per minima [38] transigatur, aut saltem per illa quae sunt minora quam ut sensum feriant, nemo se naturam regere aut vertere posse speret, nisi illa debito modo comprehenderit et notaverit.

[38] Sc. the ultimate particles of bodies. [TF]

VII.

Similiter, inquisitio et inventio *latentis schematismi* [39] in corporibus res nova est, non minus quam inventio latentis processus et formae [40]. Versamur enim plane adhuc in atriis naturae, neque ad interiora paramus aditum. At nemo corpus datum nova natura dotare vel in novum corpus foeliciter et apposite transmutare potest, nisi corporis alterandi aut transformandi bonam habuerit notitiam. In modos enim vanos incurret, aut saltem difficiles et perversos, nec pro corporis natura in quod operatur. Itaque ad hoc etiam via plane est aperienda et munienda.

[39] By the 'latent schematism' Bacon seems to mean the configuration and relative position of the ultimate particles of bodies. As Professor Playfair says, 'When we enquire into the constitution of crystals, or into the internal structure of plants, etc., we are examining into the latent schematism.' [TF]

[40] Notice that 'form' is here coupled with latent process, and distinguished from latent schematism. It must here, therefore, have the sense of law or cause rather than of essence.

'The distinction between the Latent Process and Latent Schematism in the absolute way in which it is here stated, involves an assumption which the progress of science will probably show to be unfounded; namely, that bodies apparently at rest are so molecularly … The introduction of the idea of unstable equilibrium, in connexion with organic chemistry, was a step in the direction which molecular Physics will probably soon take.'

The view propounded in the above note by Mr. Ellis as to the ultimate constitution of bodies is that which, is now generally adopted. Bacon himself, however, says distinctly (Aphorism, 48, ad fin.): 'In corporibus hic apud nos nulla vera est quies, nec in integris, nec in partibus; sed tantum secundum apparentiam.' [TF]

Atque in anatomia corporum organicorum (qualia sunt hominis et animalium) opera sane recte et utiliter insumitur, et videtur res subtilis et scrutinium naturae bonum. At hoc genus anatomiae spectabile est, et sensui subjectum, et in corporibus tantum organicis locum habet. Verum hoc ipsum obvium quiddam est, et in promptu situm, prae anatomia vera *schematismi latentis* in corporibus quae habentur pro similaribus [41]: praesertim in rebus specificatis [42] et earum partibus, ut ferri, lapidis; et partibus similaribus plantae, animalis, veluti radicis, folii, floris, carnis, sanguinis, ossis, etc. At etiam in hoc genere non prorsus cessavit industria humana; hoc ipsum enim innuit separatio corporum similarium per distillationes et alios solutionum modos, ut dissimilaritas compositi per congregationem partium homogenearum appareat. Quod etiam ex usu est, et facit ad id quod quaerimus; licet saepius res fallax sit; quia complures naturae separationi imputantur et attribuuntur, ac si prius substitissent in composito,

quas revera ignis et calor et alii modi apertionum de novo indunt et superinducunt. Sed et haec quoque parva pars est operis, ad inveniendum *schematismum* verum in composito; qui *schematismus* res est longe subtilior et accuratior, et ab operibus ignis potius confunditur quam eruitur et elucescit.

[41] That is, which are homogeneous. It is comparatively easy to distinguish heterogeneous parts; but the anatomy which attempts to penetrate to the ultimate structure of homogeneous matter proposes to itself a task of incomparably greater difficulty. [TF]

[42] By 'res specificatae' was meant things falling under a definite species, as opposed to mere aggregates or combinations of elementary matter uninformed by the specific quality which constitutes things into a distinct class. The former division of things appears to have been regarded by Bacon as characterised by a more uniform (homogeneous) structure than the latter. The examples also shew that Bacon draws a distinction between *res* specificatae and corpora *organica* (entire plants and animals).

The student may find it worth while to compare Mr. Ellis' note on De Augmentis Scientiarum, Libro II. Cap. 3.

The word 'stone' is, of course, used here in the most unscientific way. The same may be said of 'root,' 'leaf,' etc., below. [TF]

Itaque facienda est corporum separatio et solutio; non per ignem certe, sed per rationem et *inductionem* veram, cum experimentis auxiliaribus; et per comparationem ad alia corpora, et reductionem ad naturas simplices et earum formas [43], quae in composito conveniunt et complicantur; et transeundum plane a *Vulcano ad Minervam*, si in animo sit veras corporum texturas et *schematismos* (unde omnis occulta atque, ut vocant, specifica proprietas et virtus in rebus pendet; unde etiam omnis potentis alterationis et transformationis norma educitur) in lucem protrahere.

[43] Here 'forms' are spoken of in connexion with 'latent schematisms,' though, at the beginning of the Aphorism, form was distinguished from latent schematism and coupled with latent process. This circumstance affords a good illustration of the vagueness and ambiguity of the term, and of the mode in which Bacon seems to oscillate between its two meanings.

The various 'Schematismi Materiae,' are enumerated in the De Augmentis Scientiarum, Libro III. Cap. 4 (Ellis and Spedding, Vol. I. p. 560). In the passage in the text, Bacon seems to think that, in order to determine the latent schematism or ultimate constitution of any body, we must specify its qualities, dense, heavy, hot, etc., and then proceed to ascertain the 'forms' of these qualities. The knowledge of the 'forms' of these 'simple natures' will give all the information which we require. It is needless to point out how vague, undetermined, and purely relative are most of the terms which he employs to designate the simple natures, or how different is the roundabout process which he here

contemplates from that which recent investigators into the ultimate constitution of bodies have, with the help of the microscope, actually pursued. [TF]

Exempli gratia; inquirendum, quid sit in omni corpore spiritus [44], quid essentiae tangibilis; atque ille ipse spiritus, utrum sit copiosus et turgeat, an jejunus et paucus; tenuis, aut crassior; magis aëreus, aut igneus; acris, aut deses; exilis, aut robustus; in progressu, aut in regressu; abscissus, aut continuatus; consentiens cum externis et ambientibus, aut dissentiens; etc. Et similiter, essentia tangibilis (quae non pauciores recipit differentias, quam spiritus) atque ejus villi, et fibrae, et omnimoda textura; rursus autem collocatio spiritus per corpoream molem, ejusque pori, meatus, venae, et cellulae, et rudimenta, sive tentamenta corporis organici, sub eandem inquisitionem cadunt. Sed et in his quoque, atque adeo in omni *latentis schematismi* inventione, lux vera et clara ab axiomatibus primariis [45] immittitur, quae certe caliginem omnem et subtilitatem discutit.

[44] For Bacon's curious speculations on 'Spirit,' see Aphorism 40, with notes, and also i. 50, with note. 82. The ^spiritus' is distinguished from the 'essentia tangibilis' as being intangible and invisible. In Aphorism 40, it is described as being included in all tangible bodies. 'Omne enim tangibile apud nos continet spiritum invisibiiem et intactilem, eique obducitur, atque eum quasi vestit.' [TF]

[45] That is, the axioms which convey a knowledge of the 'forms' of 'simple natures.' Cp. Aphorism 5: 'Primaria ilia et catholica axiomata de naturis simplicibus; 'Sed altiores et radicaies operationes super naturam pendent utique ab axiomatibus primariis.' [TF]

VIII.

Neque propterea res deducetur ad atomum, quae praesupponit vacuum [46] et materiam non fluxam [47] (quorum utrumque falsum est) sed ad particulas veras, quales inveniuntur. Neque rursus est, quod exhorreat quispiam istam subtilitatem, ut inexplicabilem; sed contra, quo magis vergit inquisitio ad naturas simplices, eo magis omnia erunt sita in plano et perspicuo; translato negotio a multiplici in simplex, et ab incommensurabili ad commensurabile, et a surdo ad computabile, et ab infinito et vago ad definitum et certum; ut fit in elementis literarum, et tonis concentuum [48]. Optime autem cedit inquisitio naturalis, quando physicum terminatur in mathematico [49]. At rursus multitudinem aut fractiones nemo reformidet [50]. In rebus enim, quae per numeros transiguntur, tam facile quis posuerit aut cogitaverit millenarium, quam unum; aut millesimam partem unius, quam unum integrum.

[46] In Aphorism 48 (conclusion), he speaks more doubtfully: 'Neque enim pro certo affirmaverimus, utrum detur vacuum, sive coacervatum, sive permistum.'

The Atomic theory of Democritus postulated a vacuum between the various atoms of which matter was regarded as composed. λεύκιππος δὲ καὶ ὁ ἑταῖρος αὐτοῦ Δημόκριτος στοιχεῖα μὲν τὸ πλῆρες καὶ τὸ κενὸν εἶναί φασι. Aristotle, Metaphysics I. 4 (985 b).

Bacon, at least in this passage, while adopting the opinion that matter, in its ultimate analysis, is an aggregate of minute particles, repudiates the assumption that these particles are separated by a vacuum. His own view appears to have been that, if we could discover the inmost constitution of things, we should find the ultimate particles, not separated by a vacuum, but so nicely adjusted, or rather so nicely adjusting themselves, as to leave no breach of continuity in passing from one to another.

M. Bouillet gives an appropriate reference to the beginning of the treatise 'Cogitationes de Natura Rerum' (Ellis and Spedding, Vol. III. pp. 15, etc.). CP. also Novum Organum I. 66, ad fin.

On the question whether Bacon did or did not reject the doctrine of a vacuum, see my notes on II. 48 (2) and on the conclusion of the same Aphorism.

On the conception of ultimate particles of matter, CP. a very interesting passage in Newton's Optics, Book III.qu.31 (Horsley's Ed., Vol. IV. pp. 260-1). [TF]

[47] That is, matter consisting of rigid, unchangeable, and eternal atoms, as they were conceived of by Democritus. See note 59 on Book I. Aphorism 66. Bacon, on the other hand, maintained the theory of a 'plica materiae,' or a power in the atoms themselves of expanding or contracting themselves within certain limits. See conclusion of II. 48. This theory enabled him to dispense with the assumption of a vacuum. [TF]

[48] 'Tones' are, as it were, the alphabet of Music. The above passage is important as throwing light on Bacon's doctrine of forms and simple natures. It shews, as I have pointed out elsewhere, that he regarded the 'simple natures' as constituting a sort of alphabet, and that he supposed that, if we only possessed a complete knowledge of this alphabet, we should be able to explain and reproduce nature in all her complexity. [TF]

[49] CP. I. 96 and note 75 on that Aphorism. The meaning of the passage in the text, when taken in connexion with the context, is somewhat doubtful. It may refer generally to the deductive branches of natural philosophy, stated and worked out mathematically (as I believe is the case with the passage in I. 96), or (as the context would rather lead us to suppose) it may have a more special reference. In the latter case, it probably contemplates the application of mathematics to the enumeration, mensuration, and determination of the form of the ultimate particles of matter; or possibly it may have reference to the combination of 'simple natures' in concrete substances, mathematics being applied to determine the number of such 'simple natures' which are to be found in any given substance, or are requisite to its production, and, perhaps, also the several proportions in which they are combined. [TF]

[50] This sentence does not appear to mean more than that in Mathematics we may have to deal with very large or very small quantities. There may possibly be an allusion to a curious passage in the Republic of Plato (Book VII. p. 525 E), where Socrates says

that the arithmetician will not tolerate fractions, but insists on multiplying them back again into integers. [TF]

IX.

Ex duobus generibus axiomatum, quae superius posita sunt [51], oritur vera divisio philosophiae et scientiarum; translatis vocabulis receptis (quae ad indicationem rei proxime accedunt) ad sensum nostrum. Videlicet, ut inquisitio *formarum*, quae sunt (ratione certe, et sua lege [52]) aeternae et immobiles, constituat *metaphysicam* [53]; inquisitio vero *efficientis*, et *materiae*, et *latentis processus*, et *latentis schematismi* (quae omnia cursum naturae communem et ordinarium, non leges fundamentales et aeternas respiciunt [54]) constituat physicam: atque his subordinentur similiter practicae duae; *physicae mechanica*, *metaphysicae* (perpurgato nomine) *magia* [55], propter latas ejus vias et majus imperium in naturam.

[51] See Aphorism 5. [TF]

[52] 'Meaning,' says Mr. Ellis, 'that God could change them, but that this change would be above reason and a change of the law of the form, otherwise unchangeable.' [TF]

[53] Cp. De Augmentis Scientiarum III. 4. There he includes the investigation of Final Causes under Metaphysic. Here, as they stand in no relation to the present discussion, he omits all mention of them.

It is, perhaps, needless to observe that this is a special and arbitrary use of the word 'Metaphysic.' The word, as I have already pointed out (Book I. Aphorism 63. n. 31), originated as a designation of a certain collection of Aristotelian treatises (τὰ μετὰ τὰ φυσικά), which was regarded by those who arranged Aristotle's works as a sort of appendix to the Physics. On the various and often contradictory meanings which it has subsequently borne, it would be beside my purpose to speak. In the ordinary sense of the term, Bacon did not recognise Metaphysics as a science distinct from Physics, on the one side, and Natural Theology, on the other. See Introduction, p. 67, and CP. pp. 15, 16. [TF]

[54] In this Aphorism, it would be difficult to say whether 'forms' are used in the sense of 'laws' or 'essences.' Bacon probably had no clear perception of the distinction between the two ideas. [TF]

[55] CP. De Augmentis Scientiarum III. 5, which will furnish a full explanation of this passage. [TF]

X.

Posito itaque doctrinae scopo, pergendum ad praecepta; idque ordine minime perverso aut perturbato. Atque indicia de *interpretatione naturae* complectuntur partes in genere duas [56]; primam, de educendis aut excitandis axiomatibus ab experientia; secundam, de deducendis aut derivandis experimentis novis ab axiomatibus. Prior autem trifariam dividitur: in tres nempe ministrationes; ministrationem ad sensum, ministrationem ad memoriam, et ministrationem ad mentem sive rationem [57].

[56] Namely, Induction and Deduction. On the latter method, the Novum Organum, in its fragmentary state, contains nothing (unless we except the Instances mentioned in II. 52, as conducing 'ad operativam'), though the seventh, ninth, and possibly fourth parts (see Aphorism 21) were to deal with this subject.

M. Bouillet remarks that, in the Partis Secundae Delineatio, the Pars Activa is distinguished from the Deductive branch of the Pars Contemplativa, whereas here the two are spoken of as one. See Ellis and Spedding, Vol. III. pp. 556-7. M. Bouillet also remarks that it is doubtful whether Bacon would have found in the practical or operative part sufficient matter for a special treatise, bearing in mind what he himself says: 'inter contemplativam partem activam perpetuo intercurrere' (Partis Secundae Delineatio, Ellis and Spedding, Vol. III. p. 556). [TF]

[57] This division, as given in the present passage, is easily explicable. The 'ministratio ad sensum', supplies a collection of observations and experiments, 'Historia Naturalis et Experimentalis.' The 'ministratio ad memoriam' arranges these in Tables, in a form adapted for use. The 'ministratio ad mentem sive rationem' is the process of Induction itself, drawing from the tables the inferences to which they legitimately lead. M. Bouillet has a long note on the mode in which the two first 'ministrationes' may be supplied from different parts of Bacon's works.

On the discrepancy between the account of these 'ministrationes,' as given here and in the Partis Secundae Delineatio, the student, who is curious to trace the growth of Bacon's doctrine, may refer to Mr. Spedding's note on the present passage and to the General Preface, prefixed to the 1st Vol. of Ellis and Spedding's Edition, § 10. [TF]

Primo enim paranda est *historia naturalis* et *experimentalis*, sufficiens et bona; quod fundamentum rei est: neque enim fingendum, aut excogitandum, sed inveniendum, quid natura faciat aut ferat.

Historia vero *naturalis* et *experimentalis* tam varia est et sparsa, ut intellectum confundat et disgreget, nisi sistatur et compareat ordine idoneo. Itaque formandae sunt *tabulae* et *coordinationes instantiarum*, tali modo et instructione ut in eas agere possit intellectus.

Id quoque licet fiat, tamen intellectus sibi permissus, et sponte movens, incompetens est et inhabilis ad opificium axiomatum, nisi regatur et muniatur. Itaque tertio, adhibenda est *inductio* legitima et vera, quae ipsa *clavis* est *interpretationis*. Incipiendum autem est a fine, et retro pergendum ad reliqua [58].

[58] It must be recollected that the ‘Tables’ which occur in the Novum Organum are only specimens of what Bacon designed. From the ‘Distributio Operis,’ we learn that the first ‘ministratio’ was to be treated in the third part of the Instauratio Magna, and the second ‘ministratio’ in the fourth part. [TF]

XI.

Inquisitio formarum sic procedit; super naturam datam primo facienda est *comparentia* [59] ad *intellectum* omnium instantiarum notarum, quae in eadem natura conveniunt, per materias licet dissimillimas. Atque hujusmodi collectio facienda est historice [60], absque contemplatione praefestina, aut subtilitate aliqua majore. Exempli gratia; in inquisitione de forma calidi [61].

[59] An ‘appearance,' a word borrowed from legal phraseology. We have the phrase ‘to enter’ or ‘to put in’ an appearance.

This investigation into the nature of Heat (Aphorisms 11-20) was included in a small volume, published at Leyden, in 1638, entitled Francisci de Verulamio Historia Naturalis et Experimentalis De Ventis.’ Etc. See Introduction, § 17. [TF]

[60] That is, according to the actual order in which they present themselves to the investigator in the course of his observations; not according to any predetermined order, The order of arrangement must be determined after collection, when all the instances are before us; otherwise, we are in danger of overlooking altogether instances which may be material to our enquiry. [TF]

[61] De Rémusat (Bacon, etc., p, 246) translates ‘forma calidi' by nature of heat. And this, perhaps, is the nearest equivalent (cp. the fourth paragraph of Aphorism 20, beginning ‘Intelligatur hoc,’ etc.). But, as a knowledge of the *nature* of heat implies a knowledge of its cause and of the law of its production, we may, in this instance, employ all three words alike in illustration of Bacon's use of the word ‘Form.’ [TF]

Instantiae [62] *convenientes in natura calidi.*

[62] The significance of these Instances, as well as of the Tables which occur in the following Aphorisms, may, perhaps, best be understood by comparing them with the far more natural and scientific form which they assume in Mr. Mill’s ‘Experimental Methods.’ To assist the student in this task, I extract the following passages from one of the notes in my Inductive Logic (Chapter 3, Appended Note 2, 4th ed., pp. 207-10):

‘If the “Instantiae convenientes in natura calidi” were so related to one another that, besides the given phenomenon (heat), only one other circumstance were common to them all, that other circumstance might be regarded, with more or less probability, as

the cause (or effect) of heat, or, at least, as connected with it through some fact of causation. Such instances would then come under the Method of Agreement.

'If one instance in the Table of Agreement ("Instantiae convenientes in natura calidi" were so related, to one of the instances in the Table of Privation ("Instantiae in proximo, quae privantur natura calidi") as to have every circumstance in common with it, except that the former, besides presenting the phenomenon of heat which is supposed to be absent in the latter, also presented some other circumstance which was absent from the latter, this other circumstance would be the cause (or effect), or a necessary part of the cause, of heat. We should here have the Method of Difference.

'If, in the "Tabula graduum, sive comparativae in calido," we could discover some one phenomenon which increased and diminished proportionately with the increase and diminution of heat, that phenomenon would be the cause or the effect of heat, or, at least, connected with it through some fact of causation, and the conditions would thus conform to the requirements of the Method of Concomitant Variations. If it could be shewn that this phenomenon and heat were the *only* circumstances which varied concurrently, then the phenomenon would be proved to be either the cause or the effect of heat, and would conform to the requirements of the rider to this last Method' (given in Inductive Logic, p. 183).

'The "Exemplum exclusivae, sive rejcctlonis naturarum a forma calidi," (which is based on the three foregoing Tables) bears some, though, it must be acknowledged, a very slight, resemblance to the Method of Residues. These "rejections" consist in excluding some possible explanation of the phenomenon, either because an instance, which does not present the phenomenon, does present the assigned cause, or because an instance, which does present the phenomenon, does not present the assigned cause (and similarly with regard to increase and decrease). As an instance of the former, we may take the following "rejectio": ''Per radios lunae (which were then supposed to be cold) et aliarum stellarum rejice lucem et lumen." As instances of the latter, we may take the two following; "Per radios solis, rejice naturam elementarem ithat is, "terrestrial nature, which is composed of "the four elements: Per ignem communem, et maxime per ignes subterraneos (qui remotissimi sunt, et plurimum intercluduntur a radiis coelestibus) rejice naturam coelestem." By a succession of these "rejectiones," we limit the number of possible explanations, amongst which we are to look for the true one. Bacon's "rejections," however, not being, as a matter of fact, exhaustive, lead to a purely negative result; they may save us from unnecessary trouble in seeking for a cause where it cannot be found, but they do not, like the Method of Residues, leave a definite number of antecedents which either constitute the cause, or amongst which we know that the cause is to be sought.'

It is plain that if there were a certain number only of possible causes of the given phenomenon, and by the Method of Rejections we could exclude all but one, this one remaining cause would be the undoubted cause of the given phenomenon. This case Bacon appears to have regarded as the perfect type of Induction, and as alone capable

of affording certainty. For a criticism of Bacon's Method of Rejections or Exclusions, see Introduction, § 9.

In comparing the logical procedure of Bacon and Mill, it should be carefully borne in mind that, whereas each of Mr. Mill's Methods may be worked independently, and lead to a final conclusion, Bacon contemplated the concurrent use of ail the Tables as preparatory to his Method of Rejections, and regarded the construction of the Tables and the subsequent application to them of the Method of Rejections as constituting only one process. [TF]

1. Radii solis, praesertim aestate et meridie.
2. Radii solis, reflexi et constipati, ut inter montes, aut per parietes, et maxime omnium in speculis comburentibus.
3. Meteora ignita.
4. Fulmina comburentia.
5. Eructationes flammarum ex cavis montium, etc.
6. Flamma omnis.
7. Ignita solida.
8. Balnea calida naturalia.
9. Liquida ferventia, aut calefacta.
10. Vapores et fumi ferventes, atque aër ipse, qui fortissimum et furentem suscipit calorem, si concludatur; ut in reverberatoriis [63].

    [63] Reverberatories are furnaces constructed with two chambers; an outer one, which has no chimney, but has a passage connecting it with an inner one which has a chimney. The substance to be exposed to the heat is placed on the floor of the inner chamber, and lire is lighted in the other: so that the flame, having no outlet in the outer chamber, passes into the inner, over the substance, and is so concentrated with vast power upon it,' Dr. Kitchin's note. [TF]

11. Tempestates aliquae sudae [64] per ipsam constitutionem aëris, non habita ratione temporis anni.

    [64] Sudae. Cloudless, clear. [TF]

12. Aer conclusus et subterraneus in cavernis nonnullis, praesertim hyeme.
13. Omnia villosa, ut lana, pelles animalium, et plumagines, habent nonnihil teporis.
14. Corpora omnia, tam solida, quam liquida, et tam densa, quam tenuia (qualis est ipse aër), igni ad tempus approximata.
15. Scintillae ex silice et chalybe per fortem percussionem.
16. Omne corpus fortiter attritum, ut lapis, lignum, pannus, etc.; adeo ut temones et axes rotarum aliquando flammam concipiant: et mos excitandi ignis apud Indos occidentales fuerit per attritionem.
17. Herbae virides et humidae simul conclusae et contrusae, ut rosae, pisae [65] in corbibus; adeo ut foenum, si repositum fuerit madidum, saepe concipiat flammam.

[65] Mr. Ellis reads *pinsae*, but the two words have the same meaning, namely, 'crushed' or 'pounded.' [TF]

18. Calx viva, aqua aspersa.
19. Ferrum, cum primo dissolvitur per aquas fortes in vitro, idque absque ulla admotione ad ignem: et stannum similiter, etc. sed non adeo intense.
20. Animalia, praesertim et perpetuo per interiora; licet in insectis calor ob parvitatem corporis non deprehendatur ad tactum.
21. Fimus equinus, et hujusmodi excrementa animalium recentia.
22. Oleum forte sulphuris et vitrioli [66] exequitur opera caloris, in linteo adurendo.

[66] This is probably an instance of the grammatical figure, ἕν διὰ δυοῖν, meaning, as Dr. Kitchin suggests, Sulphuric Acid.

Of the substances alluded to in this and some of the following examples, Sir John Herschel (Discourse on the Study of Natural Philosophy, § 345) remarks that they 'excite in our organs, and especially in that of taste, a sensation of heat which they owe to their being chemical stimulants, and not at all to their being actually hot.' [TF]

23. Oleum origani, et hujusmodi, exequitur opera caloris in adurendis ossibus dentium.
24. Spiritus vini fortis et bene rectificatus exequitur opera caloris; adeo ut si albumen ovi in eum injiciatur, concrescat et albescat, fere in modum albuminis cocti; panis injectus torrefiat et incrustetur, ad modum panis tosti [67].

[67] The latter phenomenon, Mr. Ellis remarks, 'arises probably from the desiccative power due to the strong affinity of alcohol for water.' [TF]

25. Aromata, et herbae calidae, ut dracunculus [68], nasturtium vetus, etc. licet ad manum non sint calida (nec integra, nec pulveres eorum), tamen ad linguam et palatum parum masticata percipiuntur calida, et quasi adurentia.

[68] 'Dragon-wort.' It was so called, because it was supposed to be obnoxious to serpents, and also to be efficacious against their bites. See Pliny, Naturalis Historia XXIV. sects. 142-150, Chapters 91-93. In quoting or referring to Pliny's Naturalis Historia, I shall employ the Teubner edition of 1857, and refer both to the sections and to the chapters as numbered within brackets. [TF]

26. Acetum forte, et omnia acida, in membro ubi non sit epidermis, ut in oculo, lingua, aut aliqua alia parte vulnerata, et cute detecta, dolorem cient, non multum discrepantem ab eo, qui inducitur a calido.

27. Etiam frigora acria et intensa inducunt sensum quendam ustionis;

Nam Boreae penetrabile frigus adurit [69].

[69] Virgil, Georg, I. 93. [TF]

28. Alia.

Hanc *tabulam essentiae et praesentiae* appellare consuevimus.

XII.

Secundo, facienda est comparentia ad intellectum *instantiarum*, quae natura data privantur: quia forma (ut dictum est) non minus abesse debet, ubi natura data abest, quam adesse, ubi adest [70]. Hoc vero infinitum esset in omnibus.

[70] So far as Form = Cause, it must, as already remarked, be absent where the given nature is absent (unless counteracting causes have destroyed its effects), but (owing to the circumstance of Plurality of Causes) it need not necessarily be present, where the given nature is present; for the given nature may also be due to some other cause. [TF]

Itaque subjungenda sunt *negativa affirmativis*, et privationes inspiciendae tantum in illis subjectis quae sunt maxime cognata illis alteris, in quibus natura data inest et comparet. Hanc *tabulam declinationis*, sive *absentiae in proximo* [71], appellare consuevimus.

[71] The value of these instances depends, of course, on the extent of their approximation to the Instantiae Convenientes, or, in other words, on the extent to which the two instances, when taken together, fulfil the conditions of the Method of Difference. The more closely they approach in other respects, the more likely are we to detect the cause of their variation. [TF]

Instantiae in proximo, quae privantur natura Calidi.

Ad Instantiam primam affirmativam, Instantia prima negativa vel subjunctiva.
1. Lunae et stellarum et cometarum radii non inveniuntur calidi ad tactum [72]: quinetiam observari solent acerrima frigora in pleniluniis [73]. At stellae fixae majores, quando sol eas subit aut iis approximatur, existimantur fervores solis augere et intendere; ut fit cum sol sistitur in Leone, et diebus canicularibus [74].

[72] On the very interesting experiment by which Melloni, in spite of great difficulties, detected heat in the lunar rays, see Tyndall's Heat considered as a Mode of Motion, 3rd ed., § 661. [TF]

[73] On the night of full-moon, though not before or after, a series of observations shews that the sky is, on an average, clearer than at other times. (See Herschel's Familiar

Lectures on Scientific Subjects, pp. 146-7.) As a consequence of the diminution of the cloudy envelope, the night will also be colder. [TF]

[74] This influence of the fixed stars is, of course, purely imaginary and the remark, moreover, shews that Bacon entertained the crudest views of astronomical distances.

I may here state that I shall not, as a rule, attempt, in the notes on the remainder of this Book, to comment on Bacon's scientific examples, or to note his scientific errors, unless they present some feature of special interest The object of this edition is to illustrate the logical and philosophical, rather than the scientific position of the author, and hence the latter, though I shall by no means ignore it, will usually be regarded as subordinate to the former. [TF]

Ad 2^{am} 2^{a}.
2. Radii solis in media (quam vocant) regione aëris non calefaciunt; cujus ratio vulgo non male redditur; quia regio illa nec satis appropinquat ad corpus solis, unde radii emanant, nec etiam ad terram, unde reflectuntur [75]. Atque hoc liquet ex fastigiis montium (nisi sint praealti), ubi nives perpetuo durant. Sed contra notatum est a nonnullis, quod in cacumine Picus de Tenariph, atque etiam in Andis Peruviae, ipsa fastigia montium nive destituta sint; nivibus jacentibus tantum inferius in ascensu [76]. Atque insuper aër illis ipsis verticibus montium deprehenditur minime frigidus, sed tenuis tantum et acer; adeo ut in Andis pungat et vulneret oculos per nimiam acrimoniam, atque etiam pungat os ventriculi, et inducat vomitum. Atque ab antiquis notatum est, in vertice Olympi tantam fuisse aëris tenuitatem, ut necesse fuerit illis qui eo ascenderant secum deferre spongias aceto et aqua madefactas, easque ad os et nares subinde apponere, quia aër ob tenuitatem non sufficiebat respirationi [77]: in quo vertice etiam relatum est, tantam fuisse serenitatem et tranquillitatem a pluviis et nivibus et ventis [78], ut sacrificantibus literae descriptae digito in cineribus sacrificiorum super aram Jovis, manerent in annum proximum absque ulla perturbatione [79]. Atque etiam hodie ascendentes ad verticem Picus de Tenariph eo vadunt noctu et non interdiu; et paulo post ortum solis monentur et excitantur a ducibus suis ut festinent descendere, propter periculum (ut videtur) a tenuitate aëris, ne solvat spiritus et suffocet.

[75] The true reason is the increasing rarefaction of the atmosphere, as we ascend from the sea-level. [TF]

[76] Simply because the peaks are so steep that the snow will not rest on them. [TF]

[77] I have not been able to trace this allusion to any classical writer. The story, however, occurs in Augustine, De Genesi contra Manichaeos, Libro i, Cap. 15, Bacon notes it also in the Fragment entitled ‘Calor et Frigus' (Ellis and Spedding, Vol. III. p.645). [TF]

[78]

Ἦ μὲν ἄρ᾽ ὡς εἰποῦσ᾽ ἀνέβη γλαυκῶπις Ἀθήνη
γὔλυμπόνδ᾽, ὅθι φασὶ θεῶν ἕδος ἀσφαλὲς αἰεὶ

ἔμμεναι" οὔτ᾽ ἀνέμοισι τινάσσεται οὔτε ποτ᾽ ὄμβρῳ
δεύεται οὔτε χιὼν ἐπιπίλναται, ἀλλὰ μάλ᾽ αἴθρη
πέπταται ἀνέφελος, λευκὴ δ᾽ ἐπιδέδρομεν αἴγλη"
τῷ ἔνι τέρπονται μάκαρες θεοὶ ἤματα πάντα.

Homer, Od. vi. 41-6.

The student will do well to read Dr. Merry's instructive note on these lines. He quotes several parallel passages. [TF]

[79] See the Aristotelian or pseudo-Aristotelian Problemata, xxvi, 36 (p. 944 b. 12-16), where, however, the author specifies Athos and 'other such mountains.' Pomponius Mela (Libro II. Cap. 2) refers also to Athos. Solinus describes the phenomenon as taking place both on Olympus (Polyhistor, Cap. ix) and on Athos (Cap. xi). Mr. Ellis cites Geminus and Philoponus, the former of whom speaks of Mount Cyllene in Arcadia, and the latter of Olympus. Augustine tells the story, at least twice, of Olympus.

All these stories are told of both Olympus and Athos in Maundeville's Travels (Ed. Halliwell, p. 17), quoted by Mr. Tozer in his Highlands of Turkey, Vol. I. p. 102. [TF]

Ad 2^{am} 3^{a}.

3. [79.5] Reflexio radiorum solis, in regionibus prope circulos polares, admodum debilis et inefficax invenitur in calore: adeo ut Belgae, qui hybernarunt in Nova Zembla [80], cum expectarent navis suae liberationem et deobstructionem a glaciali mole (quae eam obsederat) per initia mensis Julii spe sua frustrati sint, et coacti scaphae se committere. Itaque radii solis directi videntur parum posse, etiam super terram planam; nec reflexi etiam, nisi multiplicentur et uniantur, quod fit cum sol magis vergit ad perpendiculum, quia tum incidentia radiorum facit angulos acutiores, ut lineae radiorum sint magis in propinquo: ubi contra in magnis obliquitatibus solis anguli sint valde obtusi, et proinde lineae radiorum magis distantes. Sed interim notandum est, multas esse posse operationes radiorum solis, atque etiam ex natura calidi, quae non sunt proportionatae ad tactum nostrum: adeo ut respectu nostri non operentur usque ad calefactionem, sed respectu aliorum nonnullorum corporum exequantur opera calidi.

[79.5] It seems that Fowler has forgotten to add an Arabic number to the beginning of each numbered paragraph from here and up to Ad 27^{am} 32^{a}. [HJ]

[80] Referring to Barentz's Expedition in search of a North-East Passage. The event alluded to took place in June, 1597. Mr. Spedding refers to 'Three Voyages by the North-East,' etc., Hackluyt Society, 1853, p. 191. [TF]

Ad 2^{am} 4^{a}.

4. Fiat hujusmodi experimentum. Accipiatur speculum [81] fabricatum contra ac fit in speculis comburentibus, et interponatur inter manum et radios solis; et fiat observatio, utrum minuat calorem solis, quemadmodum speculum comburens eundem auget et intendit. Manifestum est enim, quoad radios opticos, prout fabricatur speculum in

densitate inaequali respectu medii et laterum, ita apparere simulachra magis diffusa aut magis contracta. Itaque idem videndum in calore.

[81] Used here for a lens. [TF]

Ad 2^{am} 5^{a}.
5. Fiat experimentum diligenter, utrum per specula comburentia fortissima et optime fabricata radii lunae possint excipi et colligi in aliquem vel minimum gradum teporis [82]. Is vero gradus teporis si fortasse nimis subtilis et debilis fuerit, ut ad tactum percipi et deprehendi non possit, confugiendum erit ad vitra illa [83] quae indicant constitutionem aëris calidam aut frigidam; ita ut radii lunae per speculum comburens incidant et jaciantur in summitatem vitri hujusmodi; atque tum notetur, si fiat depressio aquae per teporem.

[82] For a long time, the experiments which were applied to detect heat in the lunar rays were unsuccessful. For the successful experiment of Melloni, see Tyndall, as referred to above, note 72. [TF]

[83] The invention of the Thermometer, which was originally an Air Thermometer, is, according to different accounts, ascribed to Galileo in 1597, Drebbel of Alkmaer in 1609, Paolo Sarpi in 1609, and Sanctorio in 1610. M. Bouillet (note on Novum Organum II. 13 (38)) and M. de Vauzelles (Histoire, etc., de Bacon, Vol. I. pp. 30-31) ascribe it, though on insufficient grounds, to Bacon himself. The merit of the invention probably belongs, in the first instance, to Galileo. See the authorities referred to in Mr. Ellis' note on II. 13 (38), and especially the arguments employed by Libri, Histoire des Sciences Mathématiques en Italie, tome IV. pp. 187-197.

In Aphorisms 13 and 24, Bacon calls this instrument Vitrum Calendare. [TF]

Ad 2^{am} 6^{a}.
6. Practicetur etiam vitrum comburens super calidum, quod non sit radiosum aut luminosum; ut ferri et lapidis calefacti sed non igniti, aut aquae ferventis, aut similium; et notetur utrum fiat augmentum et intentio calidi, ut in radiis solis [84].

[84] Dr. Kitchin has the following interesting note on this passage: 'The questions started here and in the next paragraph have been settled; and the result is such as proves the similarity in kind of Solar and other Heat; so that in these places no Negative can be adduced. Large lenses brought before lighted candles or the fire produce sensible Heat; and by collecting the rays of Heat in the atmosphere, even when the Sun is quite hidden behind clouds, concave Mirrors produce a definite increase of Heat at their focus. Farther than this, MM. Saussure and Pictet of Geneva have established the truth as to "ferrum, vel lapis calefactus, sed non ignitus," etc. by heating an iron ball so as not to be luminous, and by experimenting on boiling water. From the results they have shewn that Heat emanates in invisible rays, and is subject to the same laws of reflexion, etc. as if it were accompanied by rays of light as well. Melloni has also established the fact that Heat is

refrangible; and (like Light of different colours) Heat from different sources has different degrees of refrangibility. Forbes has established the polarisation of Heat from both luminous and non-luminous sources: he also depolarised Heat; and as this is a consequence solely of double refraction, he thereby has proved that Heat is subject also to the Laws of double refraction. See Turner's Chemistry, Heat, pp. 14-20.'

'Mersenne says the greater number of the experiments mentioned in the second book of the Novum Organum had already been made, and mentions particularly, as if he had himself tried it, the reflexion of all kinds of heat by a burning mirror. He also asserts that light is always accompanied by heat. De la Vérité des Sciences (1625), p. 210.' Mr. Ellis' note. In the great majority of cases, I think, there is nothing in Bacon's language to imply that the experiments suggested are original. See Aphorism 14. [TF]

Ad 2^{am} 7^{a}.
7. Practicetur etiam speculum comburens in flamma communi.

Ad 3^{am} 8^{a}.
8. Cometarum (si et illos numerare inter meteora [85] libuerit) non deprehenditur constans aut manifestus effectus in augendis ardoribus anni, licet siccitates saepius inde sequi notatae sint [86]. Quinetiam trabes et columnae lucidae et chasmata [87] et similia apparent saepius temporibus hybernis quam aestivis [88]; et maxime per intensissima frigora, sed conjuncta cum siccitatibus. Fulmina tamen et coruscationes et tonitrua raro eveniunt hyeme, sed sub tempus magnorum fervorum [89]. At stellae (quas vocant) cadentes existimantur vulgo magis constare ex viscosa aliqua materia splendida et accensa [90], quam esse naturae igneae fortioris. Sed de hoc inquiratur ulterius.

[85] It was a common subject of debate amongst the ancient astronomers whether Comets were to be regarded as Meteors (which were supposed to be engendered in the atmosphere), or whether they were more analogous to the Planets. The point is discussed in a most interesting manner in the Seventh Book of Seneca's Natural Questions. 'Placet ergo nostris cometas sicut faces, sicut tubas trabesque et alia ostenta coeli denso acre creari.' He then argues with great ability against this view, referring to the comets which appeared in the time of Claudius and Nero, and sums up his own opinion as follows: 'Ego nostris non adsentior: non enim existimo cometeii subitaneom ignem, sed inter aetema opera naturae.' (Chaps. 21, 22.) A view somewhat similar to the former was regarded as possible even by, Galileo, See Il Saggiatore, 20°, etc., where he defends, as a possible explanation of comets, the theory that they are formed by exhalations from the earth, rising to a great height and reflecting the light of the Sun. The return of Hailey's Comet, nearly at the time predicted by him, in 1759, conclusively proved that these bodies belong to the solar, and not to the terrestrial system, and that, in the words of Seneca, they are 'aetema opera naturae.' [TF]

[86] Neither the one effect nor the other, so far as I am aware, has ever been established by meteorological observation. At the same time, it would be rash to deny that comets might have either or both of these effects, especially if it be true, as the most recent

spectrum analysis seems to shew, that 'the nucleus is self-luminous, and that it is very possibly composed of glowing gas containing carbon.' See a most interesting section on Comets and their Spectra in Dr. Schellen's Spectrum Analysis, translated by J. and C. Lassell, and edited by Dr. Huggins (Longmans, 1872). [TF]

[87] For 'trabes,' see Seneca's Natural Questions, I. i, VII. 4, 5; for 'columnae flagrantes,' VII. 20; and for 'chasmata,' I. 14. As Dr. Kitchin observes, they are all of them clearly names for different appearances of the Aurora Borealis, unless we suppose that 'columnae clipeique flagrantes' may stand for the Zodiacal Light. [TF]

[88] This statement is not quite accurate. The annual maxima of these appearances are, taking an average, in March and October, the latter being the greater; and the annual minima in June and January. Whether the Aurora be an electrical phenomenon (as most meteorologists suppose), or whether (as some suppose) it be a cloud of meteoric dust ignited by friction with the atmosphere, there is nothing to connect it with the rate of temperature.

It is, of course, only on clear nights that the phenomenon can be seen, and such nights are generally cold. [TF]

[89] This statement is generally, though not universally, true. As aerial electricity is, in all probability, mainly due to evaporation, and this process occurs to a much greater extent in hot weather than in cold, there is a good reason why thunder-storms should be more frequent in summer than in winter. [TF]

[90] This opinion probably arose from their pear-like shape as they dart across the heavens, and from the manner in which they appear to be suddenly kindled and then again suddenly extinguished, in reality, these aerolites usually consist mainly of metallic iron, the rest of their substance being made up of a variety of other metals. [TF]

Ad 4^{am} 9^{a}.

9. Sunt quaedam coruscationes [91] quae praebent lumen sed non urunt; eae vero semper fiunt sine tonitru.

[91] Sheet-lightning. This phenomenon occurs when the discharge of electricity takes place below the horizon, or behind a dense cloud, or at great elevations above the earth's surface. On these occasions, the distance is too great or the intervening obstacle too dense for the thunder to be heard. [TF]

Ad 5^{am} 10^{a}.

10. Eructationes et eruptiones flammarum inveniuntur non minus in regionibus frigidis quam calidis; ut in Islandia et Groenlandia: quemadmodum et arbores per regiones frigidas magis sunt quandoque inflammabiles et magis piceae ac resinosae quam per regiones calidas; ut fit in abiete, pinu, et reliquis: verum in quali situ et natura soli

hujusmodi eruptiones fieri soleant, ut possimus affirmativae subjungere negativam, non satis quaesitum est [92].

[92] We must recollect that, at this time, not even the conception of a science of geology had been formed. It is needless to say that volcanoes, hot springs (see below), and similar phenomena have no connexion whatever with the temperature of the surface of the soil. [TF]

Ad 6^{am} 11^{a}.

11. Omnis flamma perpetuo est calida magis aut minus [93], neque omnino subjungitur negativa: et tamen referunt ignem fatuum [94] (quem vocant), qui etiam aliquando impingitur in parietem, non multum habere caloris; fortasse instar flammae spiritus vini, quae clemens et lenis est [95]. Sed adhuc lenior videtur ea flamma quae in nonnullis historiis fidis et gravibus invenitur apparuisse circa capita et comas puerorum et virginum [96]; quae nullo modo comas adurebat, sed molliter circum eas trepidabat. Atque certissimum est, circa equum [97] in itinere sudantem noctu et suda tempestate apparuisse quandoque coruscationem quandam absque manifesto calore. Atque paucis abhinc annis, notissimum est et pro miraculo quasi habitum gremiale cujusdam puellae paulo motum aut fricatum coruscasse; quod fortasse factum est ob alumen aut sales quibus gremiale tinctum erat paulo crassius haerentia et incrustata, et ex fricatione fracta [98]. Atque certissimum est saccharum omne, sive conditum (ut vocant) sive simplex, modo sit durius, in tenebris fractum aut cultello scalptum coruscare [99]. Similiter aqua marina et salsa noctu interdum invenitur, remis fortiter percussa, coruscare [101]. Atque etiam in tempestatibus spuma maris fortiter agitata noctu coruscat; quam coruscationem Hispani pulmonem marinum vocant [102]. De illa flamma autem quam antiqui nautae vocabant Castorem et Pollucem, et moderni Focum Sancti Ermi [103], qualem calorem habeat non satis quaesitum est.

[93] The temperature of a flame depends on the nature of the substance burnt and on the nature of the medium in which the combustion takes place. For the relation between the heat and luminosity of different kinds of flame, see the article on Combustion in Watts' Dictionary of Chemistry. [TF]

[94] 'Will o' the Wisp.' This phenomenon probably arises from the escape of marsh gas (light carburetted hydrogen) from the earth at nighttime, when a faint light is easily visible. How the gas becomes ignited, it is sometimes difficult to say. A frequent cause of its ignition, probably, is contact with phosphoretted hydrogen. [TF]

[95] As Dr. Kitchin says, 'the flame of spirits of wine, instead of being "clemens et lenis," is one of the most intensely hot kinds of flame.' Bacon was probably deceived by the appearance. [TF]

[96] See the story about Servius Tullius in Livy, I. 59, and about Ascanius in Virgil Aen. II. 679-86;

‘Talia vociferans gemitu tectum omne replebat,
Cum subitum dictuque oritur mirabile monstrum.
Namque manus inter maestorumque ora parentum
Ecce ievis summo de vertice visus luii
Fundere lumen apex, tactuque innoxia mollis
Lambere flamma comas et circum tempora pasci.
Kos pavidi trepidare metu, crinemque tlagrantem
Excutere et sanctos restinguere fontibus ignis.'

Similar stories are told of some of the Saints, as, for instance, St. Catherine of Alexandria and St. Bridget. [TF]

[97] CP. note on St. Elmo's fire, below. [TF]

[98] ‘The girl's apron was probably made of silk, and the “coruscatio” electric.' Dr. Kitchin's note. [TF]

[99] The crystals of sugar exhibit phosphorescence, when cut or rubbed. [TF]

[101] This beautiful phenomenon must be familiar to almost every one. The following extracts (I must apologise for their length) are taken from Mr. Darwin’s Naturalist’s Voyage Round the World, Chapter 8:

‘While sailing a little south of the Plata on one very dark night, the sea presented a wonderful and most beautiful spectacle. There was a fresh breeze, and every part of the surface, which during the day is seen as foam, now glowed with a pale light. The vessel drove before her bows two billows of liquid phosphorus, and in her wake she was followed by a milky train. As far as the eye reached, the crest of every wave was bright, and the sky above the horizon, from the reflected glare of these livid flames, was not so utterly obscure as over the vault of the heavens.

‘As we proceed further southward the sea is seldom phosphorescent; and off Cape Horn I do not recollect more than once having' seen it so, and then it was far from being brilliant. This circumstance probably has a close connexion with the scarcity of organic beings in that part of the ocean. After the elaborate paper by Ehrenberg, on the phosphorescence of the sea, it is almost superfluous on my part to make any observations on the subject, I may however add that the same torn and irregular particles of gelatinous matter, described by Ehrenberg, seem, in the southern as well as in the northern hemisphere, to be the common cause of this phenomenon. * * *

‘Observing that the water charged with gelatinous, particles is in an impure state, and that the luminous appearance in all common cases is produced by the agitation of the fluid in contact with the atmosphere, I am inclined to consider that the phosphorescence is the result of the decomposition of the organic particles, by which process (one is tempted almost to call it a kind of respiration) the ocean becomes purified.’

Whether this conjecture be true or not, there can be no doubt that the phosphorescence of the sea is often due to living organisms. [TF]

[102] Mr. Ellis remarks that this is 'merely a translation of πνεύμων θαλάσσίος, which is used by Dioscorides, *De Materia Medica*, II. 39. The luminous appearance arises apparently from serpent medusae, which in texture are like the substance of the lungs, from which circumstance they derive the name which Dioscorides gives them.' [TF]

[103] 'St. Elmo's fire.' CP. Historia Ventoriim, Prognostica Ventorum, No, 43 (Ellis and Spedding, Vol. II. pp. 69, 70), and Pliny's Naturalis Historia, Book II. 101 (Chapter 37).

'The fire of St. Elmo, or Castor and Pollux, is a brilliant light which frequently appears on the summits of ships' masts, on the points of bayonets, on the tops of spears, and on the tips of the ears of horses (cp. passage above). It is obviously nothing more than the electricity discharging itself either from or into pointed bodies.' Article on Electricity in the 8th Edition of the Encyclopaedia Britannica by Sir David Brewster. (The passage is not incorporated in the 9th Edition.) The writer then proceeds to add some interesting accounts of this phenomenon, as given by Lord Napier and the Comte de Forbin. The latter says, 'we saw from different points of the ship about thirty St. Elmo's fires.'

Mr. Ellis, following Humboldt, quotes Camoens:

> 'Vi claramente visto o iume vivo,
> Oue a maritima gente tern por santo
> Em tempo de tormenta,' etc.
>
> Os Lusiadas de Camoes, canto v. est. 18.

[TF]

Ad 7^{am} 12^{a}.

12. Omne ignitum ita ut vertatur in ruborem igneum etiam sine flamma perpetuo calidum est, neque huic affirmativae subjungitur negativa; sed quod in proximo est videtur esse lignum putre, quod splendet noctu neque tamen deprehenditur calidum; et squamae piscium putrescentes, quae etiam splendent noctu, nec inveniuntur ad tactum calidae; neque etiam corpus cicindelae aut muscae (quam vocant luciolam [104]) calidum ad tactum deprehenditur.

[104] Luciola = the fire-fly, Cicindela - the glow-worm. All the instances given in this section are phenomena of phosphorescence. [TF]

Ad 8^{am} 13^{a}.

13. De balneis calidis, in quo situ et natura soli emanare soleant, non satis quaesitum est; itaque non subjungitur negativa.

Ad 9^{am} 14^{a}

14. Liquidis ferventibus subjungitur negativa ipsius liquidi in natura sua. Nullum enim invenitur liquidum tangibile quod sit in natura sua et maneat constanter calidum, sed superinducitur ad tempus tantum calor, ut natura ascititia: adeo ut quae potestate et operatione sunt maxime calida, ut spiritus vini, olea aromatum chymica, etiam olea vitrioli et sulphuris [105], et similia, quae paulo post adurunt, ad primum tactum sint frigida. Aqua autem balneorum naturalium excepta in vas aliquod et separata a fontibus suis defervescit perinde ac aqua igne calefacta. At verum est corpora oleosa ad tactum paulo minus esse frigida quam aquea; ut oleum minus quam aqua, sericum minus quam linteum. Verum hoc pertinet ad Tabulam Graduum de Frigido.

[105] Sulphuric Acid. See note 66 above. I may here again notice the same confusion as before between the temperature of an object itself and the manner in which it affects our senses. [TF]

Ad 10^{am} 15^{a}.
15. Similiter vapori fervido subjungitur negativa naturae ipsius vaporis, qualis apud nos invenitur. Etenim exhalationes ex oleosis, licet facile inflammabiles, tamen non inveniuntur calidae, nisi a corpore calido recenter exhalaverint.

Ad 10^{am} 16^{a}.
16. Similiter aëri ipsi ferventi subjungitur negativa naturae aëris ipsius. Neque enim invenitur apud nos aër calidus; nisi fuerit aut conclusus, aut attritus [106], aut manifeste calefactus a sole, igne, aut aliquo alio corpore calido.

[106] 'Subjected to friction,' namely, of its minute particles. The word cannot mean simply agitated or put in motion; for the passage would then contradict what is said in Inst. 22, q. v. Bacon was, of course, mistaken in supposing either that any motion could take place without friction, or that air could move in masses without any friction amongst its minute particles. [TF]

Ad 11^{am} 17^{a}.
17. Subjungitur negativa tempestatum frigidarum magis quam pro ratione temporis anni, quae eveniunt apud nos flante Euro et Borea; quemadmodum et contrariae tempestates eveniunt flante Austro et Zephyro. Etiam inclinatio ad pluviam (praesertim temporibus hyemalibus) comitatur tempestatem tepidam; at gelu contra frigidam.

Ad 12^{am} 18^{a}.
18. Subjungitur *negativa* aëris conclusi in cavernis tempore aestivo [107]. At de aëre concluso omnino diligentius inquirendum. Primo enim non absque causa in dubitationem venit, qualis sit natura aëris quatenus ad calidum et frigidum in natura sua propria. Recipit enim aer calidum manifesto ex impressione coelestium; frigidum autem fortasse ab expiratione terrae; et rursus in media (quam vocant) regione aëris a vaporibus frigidis et nivibus: ut nullum judicium fieri possit de aëris natura per aërem qui foras est et sub dio, sed verius foret judicium per aërem conclusum. Atqui opus est etiam ut aër concludatur in tali vasi et materia quae nec ipsa imbuat aërem calido vel frigido

ex vi propria, nec facile admittat vim aëris extranei. Fiat itaque experimentum per ollam figularem multiplici corio obductam ad muniendam ipsam ab aëre extraneo, facta mora per tres aut quatuor dies in vase bene occluso; deprehensio autem fit post apertionem vasis vel per manum vel per vitrum graduum [108] ordine applicatum.

[107] Both this and the phenomenon noticed in Inst. 12 of Aphorism 11 are really due to the same cause. Air is a bad conductor of heat, and hence, as Dr. Kitchin says, 'it receives it slowly and retains it long.' The air within a cavern being approximately of the same temperature in winter and summer, seems, as compared with the outer air, hot at the one season and cold at the other. It is for the same reason that, in walking up a high mountain, we may suffer intensely from the sun's rays over-head, while, if we retire into the shade, we may be almost frozen.

The following remarks show how little Bacon knew of the conduction of heat, or of the purely relative character of the expressions 'hot' and 'cold.' He thought that cold was as much a positive quality as heat. [TF]

[108] This word shews that the thermometer was already graduated in Bacon's time. [TF]

Ad 13^{am} 19^{a}.

19. Subest similiter dubitatio [109], utrum tepor in lana et pellibus et plumis et hujusmodi fiat ex quodam exili calore inhaerente, quatenus excernuntur ab animalibus; aut etiam ob pinguedinem quandam et oleositatem, quae sit naturae congruae cum tepore; vel plane ob conclusionem et fractionem aëris, ut in articulo praecedente dictum est. Videtur enim omnis aër abscissus a continuitate aëris forinseci habere nonnihil teporis. Itaque fiat experimentum in fibrosis quae fiunt ex lino; non ex lana aut plumis aut serico, quae excernuntur ab animatis. Notandum est etiam, omnes pulveres (ubi manifesto includitur aër) minus esse frigidos quam corpora integra ipsorum [110]; quemadmodum etiam existimamus omnem spumam (utpote quae aërem contineat) minus esse frigidam quam liquorem ipsum.

[109] The 'dubitatio' of Bacon has, of course, been wholly removed. The so-called 'warmth' of wool, skins, feathers, etc., is due to none of the causes which he suggests, but simply to the fact that they are bad conductors of heat, and hence, when the skin is covered with them, the animal warmth is retained. [TF]

[110] This circumstance is, of course, due to the bad conducting power of air. See note 7 above. [TF]

Ad 14^{am} 20^{a}.

20. Huic non subjungitur negativa. Nihil enim reperitur apud nos sive tangibile sive spiritale [111], quod admotum igni non excipiat calorem. In eo tamen differunt, quod alia excipiant calorem citius, ut aër [112], oleum, et aqua; alia tardius, ut lapis et metalla. Verum hoc pertinet ad Tabulam Graduum.

[111] The word is evidently used in this place, not as opposed to material or corporeal, but as applying to aeriform fluids. [TF]

[112] There is a confusion here between the radiation of heat through the air and the conductivity of air itself. If we kindle a fire in a room, we at once feel the increased warmth through radiation; but if we extinguish it shortly afterwards, it will be found that the temperature of the air has hardly been perceptibly increased. The glass fire-screen furnishes a familiar illustration of the same principle. Metals, on the other hand, are rapid conductors, as we may test by their coldness to the touch in ordinary temperatures. [TF]

Ad 15^{am} 21^{a}.

21. Huic Instantiae non subjungitur negativa alia, quam ut bene notetur non excitari scintillas ex silice et chalybe aut alia aliqua substantia dura nisi ubi excutiuntur minutiae aliquae ex ipsa substantia lapidis vel metalli, neque aërem attritum unquam per se generare scintillas [113], ut vulgo putant; quin et ipsae illae scintillae ex pondere corporis igniti magis vergunt deorsum quam sursum, et in extinctione redeunt in quandam fuliginem corpoream.

[113] See Tyndall, Heat a Mode of Motion, 3rd ed., § 25: 'When the air is compressed, heat is suddenly generated. Tinder may be ignited by this heat.' Compressed air, when expanded, on the other band, has a chilling effect. [TF]

Ad 16^{am} 22^{a}.

22. Existimamus huic instantiae non subjungi negativam. Nullum enim invenitur apud nos corpus tangibile, quod non ex attritione manifesto calescat [114]; adeo ut veteres somniarent non inesse coelestibus aliam viam aut virtutem calefaciendi nisi ex attritione aëris per rotationem rapidam et incitatam [115]. Verum in hoc genere ulterius inquirendum est, utrum corpora quae emittuntur ex machinis (qualia sunt pilae ex tormentis) non ex ipsa percussione contrahant aliquem gradum caloris; adeo ut postquam deciderint inveniantur nonnihil calida [116]. At aër motus magis infrigidat quam calefacit; ut in ventis et follibus et flatu oris contracti [117]. Verum hujusmodi motus non est tam rapidus ut excitet calorem, et fit secundum totum, non per particulas [118]; ut mirum non sit, si non generet calorem.

[114] This statement is perfectly true. Motion or mechanical force (which always involves friction) and heat are mutually convertible. Motion may always be converted into heat, and heat into motion. This is the fundamental axiom of the modern science of Heat. [TF]

[115] Mr. Ellis refers to Aristotle, Meteorologica Book I. Chapter 2 (Chapter 3 of Berlin Edition, p. 341 a) sub finem, and De Coelo, II. 7 (p. 288 a). The latter passage is peculiarly interesting: ἡ δὲ θερμότης ἀπ᾽ αὐτῶν (sc. τῶν ἄστρων) καὶ τὸ φῶς γίνεται παρεκτριβομένου τοῦ ἀέρος ὑπὸ τῆς ἐκείνων φορᾶς. πέφυκε γὰρ ἡ κίνησις ἐκπυροῦν καὶ ξύλα καὶ λίθους καὶ σίδηρον᾽ εὐλογώτερον οὖν τὸ ἐγγύτερον τοῦ πυρός, ἐγγύτερον δὲ ὁ ἀήρ, οἷον καὶ ἐπὶ τῶν φερομένων βελῶν" ταῦτα γὰρ αὐτὰ ἐκπυροῦται οὕτως, κιτιλ.

Mr. Ellis remarks that 'it seems probable that Aristotle was influenced by a wish to secure the doctrine of the eternity of the universe, which he saw would be put in peril if celestial heat was ascribed to anything akin to combustion.'

That Aristotle's theory was not inherently impossible will be plain from the following passage, taken from Tyndall's Heat a Mode of Motion, 3rd ed., § 12: 'The most probable theory of shooting stars is that they are small planetary bodies revolving round the sun, which are caused to swerve from their orbits by the attraction of the earth, and are raised to incandescence by friction against our atmosphere. Chladni propounded this view, and Dr. Joule has shewn that the atmospheric friction is competent to produce the effect. Professor Tyndall, at the beginning of this section, refers to Aristotle's statement that arrows are heated by passing through the air. [TF]

[116] This is so. A bullet or a cannon-ball is heated by passing through the air. CP. what Aristotle says in the passage quoted above about the heating of arrows. [TF]

[117] The cooling effect in these cases is due to the fact that fresh draughts of air are constantly brought into contact with the body, the loss of heat from the latter being thus rendered more rapid than it would be if the surrounding atmosphere were more nearly of the same temperature with itself. [TF]

[118] From this passage, it would appear as if Bacon thought that masses of air could be put in motion, without causing any disturbance or friction amongst their minute particles — a view in which he was, of course, wrong. [TF]

Ad 17^{am} 23^{a}.

23. Circa hanc instantiam facienda est inquisitio diligentior. Videntur enim herbae et vegetabilia viridia et humida aliquid habere in se occulti caloris. Ille vero calor tam tenuis est ut in singulis non percipiatur ad tactum; verum postquam illa adunata sint et conclusa, ut spiritus ipsorum non expiret in aërem sed se invicem foveat, tum vero oritur calor manifestus, et nonnunquam flamma in materia congrua [119].

[119] This is a well-known phenomenon, as in damp hay-ricks, coal-dust, heaps of decaying vegetable matter, masses of rags or tow' saturated with oil, etc. Bacon's explanation, it is unnecessary to say, is wholly unscientific. The following is given in Watts' Dictionary of Chemistry, art. Combustion: 'The substance absorbs and condenses the air within its pores; oxidation then commences immediately and raises the temperature, which again accelerates the oxidation; and thus the process goes on with continually increasing rapidity, till at length the mass bursts into flame. The low conducting power of such a porous mass greatly facilitates the combustion, by preventing the dissipation of the heat generated. * * * * The presence of moisture greatly promotes the spontaneous ignition of porous substances, such as hay or coal-dust, the water probably supplying oxygen to the combustible matter.' Where the masses are small, the heat developed is usually carried off; so that combustion, in materials of

this character, is far more likely to take place in large masses than small. Thus, in a hay-rick the process may be arrested by pulling the rick to pieces. [TF]

Ad 18^{am} 24^{a}.
24. Etiam circa hanc instantiam diligentior facienda est inquisitio. Videtur enim calx viva aqua aspersa concipere calorem vel propter unionem caloris qui antea distrahebatur (ut ante dictum est de herbis conclusis), vel ob irritationem ex exasperationem spiritus ignei ab aqua, ut fiat quidam conflictus et antiperistasis [120]. Utra vero res sit in causa facilius apparebit, si loco aquae immittatur oleum; oleum enim aeque ac aqua valebit ad unionem spiritus inclusi, sed non ad irritationem. Etiam faciendum est experimentum latius tam in cineribus et calcibus diversorum corporum, quam per immissionem diversorum liquorum.

[120] The reason is that the water enters into combination with the quicklime, which has a powerful affinity for it, and that heat is developed in the process.

The word ‘antiperistasis’ is defined in II. 27 ad fin. as ‘rejectio naturae contrariae.’ CP. note on that passage.

The reader will not fail to notice Bacon’s curious use of the word 'spirit’ and the strange metaphors which it suggests to him. [TF]

Ad 19^{am} 25^{a}.
25. Huic instantiae subjungitur negativa aliorum metallorum, quae sunt magis mollia et fluxa. Etenim bracteolae auri, solutae in liquorem per aquam regis, nullum dant calorem ad tactum in dissolutione; neque similiter plumbum in aqua forti; neque etiam argentum vivum (ut memini); sed argentum ipsum parum excitat caloris, atque etiam cuprum (ut memini), sed magis manifesto stannum, atque omnium maxime ferrum et chalybs, quae non solum fortem excitant calorem in dissolutione, sed etiam violentam ebullitionem. Itaque videtur calor fieri per conflictum, cum aquae fortes penetrant et fodiunt et divellunt partes corporis, et corpora ipsa resistunt [121]. Ubi vero corpora facilius cedunt, vix excitatur calor.

[121] In these and similar cases, heat is developed by chemical action. 'I know of no exception,’ says Sir W. R. Grove, 'to the general proposition that all bodies, in chemically combining, produce heat.’ Correlation of Physical Forces, Section on Chemical Affinity. [TF]

Ad 20^{am} 26^{a}.
26. Calori animalium nulla subjungitur negativa, nisi insectorum (ut dictum est) ob parvitatem corporis. Etenim in piscibus collatis ad animalia terrestria magis notatur gradus caloris quam privatio. In vegetabilibus autem et plantis nullus percipitur gradus caloris ad tactum, neque in lachrymis ipsorum, neque in medullis recenter apertis. At in animalibus magna reperitur diversitas caloris, tum in partibus ipsorum (alius est enim

calor circa cor, alius in cerebro, alius circa externa), tum in accidentibus eorum, ut in exercitatione vehementi et febribus.

Ad ^{21}am 27^{a}.
27. Huic instantiae vix subjungitur negativa. Quinetiam excrementa animalium non recentia manifeste habent calorem potentialem, ut cernitur in impinguatione soli.

Ad 22^{am} et 23^{am} 28^{a}.
28. Liquores (sive aquae vocentur sive olea) qui habent magnam et intensam acrimoniam exequuntur opera caloris in divulsione corporum, atque adustione post aliquam moram; sed tamen ad ipsum tactum manus non sunt calidi ab initio. Operantur autem secundum analogiam [122] et poros corporis cui adjunguntur. Aqua enim regis aurum solvit, argentum minime; at contra aqua fortis argentum solvit, aurum minime; neutrum autem solvit vitrum. Et sic de caeteris.

[122] It is not easy to see the exact meaning of this expression here. Does it mean vaguely 'according as they are related to the objects to which they are applied'? [TF]

Ad 24^{am} 29^{a}.
29. Fiat experimentum spiritus vini in lignis, ac etiam in butyro aut cera aut pice; si forte per calorem suum ea aliquatenus liquefaciat [123]. Etenim instantia 24a ostendit potestatem ejus imitativam caloris in incrustationibus. Itaque fiat similiter experimentum in liquefactionibus. Fiat etiam experimentum per vitrum graduum sive calendare quod concavum sit in summitate sua per exterius; et immittatur in illud concavum exterius spiritus vini bene rectificatus, cum operculo, ut melius contineat calorem suum; et notetur utrum per calorem suum faciat aquam descendere [124].

[123] 'Spirits of wine will dissolve wax and pitch, but not wood or butter.' Dr. Kitchin's note. [TF]

[124] The nature of this experiment will be made clear by consulting Inst. 38 of the next Aphorism. The water will descend owing to the expansion of the spirits of wine. The employment of Spirits of Wine in the construction of thermometers was intermediate between that of air and that of mercury. [TF]

Ad 25^{am} 30^{a}.
30. Aromata, et herbae acres ad palatum, multo magis sumptae interius, percipiuntur calida. Videndum itaque in quibus aliis materiis exequantur opera caloris. Atque referunt nautae, cum cumuli et massae aromatum diu conclusae subito aperiuntur, periculum instare illis, qui eas primo agitant et extrahunt, a febribus et inflammationibus spiritus. Similiter fieri poterit experimentum, utrum pulveres hujusmodi aromatum aut herbarum non arefaciant laridum et carnem suspensam super ipsos, veluti fumus ignis.

Ad 26^{am} 31^{a}.

31. Acrimonia sive penetratio inest tam frigidis, qualia sunt acetum et oleum vitrioli, quam calidis, qualia sunt oleum origani et similia. Itaque similiter et in animatis cient dolorem et in non animatis divellunt partes et consumunt. Neque huic instantiae subjungitur *negativa*. Atque in animatis nullus reperitur dolor, nisi cum quodam sensu caloris.

Ad 27^{am} 32^{a}.
32. Communes sunt complures actiones et calidi et frigidi, licet diversa admodum ratione. Nam et nives puerorum manus videntur paulo post urere; et frigora tuentur carnes a putrefactione [125], non minus quam ignis; et calores contrahunt corpora in minus [126], quod faciunt et frigida. Verum haec et similia opportunius est referre ad Inquisitionem de Frigido [127].

[125] This remark is interesting, as connected with the experiment which was the occasion of Bacon's death. On a cold morning in the spring of 1626, he descended from his coach at the bottom of Highgate Hill, bought a hen of a poor woman, and stuffed it with snow. The chill, to which he was thus exposed, brought on an attack of what we should now call bronchitis, of which he died on the 9th of April. [TF]

[126] This effect, which is, of course, only apparent, is due to the escape of gases. With certain very rare exceptions, the invariable effect of any augmentation of temperature is to expand, not to contract, a body. [TF]

[127] As I have pointed out before, Bacon did not see the true relation of heat and cold, but regarded the latter as a positive quality. There is no systematic 'Inquisitio de Frigido' in his works. The nearest approaches to it are 'Experiments in consort touching the production of cold' in the Sylva Sylvarum, Century i, 69-75 (Ellis and Spedding, Vol. II. pp. 370-1), and a Fragment entitled 'Sequela Cartarum, sive Inquisitio Legitima de Galore et Frigore' (Ellis and Spedding, Vol. III. pp. 644-52). [TF]

XIII.

Tertio facienda est comparentia ad intellectum instantiarum in quibus natura, de qua fit inquisitio, inest secundum magis et minus; sive facta comparatione incrementi et decrementi in eodem subjecto, sive facta comparatione ad invicem in subjectis diversis. Cum enim forma rei sit ipsissima res [128]; neque differat res a forma, aliter quam differunt apparens et existens, aut exterius et interius, aut in ordine ad hominem et in ordine ad universum [129]; omnino sequitur ut non recipiatur aliqua natura pro vera forma, nisi perpetuo decrescat quando natura ipsa decrescit, et similiter perpetuo augeatur quando natura ipsa augetur [130]. Hanc itaque tabulam Tabulam Graduum sive *Tabulam Comparativae* appellare consuevimus.

[128] The language here used of Form exactly corresponds with that which might be used of the scholastic term 'Essence,' or of the 'Real Essence' of Locke. There is, perhaps,

no passage in the Novum Organum, in which we could less appropriately replace the word by 'Law' or 'Cause.' [TF]

[129] This is only another way of stating the contrast of 'apparens' et 'existens,' of a thing or quality as it appears to us, and as it is in its own inmost nature. Thus, heat, as affecting the senses, is 'in ordine ad hominem,' while its cause or essence, a motion of a certain kind amongst the minute particles of matter, is 'in ordine ad universum.' Aristotle's distinction of πρότερα or γνωριμώτερα πρὸς ἡμᾶς and πρότερα or γνωριμώτερα τῇ φύσει, as applied respectively to individuals and species, is, it will be noticed, here transferred to the relation of an effect to its cause or a phenomenon to its essence. [TF]

[130] This rule, so far as it affects the relation of cause and effect, is vitiated by the consideration of the Plurality of Causes. As an effect may be due to two or more distinct causes, being sometimes produced by one and sometimes by another, it is quite conceivable that one of the causes might remain altogether unchanged, while the effect increased or diminished concurrently with the other cause or with one of the other causes. This objection does not apply to the Canon of the Method of Concomitant Variations as stated by Mr. Mill or myself. [TF]

Tabula Graduum sive Comparativae in Calido.

Primo itaque dicemus de iis quae nullum prorsus gradum caloris habent ad tactum, sed videntur habere potentialem tantum quendam calorem, sive dispositionem et praeparationem ad calidum. Postea demum descendemus ad ea quae sunt actu sive ad tactum calida, eorumque fortitudines et gradus.

1. In corporibus solidis et tangibilibus non invenitur aliquid quod in natura sua calidum sit originaliter [131]. Non enim lapis aliquis, non metallum, non suphur, non fossile aliquod, non lignum, non aqua, non cadaver animalis, inveniuntur calida. Aquae autem calidae in balneis videntur calefieri per accidens, sive per flammam aut ignem subterraneum, qualis ex Aetna et montibus aliis compluribus evomitur, sive ex conflictu corporum, quemadmodum calor fit in ferri et stanni dissolutionibus. Itaque gradus caloris in inanimatis, quatenus ad tactum humanum, nullus est; veruntamen illa gradu frigoris differunt; non enim aeque frigidum est lignum ac metallum. Sed hoc pertinet ad *Tabulam Graduum in Frigido*.

   [131] What Bacon means is that there is no tangible body which, in its ordinary condition, affects the skin with the sensation of heat. The purely relative and negative character of 'cold,' and the laws of radiation and conduction, we must recollect, were alike unknown to him.

   By 'cold' Bacon, of course, means a temperature lower than that of the skin. [TF]

2. Attamen quoad potentiales calores et praeparationes ad flammam, complura inveniuntur inanimata admodum disposita, ut sulphur, naphtha, petrelaeum [132].

[132] Petroleum. [TF]

3. Quae antea incaluerunt, ut fimus equinus ex animali, aut calx, aut fortasse cinis aut fuligo ex igne, reliquias latentes quasdam caloris prioris retinent [133]. Itaque fiunt quaedam distillationes et separationes corporum per sepulturam in fimo equino; atque excitatur calor in calce per aspersionem aquae; ut jam dictum est.

[133] This idea is, of course, purely fantastic. By analogy, steel or glass ought to be peculiarly susceptible of heat, because they have been passed through the furnace. [TF]

4. Inter vegetabilia non invenitur aliqua planta sive pars plantae (veluti lachryma aut medulla) quae sit ad tactum humanum calida. Sed tamen (ut superius dictum est) herbae virides conclusae calescunt; atque ad interiorem tactum, veluti ad palatum aut ad stomachum aut etiam ad exteriores partes, post aliquam moram (ut in emplastris et unguentis) alia vegetabilia inveniuntur calida, alia frigida [134].

[134] This confusion between things which are hot, in the true sense of having a high degree of temperature, and those which affect any of our organs with a sensation akin to that of heat, has already been pointed out in note 66 on Aphorism II. Sir John Herschel's remarks (Discourse on the study of Natural Philosophy, § 345) on this and similar confusions apply to so many of Bacon's examples that I think it will be useful to the student if I extract them at length:

'The word heat generally implies the sensation which we experience on approaching a fire; but, in the sense it carries in physics, it denotes the cause, whatever it be, of that sensation, and of all the other phenomena which arise on the application of fire, or of any other heating cause. We should be greatly deceived if we referred only to sensation as an indication of the presence of this cause. Many of those things which excite in our organs, and especially those of taste, a sensation of heat, owe this property to chemical stimulants, and not at all to their being actually *hot*. This error of judgment has produced a corresponding confusion of language, and hence had actually at one period crept into physical philosophy a great many illogical and absurd conclusions. Again, there are a number of chemical agents, which, from their corroding, blackening, and dissolving, or drying up the parts of some descriptions of bodies, and producing on them effects not generally unlike (though intrinsically very different from) those produced by heat, are said, in loose and vulgar language, to bum them; and this error has even become rooted into a prejudice, by the fact that some of these agents are capable of becoming actually and truly during their action on moist substances, by reason of their combination with the water the latter contain. Thus, quicklime and oil of vitriol both exercise a powerful corrosive action on animal and vegetable substances, and both become violently hot by their

combination with water. They are, therefore, set down in vulgar parlance as substances of a hot nature; whereas, in their relations to the physical cause of heat, they agree with the generality of bodies similarly constituted.' [TF]

5. Non invenitur in partibus animalium, postquam fuerint mortuae aut separatae, aliquid calidum ad tactum humanum. Nam neque fimus equinus ipse, nisi fuerit conclusus et sepultus, calorem retinet. Sed tamen omnis fimus habere videtur calorem potentialem, ut in agrorum impinguatione. Et similiter, cadavera animalium hujusmodi habent latentem et potentialem calorem; adeo ut in coemeteriis, ubi quotidie fiunt sepulturae, terra calorem quendam occultum colligat, qui cadaver aliquod recenter impositum consumit longe citius quam terra pura [135]. Atque apud orientales traditur inveniri textile quoddam tenue et molle, factum ex avium plumagine, quod vi innata butyrum solvat et liquefaciat in ipso leviter involutum.

   [135] There is no ground, I believe, for this assertion. The idea may have been suggested by the effects of quick-lime, which was frequently strewn on corpses, during the time of plague, in hastening decomposition, not only at the time of being strewn but subsequently. Moreover, bodies are consumed much more quickly in some soils than others. [TF]

6. Quae impinguant agros, ut fimi omnis generis, creta, arena maris, sal, et similia, dispositionem nonnullam habent ad calidum.

7. Omnis putrefactio in se rudimenta quaedam exilis caloris habet [136], licet non hucusque ut ad tactum percipiatur. Nam nec ea ipsa quae putrefacta solvuntur in animalcula [137], ut caro, caseus, ad tactum percipiuntur calida; neque lignum putre, quod noctu splendet [138], deprehenditur ad tactum calidum. Calor autem in putridis quandoque se prodit per odores tetros et fortes.

   [136] This statement, as Mr. Ellis says, is true of eremacausis rather than of real putrefaction. For instances of the development of heat in the former process, see Inst. 23 of the last Aphorism and the note upon it. [TF]

   [137] Bacon regarded putrefaction as a co-ordinate cause of generation with copulation. See Sylva Sylvarum, Experiment 900. [TF]

   [138] This phenomenon, as already stated, is due to phosphorescence. [TF]

8. Primus itaque caloris gradus, ex iis quae ad tactum humanum percipiuntur calida, videtur esse calor animalium, qui bene magnam habet graduum latitudinem. Nam infimus gradus (ut in insectis) vix ad tactum deprenditur; summus autem gradus vix attingit ad gradum caloris radiorum solis in regionibus et temporibus maxime ferventibus [139], neque ita acris est quin tolerari possit a manu. Et tamen referunt de Constantio [140], aliisque nonnullis qui constitutionis et habitus corporis

admodum sicci fuerunt, quod acutissimis febribus correpti ita incaluerint ut manum admotam aliquantulum urere visi sint.

[139] Blood-Heat is marked at 98° Fahrenheit and Fever-Heat at 112° on the ordinary Thermometers. These are considerably below the number of degrees which the Thermometer sometimes marks in the sun even in temperate climates. [TF]

[140] The person alluded to is Constantius II, son of Constantine the Great. Mr. Ellis refers to Ammianus Marcellinus, Libro XXI, Cap. 15. The passage runs as follows: 'paullatimque urente calore nimio venas, ut ne tangi quidem corpus ejus posset in modum foculi fervens, cum usus deficeret medullarum, ultimum spirans dedebat exitium.' [TF]

9. Animalia, ex motu et exercitatione, ex vino et epulis, ex venere, ex febribus ardentibus, et ex dolore, augentur calore.

10. Animalia, in accessibus febrium intermittentium, a principio frigore et horrore corripiuntur, sed paulo post majorem in modum incalescunt; quod etiam faciunt a principio in causonibus [141] et febribus pestilentialibus.

[141] The word καύσων is employed in the New Testament to express a burning, scorching heat, as in Matt. xx. 12, Luke xii. 55, James I. II. In the Septuagint, it generally, means the East Wind, as being the wind which brings hot and scorching, weather. Here it must be employed as the equivalent of καῦσος, a bilious, intermittent fever. [TF]

11. Inquiratur ulterius de calore comparato in diversis animalibus, veluti piscibus, quadrupedibus, serpentibus, avibus; atque etiam secundum species ipsorum, ut in leone, milvio, homine; nam ex vulgari opinione, pisces per interiora minus calidi sunt, aves autem maxime calidae; praesertim columbae, accipitres, struthiones [142].

[142] Mr. Spedding thinks that the word 'struthio' is here used for a sparrow; but my relative, the Rev. J. T. Fowler, has pointed out to me that there is no reason why it should not be taken in its ordinary sense of 'an ostrich,' as the powerful digestion of this bird was commonly attributed to the fervent heat of its stomach. [TF]

12. Inquiratur ulterius de calore comparato in eodem animali, secundum partes et membra ejus diversa. Nam lac, sanguis, sperma, ova, inveniuntur gradu modico tepida, et minus calida quam ipsa caro exterior in animali quando movetur aut agitatur. Qualis vero gradus sit caloris in cerebro, stomacho, corde, et reliquis, similiter adhuc non est quaesitum.

13. Animalia omnia, per hyemem et tempestates frigidas, secundum exterius frigent; sed per interiora etiam magis esse calida existimantur.

14. Calor coelestium, etiam in regione calidissima atque temporibus anni et diei calidissimis, non eum gradum caloris obtinet, qui vel lignum aridissimum vel stramen vel etiam linteum ustum incendat aut adurat, nisi per specula comburentia roboretur; sed tamen e rebus humidis vaporem excitare potest.

15. Ex traditione astronomorum ponuntur stellae aliae magis, aliae minus calidae [143]. Inter planetas enim post solem ponitur Mars calidissimus, deinde Jupiter, deinde Venus; ponuntur autem tanquam frigidi Luna et deinde omnium maxime Saturnus. Inter fixas autem ponitur calidissimus Sirius [144], deinde Cor Leonis, sive Regulus [145], deinde Canicula [146], etc.

[143] The order here adopted is, of course, with the exception of the sun, purely fanciful The 'tradition,' with regard to the planets, was probably founded on their aspect, i.e. their colour and brilliancy; with regard to the fixed stars, partly on their brilliancy, partly on some peculiarity in their relative position in the heavens, partly on the period of their heliacal rising.

It may be noticed that the Sun is ranked amongst the Planets.

On the influence, generally, of the heavenly bodies on the seasons and weather, see Pliny, Naturalis Historia, Book II. Chapters 39-41. Sections, 105-10. [TF]

[144] *a* Canis Majoris. We- can hardly be surprised at the notion of intense heat being connected, with Sirius. Not only, is it far the most brilliant of the fixed stars, but the period of its heliacal rising corresponds with the hottest time of the year, whence the expression 'Dies Caniculares' or 'Dog-Days.' It is frequently alluded to by the ancients, as in the well-known lines of Homer and Virgil:

> Τον δ᾽ ὁ γέρων Πρίαμος πρῶτος ἴδεν ὀφθαλμοῖσιν,
> παμφαίνονθ᾽ ὥστ᾽ ἀστέρ᾽, ἐπεσσύμενον πεδίοιο,
> ὅς ῥά 7 ὀπώρης εἶσιν, ἀρίζηλοι δέ οἱ αὐγαὶ
> φαίνονται πολλοῖσι μετ᾽ ἀστράσι νυκτὸς ἀμολγῷ"
> ὅν τε κύν᾽ Ὠρίωνος ἐπίκλησιν καλέουσιν.
> λαμπρότατος μὲν ὅδ᾽ ἐστί, κακὸν δέ τε σῆμα τέτυκται,
> καί τε φέρει πολλὸν πυρετὸν δειλοῖσι βροτοῖσιν.
>
> II. xxii. 25-31. (Cp. v. 5, 6.)

> Non secus, ac liquida si quando nocte cometae
> Sanguinei lugubre rubent, aut Sirius ardor,
> Ilie sitim morbosque ferens mortalibiis aegris,
> Nascitur et laevo contristat lumine coelum.'
>
> Aen, X. 272-5. (Cp. Georg, IV. 425-S; Aen. III. 141-2.)

Pliny (Naturalis Historia II. 40. sect. 107) has an interesting description of the supposed effects of the star, which is there called 'Canicula.'

'Nam Caniculae exortu accendi Solis vapores qiiis ignorat? cujus sideris effectus amplissimi in terra sentiuntur. Fervent maria exoriente eo, fluctuant in cellis vina, moventur stagna. Orygern appellat Aegyptus feram, quam in exortu ejus contra stare, et contueri tradit, ac velut adorare, cum sternuerit. Canes quidem toto eo spatio maxime in rabiem agi, non est dubium.'

A tolerably full account of Sirius, or Canicula as it was sometimes called, is given in Smyth's Celestial Cycle, Vol. II. p. 158, Etc. [TF]

[145] *α* Leonis. See Smyth's Celestial Cycle, Vol. II. p. 225, See. 'Ptolemy calls this star Βασιλίσκος, from an opinion of its influencing the affairs of the heavens; whence comes its Latin name Regulus.' [TF]

[146] *α* Canis Minoris. See Smyth, Vol. II. pp. 182-3. This star is also called Προκύων, because it appears in the morning dawn, as the precursor of Sirius. The 'Lesser Dog' or 'Little Dog' is a star of great brilliancy, though not nearly so brilliant as Sirius or the 'Greater Dog.'

Horace refers to this star and Regulus in the well-known lines:

'Jam clarus occuitum Andromedae pater
Ostendit ignem: jam Procyon furit,
Et Stella vesani Leonis,
Sole dies referente slccos.'

Od. III. 29 {17-20). [TF]

16. Sol magis calefacit, quo magis vergit ad perpendiculum sive Zenith, quod etiam credendum est de aliis planetis, pro modulo suo caloris; exempli gratia, Jovem magis apud nos calefacere, cum positus sit sub Cancro aut Leone quam sub Capricorno aut Aquario.

17. Credendum est solem ipsum et planetas reliquos magis calefacere in perigaeis suis, propter propinquitatem ad terram, quam in apogaeis [147]. Quod si eveniat ut in aliqua regione sol sit simul in perigaeo et propius ad perpendiculu, necesse est ut magis calefaciat quam in regione ubi sol sit similiter in perigaeo sed magis ad obliquum. Adeo ut comparatio exaltationis planetarum notari debeat, prout ex perpendiculo aut obliquitate participet, secundum regionum varietatem.

[147] The furthest and nearest distances between the earth and sun are, of course, in the Copernican system described as aphelion and perihelion, not as apogee and perigee. The variations of distance from the sun, due to the elliptic orbit of the earth, have, as a matter of fact, little influence in determining temperature, being

compensated by the variations in the angular velocity. Were it not for this fact, the summers and winters would be intensified in the southern, and moderated in the northern hemisphere.

For an explanation of the phenomena of the seasons, see Herschel's Astronomy (10th Ed., § 362-370). [TF]

18. Sol etiam, et similiter reliqui planetae calefacere magis existimantur cum sint in proximo ad stellas fixas majores; veluti cum sol ponitur in Leone, magis vicinus fit Cordi Leonis, Caudae Leonis, et Spicae Virginis, et Sirio, et Caniculae, quam cum ponitur in Cancro, ubi tamen magis sistitur ad perpendiculum [148]. Atque credendum est partes coeli majorem infundere calorem (licet ad tactum minime perceptibilem) quo magis ornatae sint stellis, praesertim majoribus.

[148] This is an attempt to account for July being hotter than the time of the summer solstice. The true reason is, of course, the same as that for the early afternoon being hotter than noon-day, namely, the increased radiation of heat from the earth's surface. [TF]

19. Omnino calor coelestium augetur tribus modis; videlicet ex perpendiculo, ex propinquitate sive perigaeo, et ex conjunctione sive consortio stellarum.

20. Magnum omnino invenitur intervallum inter calorem animalium ac etiam radiorum coelestium (prout ad nos deferuntur), atque flammam, licet lenissimam, atque etiam ignita omnia, atque insuper liquores, aut aërem ipsum majorem in modum ab igne calefactum. Etenim flamma spiritus vini, praesertim rara nec constipata, tamen potis est stramen aut linteum aut papyrum incendere; quod nunquam faciet calor animalis vel solis, absque speculis comburentibus [149].

[149] And yet, in parts of Australia and South Africa, during summer, a lucifer match accidentally falling on the ground will ignite. See Herschel's Astronomy, § 369. [TF]

21. Flammae autem et ignitorum plurimi sunt gradus in fortitudine et debilitate caloris [150]. Verum de his nulla est facta diligens inquisitio; ut necesse sit ista leviter transmittere. Videtur autem ex flammis illa ex spiritu vini esse mollissima; nisi forte ignis fatuus, aut flammae seu coruscationes ex sudoribus animalium, sint molliores. Hanc sequi opinamur flammam ex vegetabilibus levibus et porosis, ut stramine, scirpis, et foliis arefactis, a quibus non multum differre flammam ex pilis aut plumis. Hanc sequitur fortasse flamma ex lignis, praesertim iis quae non multum habent ex resina aut pice; ita tamen ut flamma ex lignis quae parva sunt mole (quae vulgo colligantur in fasciculos) lenior sit quam quae fit ex truncis arborum et radicibus. Id quod vulgo experiri licet in fornacibus quae ferrum excoquunt, in quibus ignis ex fasciculis et ramis arborum non est admodum utilis [151]. Hanc sequitur (ut arbitramur) flamma ex oleo et sevo et cera, et hujusmodi oleosis et pinguibus, quae sunt sine magna acrimonia. Fortissimus autem calor reperitur in pice et resina; atque

adhuc magis in sulphure et caphura [152], et naphtha et petrelaeo et salibus (postquam materia cruda eruperit), et in horum compositionibus, veluti pulvere tormentario, igne Graeco [153] (quem vulgo ignem ferum vocant), et diversis ejus generibus, quae tam obstinatum habent calorem ut ab aquis non facile exstinguantur.

[150] It is almost unnecessary to remark that the order in which Bacon arranges the temperature of flames bears hardly any relation to the conclusions established by modern physicists. He was partly, no doubt, deceived by the luminosity or illuminating power of flames, which is often very low, when the temperature is very high. Thus, for instance, a hydrogen dame, which is the palest of all, gives out the greatest heat.

A good account of the nature of Flame is given in Miller's Elements of Chemistry, Part II. In Ganot's Physics (Translation, 12th Ed., § 484) there is a table of the relative quantities of heat disengaged by various bodies during combustion. Marsh-gas comes next to hydrogen in this list, while spirits of wine is relatively high and sulphur relatively low. [TF]

[151] The quantity of heat disengaged by moist wood during combustion is much less than that disengaged by dry wood. [TF]

[152] Camphor. [TF]

[153] Not to be confounded with gunpowder. 'It was known in the east of Europe as early as the year A.D, 673, when, it is said, Callinicus, an architect of Heliopolis, taught the use of it to the Greeks. It did not reach the west of Europe till much later.' Brande and Cox's Dictionary of Science, etc. [TF]

22. Existimamus etiam flammam, quae resultat ex nonnullis metallis imperfectis [154], esse valde robustam et acrem. Verum de istis omnibus inquiratur ulterius.

[154] He probably means what were commonly called the baser or viler, as opposed to the more precious metals (gold and silver). Thus, in the Catalogus Historiarum Particularium, published at the end of the first edition of the Novum Organum, he enumerates 'Historia Metallorum perfectoruin, Auri, Argenti' (Ellis and Spedding, Vol. I. p. 406). It is possible, however, that he may mean 'metals while being smelted in the furnace,' See the expression 'ferrum ipsum perfectum' in the next instance. [TF]

23. Videtur autem flamma fulminum potentiorum [155] has omnes flammas superare; adeo ut ferrum ipsum perfectum aliquando colliquaverit in guttas, quod flammae illae alterae facere non possunt.

[155] As opposed to sheet-lightning. See II. 12. Inst. 9. [TF]

24. In ignitis autem diversi sunt etiam gradus caloris, de quibus etiam non facta est diligens inquisitio. Calorem maxime debilem existimamus esse ex linteo usto, quali ad flammae excitationem uti solemus; et similiter ex ligno illo spongioso [156] aut funiculis arefactis qui ad tormentorum accensionem adhibentur. Post hunc sequitur carbo ignitus ex lignis et anthracibus, atque etiam ex lateribus ignitis, et similibus. Ignitorum autem vehementissime calida existimamus esse metalla ignita, ut ferrum et cuprum et caetera. Verum de his etiam facienda est ulterior inquisitio.

    [156] Touchwood. [TF]

25. Inveniuntur ex ignitis nonnulla longe calidiora quam nonnullae ex flammis. Multo enim calidius est et magis adurens ferrum ignitum quam flamma spiritus vini.

26. Inveniuntur etiam ex illis quae ignita non sunt sed tantum ab igne calefacta, sicut aquae ferventes et aër conclusus in reverberatoriis, nonnulla quae superant calore multa ex flammis ipsis et ignitis.

27. Motus auget calorem [157]; ut videre est in follibus et flatu; adeo ut duriora ex metallis non solvantur aut liquefiant per ignem mortuum aut quietum, nisi flatu excitetur.

    [157] By supplying a greater quantity of oxygen from the air. It is not mere motion, for the manufacturer, who tried to blow his fires by means of steam jets, simply blew them out' Dr. Kitchin's note. [TF]

28. Fiat experimentum per specula comburentia, in quibus (ut memini) hoc fit; ut si speculum ponatur (exempli gratia) ad distantiam spithamae ab objecto combustibili, non tantopere incendat aut adurat quam si positum fuerit speculum (exempli gratia) ad distantiam semi spithamae, et gradatim et lente trahatur ad distantiam spithamae. Conus tamen et unio radiorum eadem sunt, sed ipse motus auget operationem caloris [158].

    [158] The only explanation of this curious supposition, as Mr. Ellis suggests, is that the focal length of the lens lay between a span and half a span, and was found by moving the lens. Bacon's remark, it must be confessed, betrays great ignorance of the laws of Optics. [TF]

29. Existimantur incendia illa, quae fiunt flante vento forti, majores progressus facere adversus ventum quam secundum ventum; quia scilicet flamma resilit motu perniciore, vento remittente, quam procedit, vento impellente [159].

    [159] Here the fact is inaccurately stated, and the reason assigned fanciful. In a fire, however, the flames will burn most brightly where the wind is highest (provided it is

not sufficiently violent to put them out), the reason being that fresh supplies of oxygen are being constantly brought into contact with the ignited mass. [TF]

30. Flamma non emicat aut generatur, nisi detur aliquid concavi in quo flamma movere possit et ludere [160]; praeterquam in flammis flatuosis pulveris tormentarii, et similibus, ubi compressio et incarceratio flammae auget ejus furorem [161].

[160] In ordinary cases, a supply of oxygen is essential to combustion, and, therefore, there must be contact with the air. 'But combustion does not necessarily involve the presence of oxygen. If either powdered antimony or a fragment of phosphorus be placed in a vessel of chlorine, it unites with chlorine, producing thereby heat and flame,' the principle being, in fact, the same as in the case of oxygen. Ganot's Physics, 12th Ed., §. 483. [TF]

[161] In this case, the supply of oxygen is derived from the saltpetre. It is, perhaps, needless to add that the amount of explosion is exactly the same in the gun as it would be in the open air. [TF]

31. Incus per malleum calefit admodum; adeo ut si incus fuerit laminae tenuioris, existimemus illam per fortes et continuos ictus mallei posse rubescere, ut ferum ignitum [162]; sed de hoc fiat experimentum.

[162] This would be so. Bacon was here on the right track for discovering the connexion between heat and motion. [TF]

32. At in ignitis quae sunt porosa, ita ut detur spatium ad exercendum motum ignis, si cohibeatur hujusmodi motus per compressionem fortem, statim extinguitur ignis; veluti cum linteum ustum aut filum ardens candelae aut lampadis aut etiam carbo aut pruna ardens comprimitur per pressorium aut pedis conculcationem aut hujusmodi, statim cessant operationes ignis.

33. Approximatio ad corpus calidum auget calorem, pro gradu approximationis; quod etiam fit in lumine: nam quo proprius collocatur objectum ad lumen eo magis est visibile [163].

[163] 'To the eye of the philosopher these obscure radiations' (namely, of heat)' are precisely the same in kind, as those which produce the impression of light. You must, therefore, figure the particles of the heated body as in a state of motion; you must figure that motion as communicated to the surrounding ether, and transmitted through it with a velocity, which we have the strongest reason for believing to be the same as that of light.' Tyndall's Heat a Mode of Motion, 3rd Ed., § 306. The law of the in- tensity of radiant heat on a given surface is the same as that of illumination, that is to say, it varies inversely as the square of the distance from the source of heat, as the other from the source of light. [TF]

34. Unio calorum diversorum auget calorem, nisi facta sit commistio corporum. Nam focus magnus et focus parvus in eodem loco nonnihil invicem augent calorem; at aqua tepida immissa in aquam ferventem refrigerat.

35. Mora corporis calidi auget calorem. Etenim calor perpetuo transiens et emanans commiscetur cum calore praeinexistente, adeo ut multiplicet calorem. Nam focus non aeque calefacit cubiculum per moram semihorae ac si idem focus duret per horam integram. At hoc non facit lumen; etenim lampas aut candela in aliquo loco posita non magis illuminat per moram diuturnam quam statim ab initio.

36. Irritatio per frigidum ambiens auget calorem; ut in focis videre est per gelu acre [164]. Quod existimamus fieri non tantum per conclusionem et contractionem caloris, quae est species unionis, sed per exasperationem; veluti cum aër aut baculum violenter comprimitur aut flectitur, non ad punctum loci prioris resilit, sed ulterius in contrarium. Itaque fiat diligens experimentum per baculum vel simile aliquid immissum in flammam, utrum ad latera flammae non uratur citius quam in medio flammae.

[164] This circumstance is due to the increased draught produced by the difference between the temperatures of the internal and external air, and, consequently, to the more frequent renewal of the supplies of oxygen which are, ordinarily, a condition of combustion. See note 160 above.

The ideas of exasperation and irritation, as applied to these phenomena, are peculiarly fanciful. [TF]

37. Gradus autem in susceptione caloris sunt complures. Atque primo omnium notandum est, quam parvus et exilis calor etiam ea corpora, quae caloris minime omnium sunt susceptiva, immutet tamen et nonnihil calefaciat. Nam ipse calor manus globulum plumbi aut alicujus metalli paulisper detentum nonnihil calefacit. Adeo facile et in omnibus transmittitur et excitatur calor, corpore nullo modo ad apparentiam immutato.

38. Facillime omnium corporum apud nos et excipit et remittit calorem aër [165]; quod optime cernitur in vitris calendaribus. Eorum confectio est talis [166]: accipiatur vitrum ventre concavo, collo tenui et oblongo; resupinetur et demittatur hujusmodi vitrum, ore deorsum verso, ventre sursum, in aliud vasculum vitreum ubi sit aqua, tangendo fundum vasculi illius recipientis extremo ore vitri immissi, et incumbat paullulum vitri immissi collum ad os vitri recipientis, ita ut stare possit; quod ut commodius fiat, apponatur parum cerae ad os vitri recipientis; ita tamen ut non penitus obturetur os ejus, ne ob defectum aëris succedentis impediatur motus de quo jam dicetur, qui est admodum facilis et delicatus.

[165] As I have before said, air is a bad conductor of heat. It was on account of its expansive and not on account of its conductive capacity that it served roughly as a thermometer, before the substitution, first of alcohol, and then of mercury. [TF]

[166] Mr. Ellis remarks: 'I am very much inclined to think that Bacon heard of the vitrum calendare from Fludde, or à Fluctibus, as he is called in Latin, who returned from Italy in [1605], and in whose philosophy, built upon certain abstract notions of rarefaction and condensation, perpetual reference is made to the air-thermometer, to which he gives the same name.'

As I have already noticed in note 83 on the last Aphorism, the invention of the thermometer has been ascribed to several persons, including Galileo, Drebbel, and, though on insufficient grounds, even Bacon himself. See also Introduction, p. 43, n. 19. Mr. Ellis has a long note on the invention of the Thermometer (Vol. I. p. 255. n. 1). To this note, which is too long for quotation, I must refer the reader who is specially interested in the question. [TF]

Oportet autem ut vitrum demissum, antequam inseratur in alterum, calefiat ad ignem a parte superiori, ventre scilicet. Postquam autem fuerit vitrum illud collocatum, ut diximus, recipiet et contrahet se aër (qui dilatatus erat per calefactionem), post moram sufficientem pro extinctione illius ascititii caloris, ad talem extensionem sive dimensionem qualis erit aëris ambientis aut communis tunc temporis quando immittitur vitrum, atque attrahet aquam in sursum ad hujusmodi mensuram. Debet autem appendi charta angusta et oblonga, et gradibus (quot libuerit) interstincta. Videbis autem, prout tempestas diei incalescit aut frigescit, aërem se contrahere in angustius per frigidum et extendere se in latius per calidum; id quod conspicietur per aquam ascendentem quando contrahitur aër, et descendentem sive depressum quando dilatatur aër. Sensus autem aëris, quatenus ad calidum et frigidum, tam subtilis est et exquisitus ut facultatem tactus humani multum superet; adeo ut solis radius aliquis, aut calor anhelitus, multo magis calor manus, super vitri summitatem positus, statim deprimat aquam manifesto. Attamen existimamus spiritum animalium [167] magis adhuc exquisitum sensum habere calidi et frigidi, nisi quod a mole corporea impediatur et hebetetur.

[167] This remark is in accordance with Bacon's ordinary conception of 'spirit,' and especially of 'vital spirit,' as the most refined and delicate of all substances. In the Historia Vitae et Mortis (Ellis and Spedding, Vol. II. p 215) he regards 'vital spirit' as composed of air and flame. 'Alterum discrimen inter spiritus est; quod spiritus vitalis nonnuliam habeat incensionem, atque sit tanquam aura composita ex flamma et aere.' [TF]

39. Post aërem, existimamus corpora esse maxime sensitiva caloris ea quae a frigore recenter immutata sint et compressa, qualia sunt nix et glacies; ea enim leni aliquo tepore solvi incipiunt et colliquari. Post illa sequitur fortasse argentum vivum. Post illud sequuntur corpora pinguia, ut oleum butyrum, et similia; deinde lignum; deinde

aqua; postremo lapides et metalla, quae non facile calefiunt, praesertim interius [168]. Illa tamen calorem semel susceptum diutissime retinent; ita ut later aut lapis aut ferrum ignitum in pelvim aquae frigidae immissum et demersum, per quartam partem horae (plus minus) retineat calorem, ita ut tangi non possit.

[168] On the different powers of conducting heat possessed by different bodies, see Tyndall's Heat a Mode of Motion, 3rd Ed., §§ 244-250, As a general rule, metals are the best conductors of heat. This is preeminently the case with silver and copper. Iron is comparatively a bad conductor. [TF]

40. Quo minor est corporis moles, eo citius per corpus calidum approximatum incalescit [169]; id quod demonstrat omnem calorem apud nos esse corpori tangibili quodammodo adversum.

[169] In other words, the conduction of heat requires time, which is undoubtedly true. [TF]

41. Calidum, quatenus ad sensum et tactum humanum, res varia est et respectiva: adeo ut aqua tepida, si manus frigore occupetur, sentiatur esse calida; sin manus incaluerit, frigida.

XIV.

Quam inopes simus historiae quivis facile advertet, cum in tabulis superioribus, praeterquam quod loco historiae probatae et instantiarum certarum nonnunquam traditiones et relationes inseramus (semper tamen adjecta dubiae fidei et auctoritatis nota), saepenumero etiam hisce verbis, *fiat experimentum*, vel *inquiratur ulterius*, uti cogamur [170].

[170] In criticising Bacon's instances, this apology should be borne in mind. He ought, at least, to have the benefit of having been aware of the insufficiency and untrustworthiness of his own data. CP. I. 117. [TF]

XV.

Atque opus et officium harum trium tabularum *Comparentiam instantiarum ad intellectum* vocare consuevimus. Facta autem *comparentia*, in opere ponenda est ipsa inductio. Invenienda est enim, super *comparentiam* omnium et singularum instantiarum, natura talis, quae cum natura data perpetuo adsit, absit [171], atque crescat, et decrescat; sitque (ut superius dictum est) limitatio naturae magis communis [172]. Hoc si mens jam ab initio facere tentet affirmative [173] (quod sibi permissa semper facere solet), occurrent phantasmata et opinabilia et notionalia male terminata et axiomata quotidie emendanda; nisi libeat (scholarum more) pugnare pro falsis [174]. Ea tamen proculdubio erunt meliora aut praviora pro facultate et robore intellectus qui

operatur. At omnino Deo (formarum inditori et opifici) aut fortasse angelis et intelligentiis competit formas per affirmationem immediate nosse, atque ab initio contemplationis. Sed certe supra hominem est; cui tantum conceditur, procedere primo per *negativas*, et postremo loco desinere in *affirmativas*, post omnimodam exclusionem.

[171] If both these conditions were satisfied, the case would fall under the Double Method of Agreement, or Joint Method of Agreement and Difference, as it is variously called. It would not then be subject to the characteristic imperfection of the Method of Agreement, arising from Plurality of Causes, as would happen if we were simply able to establish the concomitance of the nature in question ('natura talis') and the 'natura data.' See notes on Aphorism 4 and note 30 on beginning of Aphorism 13. Moreover, if *both* conditions were satisfied, it would be proved that the ascertained cause was not only a cause but *the only* cause of the given phenomenon.

On the Double Method of Agreement, and its relation to the question of Plurality of Causes, the student may refer to the Editor's Inductive Logic, Chapter 3. [TF]

[172] See Aphorism 4. The 'Form' is here regarded as = differentia, that which added to the genus, or common nature, gives its distinctive character to the nature in question. Bacon illustrates his meaning in Aphorism 20, where several ' differentiae' are proposed as limiting/ motus,' which is described as 'instar generis ad calorem.' [TF]

[173] CP. I. 46, 105. [TF]

[174] Alluding to the scholastic disputations, in which both sides of a question were defended, however false or heretical one of them might be regarded as being. [TF]

XVI.

Itaque naturae facienda est prorsus solutio et separatio; non per ignem certe, sed per mentem, tanquam ignem divinum. Est itaque inductionis verae opus primum (quatenus ad inveniendas formas) *rejectio* sive *exclusiva* naturarum singularum, quae non inveniuntur in aliqua instantia, ubi natura data adest [175]; aut inveniuntur in aliqua instantia, ubi natura data abest [176]; aut inveniuntur in aliqua instantia crescere, cum natura data decrescat [177]; aut decrescere, cum natura data crescat [178]. Tum vero post *rejectionem* et exclusivam debitis modis factam, secundo loco (tanquam in fundo) manebit (abeuntibus in fumum opinionibus volatilibus) forma affirmativa, solida, et vera [179], et bene terminata. Atque hoc breve dictu est, sed per multas ambages ad hoc pervenitur. Nos autem nihil fortasse ex iis, quae ad hoc faciunt, praetermittemus.

[175] Owing to the Plurality of Causes, the 'given nature' might be present without the other 'nature,' even though this last was one of the causes capable of producing it. For it might not be the only cause, and, in this particular instance, the 'given nature' might be due to some other cause. Hence, the 'rejection' might be unwarranted.

On the Method of Exclusions or Rejections generally, see Introduction, §9. [TF]

[176] As a cause must produce its effect, unless there be some counteracting cause, the 'rejection,' with this qualification, is warranted. [TF]

[177] The same remark applies to this case as to the last. [TF]

[178] Here again, owing to the consideration of the Plurality of Causes, the 'rejection' might not be justified. Thus, the mortality of a town might increase, while a pestilence was diminishing, providing famine, war, or any other cause of death supervened.

The objection founded on Plurality of Causes, of course, only applies so far as 'Form' is intended to express the same idea as Cause. There can only be one 'essence,' or, in the strict sense of the terms, only one 'differentia' (that is, sum of characteristics) or 'definition' of an object or quality. [TF]

[179] That is, provided all possible causes have been considered, and the rejection has been so exhaustive, that only one cause remains – conditions which it is almost impossible to fulfil. [TF]

XVII.

Cavendum autem est, et monendum quasi perpetuo, ne, cum tantae partes formis videantur a nobis tribui, trahantur ea, quae dicimus, ad formas eas, quibus hominum contemplationes et cogitationes hactenus assueverunt [180].

[180] CP. I. 51, 65. [TF]

Primo enim, de formis copulatis [181], quae sunt (ut diximus) naturarum simplicium conjugia ex cursu communi universi, ut leonis, aquilae, rosae, auri, et hujusmodi, impraesentiarum non loquimur. Tempus enim erit de iis tractandi, cum ventum fuerit ad *latentes processus*, et *latentes schematismos*, eorumque inventionem, prout reperiuntur in substantiis (quas vocant) seu naturis concretis [182].

[181] These are the forms of concrete substances, and, as concrete substances are supposed to be constituted by a number of qualities or 'simple natures,' their forms will be the aggregate of the forms of the simple natures of which they are composed. See Aphorism 5 ad init. to which Bacon here refers. [TF]

[182] Bacon had intended to proceed to these enquiries in a subsequent part of the Novum Organum. See Aphorism 21 ('de variatione inquisitionis pro natura subjecti') and the last paragraph of Aphorism 52. [TF]

Rursus vero, non intelligantur ea quae dicimus (etiam quatenus ad naturas simplices) de formis et ideis abstractis [183], aut in materia non determinatis, aut male determinatis

[184]. Nos enim, quum de formis loquimur, nil aliud intelligimus quam leges illas et determinationes actus puri, quae naturam aliquam simplicem ordinant et constituunt, ut calorem, lumen, pondus, in omnimoda materia et subjecto susceptibili. Itaque eadem res est forma calidi aut forma luminis, et lex calidi sive lex luminis; neque vero a rebus ipsis et parte operativa unquam nos abstrahimus aut recedimus. Quare cum dicimus (exempli gratia) in inquisitione formae caloris, *Rejice tenuitatem*, aut *Tenuitas non est ex forma caloris*; idem est ac si dicamus, *Potest homo superinducere calorem in corpus densum*, aut contra, *Potest homo auferre aut arcere calorem a corpore tenui*.

[183] Referring to the ἰδέαι of Plato and the Forms of the Schoolmen. This paragraph seems to be nothing more than an expansion of the latter part of I. 51, on which see the notes.

This is one of the passages in which 'Form' appears to be most unequivocally used in the sense of 'Law' or 'Cause.' [TF]

[184] CP. De Augmentis Scientiarum III. 4 (Ellis and Spedding, Vol. I. p. 565): 'At manifestum est, Platonem, virum sublimis ingenii (quique veluti ex rupe excelsa omnia circumspiciebat), in sua de Ideis doctrina *Formas esse verum scientiae objectum* vidisse; utcunque sententiae hujus verissiinae fructum amiserit, Formas penitus a Materia abstractas, non in Materia determinatas, contemplando et prensando; unde factum est, ut ad speculationes theologicas diverteret, quod omnem naturalem suam philosophiam infecit et polluit.' [TF]

Quod si cuiquam videantur etiam formae nostrae habere nonnihil abstracti, quod misceant et conjungant heterogenea (videntur enim valde esse heterogenea calor coelestium, et ignis; rubor fixus in rosa aut similibus, et apparens in iride aut radiis opalii aut adamantis; mors ex summersione, ex crematione, ex punctura gladii, ex apoplexia, ex atrophia; et tamen conveniunt ista in natura calidi, ruboris, mortis), is se habere intellectum norit consuetudine et integralitate [185] rerum et opinionibus captum et detentum. Certissimum enim est ista, utcunque heterogenea et aliena, coire in formam [186] sive legem eam, quae ordinat calorem, aut ruborem, aut mortem; nec emancipari posse potentiam humanam et liberari a naturae cursu communi, et expandi et exaltari ad efficientia nova et modos operandi novos, nisi per revelationem et inventionem hujusmodi formarum; et tamen post istam unionem naturae, quae est res maxime principalis, de naturae divisionibus et venis, tam ordinariis quam interioribus et verioribus, suo loco postea dicetur.

[185] The vague, general, or superficial appearances of things. [TF]

[186] It almost seems from this passage as if Bacon had anticipated the objections to his methods, based on the consideration of the Plurality of Causes. But here, as elsewhere, his vague and vacillating use of the word 'Form' makes it exceedingly difficult to attach a precise meaning to his language. It is undeniable, for instance, that the 'nature' of heat, that which constitutes it, its 'essence,' as the Schoolmen would have said, is the same in

all cases; or else we should require two or more distinct words to express the phenomenon. But its efficient causes, the agencies which produce it, may be, and are, several; as, for instance, friction, chemical combination, electricity, etc. Hence, where by 'form' Bacon means, as I think he usually does, 'nature,' there is only one form, and to the question, for example, What is heat? there is, and only can be, one answer. But, where by 'form' he means 'law' or 'cause,' there may be many forms; thus there are, for example, in this sense, as many forms of heat as there are distinct modes of its production. At the same time, we must remember that, if the word 'form' with Bacon is vague and obscure, the word 'law' is so also, and we are not always justified in assuming that the latter word is employed by him in the same sense in which it is usually employed by us. The 'law' of an object or quality may be what we sometimes call the Law of its being,' and thus not differ really from its 'nature.' To add, therefore, to our perplexity with reference to Bacon's employment of the word 'form,' we can seldom be quite certain in which of its two senses, nature or essence, and law or cause, he is using it; and, in fact, sometimes he seems to be using it in both at once. For a further discussion of this subject, see Introduction, § 8. The objections founded on the consideration of the Plurality of Causes would, of course, not apply to 'Form' employed as —Nature. But it need hardly be remarked that a philosophy which confined itself to investigating the 'natures' or 'essences' of things, without taking any account of their causes or the laws which determine their production, would be exceedingly defective on the side of both knowledge and practice. [TF]

XVIII.

Jam vero proponendum est exemplum exclusionis sive *rejectionis* naturarum, quae per tabulas *comparentiae* reperiuntur non esse ex forma calidi; illud interim monendo, non solum sufficere singulas *tabulas* ad *rejectionem* alicujus naturae, sed etiam unamquamque ex instantiis singularibus in illis contentis. Manifestum enim est ex iis, quae dicta sunt, omnem *instantiam contradictoriam* destruere opinabile de forma [187]. Sed nihilominus quandoque perspicuitatis causa, et ut usus *tabularum* clarius demonstretur, *exclusivam* duplicamus aut repetimus.

[187] CP. notes on Aphorism 16. These will shew the qualifications with which Bacon's assertion must be taken. [TF]

Exemplum *exclusivae*, *sive rejectionis naturarum* a forma calidi.

1. Per radios solis, *rejice* naturam elementarem [188].

   [188] That is terrestrial as opposed to celestial, all terrestrial natures being regarded as admitting of resolution into one or more of the four elements. [TF]

2. Per ignem communem, et maxime per ignes subterraneos (qui remotissimi sunt, et plurimum intercluduntur a radiis coelestibus), *rejice* naturam coelestem.

3. Per calefactionem omnigenum corporum (hoc est, mineralium, vegetabilium, partium exteriorum animalium, aquae, olei, aëris, et reliquorum) ex approximatione sola ad ignem aut aliud corpus calidum, *rejice* omnem varietatem sive subtiliorem texturam corporum.

4. Per ferrum et metalla ignita, quae calefaciunt alia corpora, nec tamen omnino pondere aut substantia minuuntur, *rejice* inditionem sive mixturam substantiae alterius calidi.

5. Per aquam ferventem atque aërem, atque etiam per metalla et alia solida calefacta, sed non usque ad ignitionem sive ruborem, *rejice* lucem et lumen [189].

   [189] '*Lux*, id quod *lumine* diffunditur, claritas, fulgor; *Lumen*, id quod splendorem diffundit.' Döderlein, II. 66, as quoted by Dr. Kitchin. [TF]

6. Per radios lunae et aliarum stellarum (excepto sole), *rejice* etiam lucem et lumen.

7. Per *comparativam* ferri igniti et flammae spiritus vini (ex quibus ferrum ignitum plus habet calidi et minus lucidi, flamma autem spiritus vini plus lucidi et minus calidi [190]), *rejice* etiam lucem et lumen.

   [190] Bacon is comparing two disparate phenomena, namely, the heat arising from the *consumption* by fire of spirits of wine with the heat arising from iron, when merely rendered red-hot. If we compare the heat evolved by the *consumption* of both substances, the advantage is greatly on the side of Spirits of Wine. Taking as thermal unit the heat necessary to raise the temperature of a pound of water through *one* degree Centigrade, the thermal units in round numbers disengaged by a pound of Absolute Alcohol and a pound of Iron, while burning in oxygen, are respectively 7180 and 1181. See Ganot's Physics, Translation, 12th Ed., § 484. [TF]

8. Per aurum et alia metalla ignita, quae densissimi sunt corporis secundum totum, *rejice* tenuitatem.

9. Per aërem, qui invenitur ut plurimum frigidus, et tamen manet tenuis, *rejice* etiam tenuitatem.

10. Per ferrum ignitum, quod non intumescit mole [191], sed manet intra eandem dimensionem visibilem, *rejice* motum localem aut expansivum secundum totum.

    [191] This statement is, of course, erroneous. But see notes on Aphorism 24. [TF]

11. Per dilatationem aëris in vitris calendariis et similibus, qui movetur localiter et expansive manifesto, neque tamen colligit manifestum augmentum caloris [192], *rejice* etiam motum localem aut expansivum secundum totum.

    [192] The sole cause of the expansion of the air is its increase in temperature, though, in so small a quantity of air as is contained in a thermometer, the increased temperature is not sensible to the touch. It is the more curious that Bacon should have fallen into this error, when we compare what he says at the beginning of Inst. 38 of Aphorism 13.

    'Secundum totum' here and elsewhere is, of course, opposed to 'per particulas.' It is, perhaps, hardly necessary to notice the perverse interpretation of this expression by Liebig as ' on the whole; ' as if Bacon meant that in the majority of cases, but not in all, expansion enters into the ' form of heat.' See Liebig's answer to Sigwart in the Allgemeine Zeitung (Tchihatchef, p. 159). What Bacon obviously refers to is the motion of the entire body, as distinct from that of the minute particles. CP. Aphorism 20, Tertia Differentia. [TF]

12. Per facilem tepefactionem omnium corporum, absque aliqua destructione aut alteratione notabili, *rejice* naturam destructivam aut inditionem violentam alicujus naturae novae.

13. Per consensum et conformitatem operum similium quae eduntur a calore et a frigore, *rejice* motum tam expansivum quam contractivum secundum totum.

14. Per accensionem caloris ex attritione corporum, *rejice* naturam principialem. Naturam principialem [193] vocamus eam, quae positiva reperitur in natura, nec causatur a natura praecedente.

    [193] Such would be the so-called substance of caloric, which was long supposed to be contained in bodies, and to be the cause of heat. The existence of this supposed substance was disproved by Rumford and Davy. See Tyndall's Heat a Mode of Motion, 3rd Ed., §§ 20-23, and Appendix II. to chap, II. Both Bacon and Locke, however, had already anticipated what is now called the dynamical or mechanical theory of heat.

    'Bacon here anticipates not merely the essential character of the most recent theory of heat, but also the kind of evidence by which it has been established. The proof that caloric does not exist, - in other words that heat is not the manifestation of a peculiar substance diffused through nature, - rests mainly on experiments of friction.' Mr. Ellis' note. [TF]

Sunt et aliae naturae: neque enim tabulas conficimus perfectas, sed exempla tantum.

Omnes et singulae naturae praedictae non sunt ex forma calidi. Atque ab omnibus naturis praedictis liberatur homo in operatione super calidum.

XIX.

Atque in *exclusiva* jacta sunt fundamenta *inductionis* verae, quae tamen non perficitur donec sistatur in affirmativa. Neque vero ipsa *exclusiva* ullo modo perfecta est, neque adeo esse potest sub initiis. Est enim *exclusiva* (ut plane liquet) *rejectio* naturarum simplicium [194]. Quod si non habeamus adhuc bonas et veras notiones [195] naturarum simplicium, quomodo rectificari potest *exclusiva*? At nonnullae ex supradictis (veluti notio naturae elementaris, notio naturae coelestis, notio tenuitatis) sunt notiones vagae, nec bene terminatae. Itaque nos, qui nec ignari sumus nec obliti quantum opus aggrediamur (viz. ut faciamus intellectum humanum rebus et naturae parem), nullo modo acquiescimus in his, quae adhuc praecepimus: sed et rem in ulterius provehimus, et fortiora auxilia in usum intellectus machinamur et ministramus; quae nunc subjungemus. Et certe in *interpretatione naturae* animus omnino taliter est praeparandus et formandus, ut et sustineat se in gradibus debitis certitudinis, et tamen cogitet (praesertim sub initiis) ea quae adsunt multum pendere ex iis quae supersunt.

[194] As opposed to concrete bodies, the forms of which are 'formae copulate.' [TF]

[195] But these notions are themselves to be gained by Induction. See Book I. Aphorisms 14, 18, 40. The fact is that true axioms and sound notions are interdependent and Imply each other. In Mathematics, the work of definition is elementary and comparatively easy, but, in the Physical and Moral Sciences, we must already have made considerable advances, before we can begin to define with any precision, CP. note 99 on I. 59. Our notions become clearer as we ascertain more facts, and, as our notions become clearer, the facts we collect or infer become more pertinent and more pregnant. Hence, I am inclined to think that Bacon did not contemplate two distinct kinds of induction, one for the clearing up of conceptions and another for the establishment of axioms. Mr. Ellis, however (see General Preface, Vol. I. p. 37), is apparently of a different opinion. [TF]

XX.

Attamen quia citius emergit veritas ex errore quam ex confusione, utile putamus, ut fiat permissio intellectui [196], post tres tabulas *comparentiae primae* (quales posuimus) factas et pensitatas, accingendi se et tentandi opus *interpretationis* naturae in affirmativa; tam ex instantiis tabularum, quam ex iis quae alias occurrent. Quod genus tentamenti, *permissionem intellectus*, sive *interpretationem inchoatam*, sive *vindemiationem primam* appellare consuevimus.

[196] Here Bacon advocates the employment of hypothesis, notwithstanding his implied condemnation of it in the First Book. See I. 19, and my note upon it. His remark at the beginning of the present Aphorism is conceived in a far truer and more scientific spirit than the language which (unless we except that of I. 106, q. v.) he has hitherto employed on the subject. To repeat what I have said elsewhere: 'Even though a hypothesis may

ultimately be discovered to be false, it may be of great service in pointing the way to a truer theory. Thus the circular theory of planetary motion, and the supplementary theory of epicycles and eccentrics, undoubtedly contributed to the formation of the hypothesis which was eventually proved to be true. 'Kepler himself tried no less than nineteen different hypotheses, before he hit upon the right one, and his ultimate success was doubtless in no slight degree due to his unsuccessful efforts. There is hardly any branch of science in which it might not be affirmed that, without a number of false guesses, true theories could never have been attained.' Inductive Logic, 4th Ed., p. 98.

Mr. Ellis (in his General Preface, Vol. I. pp. 36, 37) makes the following important remarks on the relation of this Aphorism to the others of the Second Book: 'The phrase Permissio Intellectus sufficiently indicates that in this process the mind is suffered to follow the course most natural to it; it is relieved from the restraints hitherto imposed on it, and reverts to its usual state. In this Vindemiatio we accordingly find no reference to the method of exclusion: it rests immediately on the three tables of Comparentia; and though of course it does not contradict the results of the Exclusiva, yet on the other hand it is not derived from them. If we lose sight of the real nature of this part of the investigation, which is merely introduced by the way ''because truth is more easily extricated from error than from confusion," we also lose sight of the scope and purport of the whole method. All that Bacon proposes henceforth to do is to perfect the Exclusiva; the Vindemiatio prima, though it is the closing member of the example which Bacon makes use of, is not to be taken as the type of the final conclusion of any investigation which he would recognise as just and legitimate. It is only a parenthesis in the general method, whereas the Exclusiva, given in the eighteenth aphorism of the second book, is a type or paradigm of the process on which every true induction (inductio vera) must in all cases depend.' [TF]

Vindemiatio prima de forma calidi.

Animadvertendum autem est, formam rei inesse (ut ex iis quae dicta sunt plane liquet) instantiis universis et singulis, in quibus res ipsa inest [197]; aliter enim forma non esset: itaque nulla plane dari potest *instantia* contradictoria. Attamen longe magis conspicua invenitur forma et evidens in aliquibus *instantiis*, quam in aliis; in iis videlicet, ubi minus cohibita est natura formae et impedita et redacta in ordinem per naturas alias. Hujusmodi autem instantias, *elucescentias* vel instantias ostensivas appellare consuevimus [198]. Pergendum itaque est ad *vindemiationem* ipsam *primam* de forma calidi.

[197] See notes on Aphorisms 16, 17. The argument would have been perfectly correct, not only with reference to 'natures' but also with reference to 'causes,' if he had said that, wherever the supposed form is, there the thing itself must be. Thus, if we start the hypothesis that motion is causally connected with heat, and we find, as a matter of fact, that motion is always attended by an increase of temperature, the hypothesis becomes

an ascertained truth. We can, as I have so frequently stated, argue with certainty from the cause to the effect, but not from the effect to the cause. [TF]

[198] See Aphorism 24. [TF]

> Per universas et singulas instantias, natura cujus limitatio est calor videtur esse motus. Hoc autem maxime ostenditur in flamma, quae perpetuo movetur; et in liquoribus ferventibus aut bullientibus, qui etiam perpetuo moventur. Atque ostenditur etiam in incitatione sive incremento caloris facto per motum; ut in follibus [199], et ventis; de quo vide Instant. 29. Tab. 3. Atque similiter in aliis modis motus, de quibus vide Instant. 28. et 31. Tab. 3. Rursus ostenditur in extinctione ignis et caloris per omnem fortem compressionem, quae fraenat et cessare facit motum; de qua vide Instant. 30. et 32. Tab. 3. Ostenditur etiam in hoc, quod omne corpus destruitur aut saltem insigniter alteratur ab omni igne et calore forti ac vehementi; unde liquido constat, fieri a calore tumultum et perturbationem et motum acrem in partibus internis corporis, qui sensim vergit ad dissolutionem [201].
>
> [199] On this and some of the other instances here alluded to, see notes above. We have now reached a point at which it becomes superfluous to criticise in detail either the instances themselves or the inferences based upon them. [TF]
>
> [201] These facts are well and correctly stated, though Bacon did not know what becomes of the parts of the body, on 'dissolution.' [TF]

Intelligatur hoc quod diximus de motu (nempe, ut sit instar generis ad calorem), non quod calor generet motum, aut quod motus generet calorem (licet et haec in aliquibus [202] vera sint), sed quod ipsissimus calor, sive *quid ipsum* [203] caloris, sit motus et nihil aliud; limitatus tamen per *differentias* quas mox subjungemus, postquam nonnullas cautiones adjecerimus ad evitandum aequivocum.

[202] Heat and motion are not only occasionally, but invariably convertible or capable of passing into each other. [TF]

[203] τὸ τι ἐστί. Here, of course, form is used unequivocally for 'nature' or 'essence.' CP. the expressions below: 'differentias veras, quae limitant motum, et constituunt eum in formam calidi 'forma sive definitio vera caloris.' [TF]

Calidum ad sensum [204] res respectiva est, et in ordine ad hominem non ad universum; et ponitur recte ut effectus caloris tantum in spiritum animalem. Quin etiam in seipso res varia est, cum idem corpus (prout sensus praedisponitur) inducat perceptionem tam calidi quam frigidi; ut patet per Instant. 41. Tab. 3.

[204] ‘Calidum ad sensum’ is here opposed to ‘calor’ the former being an affection of our organism, the latter an affection of the body itself. [TF]

Neque vero communicatio caloris, sive natura ejus transitiva per quam corpus admotum corpori calido incalescit, confundi debet cum forma calidi [205]. Aliud enim est calidum, aliud calefactivum. Nam per motum attritionis inducitur calor absque aliquo calido praecedente, unde excluditur calefactivum a forma calidi. Atque etiam ubi calidum efficitur per approximationem calidi, hoc ipsum non fit ex forma calidi, sed omnino pendet a natura altiore et magis communi; viz. ex natura assimilationis sive multiplicationis sui; de qua facienda est separatim inquisitio [206].

[205] Heat itself is distinct from its production or communication. This is all that Bacon seems to mean. So far as he is here referring to the ‘cause’ of heat, it is to the remote, not to the proximate cause. [TF]

[206] See Aphorism 48, ‘Motus undecimus.’ [TF]

At notio ignis plebeia est, et nihil valet: composita enim est ex concursu qui fit calidi et lucidi in aliquo corpore; ut in flamma communi, et corporibus accensis usque ad ruborem.

Remoto itaque omni aequivoco, veniendum jam tandem est ad *differentias* veras, quae limitant motum et constituunt [207] eum in formam calidi.

[207] In the language of the scholastic logic, the differentia is said to divide the genus and to constitute the species. [TF]

> *Prima* igitur *differentia* ea est, quod calor sit motus expansivus [208], per quem corpus nititur ad dilatationem sui, et recipiendi [209] se in majorem sphaeram sive dimensionem quam prius occupaverat. Haec autem *differentia* maxime ostenditur in flamma; ubi fumus sive halitus pinguis manifesto dilatatur et aperit se in flammam.
>
> [208] In Aphorism 18, Inst. 10, he rejects, ‘motum expansivum, secundum totum,’ and in the third differentia assigned in this Aphorism, he describes heat as ‘motus, non expansivus uniformiter secundum totum, sed expansivus per particulas minores corporis,’ It is difficult, however, to see how the minute particles of a body could be expanded without causing the expansion of the whole body, especially as Bacon (see Aphorism 8) rejected the idea of a vacuum between the particles. As a fact, ail bodies (with a few exceptions, such as water between 32° and 39° Fahrenheit, and bismuth at the moment of solidification) expand with an augmentation of temperature. [TF]

[209] This, which is the reading of the First Edition, is probably a misprint for 'recipiendum,' the reading of the second and most subsequent editions. If we retain 'recipiendi,' it must be governed by 'motus' above. [TF]

Ostenditur etiam in omni liquore fervente, qui manifesto intumescit, insurgit, et emittit bullas; atque urget processum expandendi se, donec vertatur in corpus longe magis extensum et dilatatum quam sit ipse liquor; viz. in vaporem aut fumum aut aerem [210].

[210] CP. an interesting passage on the conversion of solids into liquids, and of liquids into vapours, in Herschel's Discourse on the Study of Natural Philosophy, §§ 357, 358, and see especially note 37 on Aphorism 33. [TF]

Ostenditur etiam in omni ligno et combustibili; ubi fit aliquando exudatio, at semper evaporatio.

Ostenditur etiam in colliquatione metallorum, quae (cum sint corporis compactissimi) non facile intumescunt et se dilatant; sed tamen spiritus eorum [211], postquam fuerit in se dilatatus, et majorem adeo dilatationem concupierit, trudit plane et agit partes crassiores in liquidum. Quod si etiam calor fortius intendatur, solvit et vertit multum ex iis in volatile.

[211] Notice again the curious language which Bacon employs about the 'spirits' of inanimate objects. CP. I. 50, II. 7, II. 40, etc. [TF]

Ostenditur etiam in ferro aut lapidibus; quae licet non liquefiant aut fundantur, tamen emolliuntur. Quod etiam fit in baculis ligni; quae calefacta paululum in cineribus calidis fiunt flexibilia.

Optime autem cernitur iste motus in aëre, qui per exiguum calorem se dilatat continuo et manifesto; ut per Instant. 38. Tab. 3.

Ostenditur etiam in natura contraria frigidi [212]. Frigus enim omne corpus contrahit [213] et cogit in angustius; adeo ut per intensa frigora clavi excidant ex parietibus, aera dissiliant, vitrum etiam calefactum et subito positum in frigido dissiliat et frangatur. Similiter aër per levem infrigidationem recipit se in angustius; ut per Instant. 38. Tab. 3. Verum de his fusius dicetur in inquisitione de Frigido.

[212] Here again we have the conception of cold as a positive quality. [TF]

[213] This statement is not universally true. See note 8 above. Waterpipes, for instance, are often burst by the expansion of ice at the moment of solidification. [TF]

Neque mirum est si calidum et frigidum edant complures actiones communes (de quo vide Instant. 32. Tab. 2), cum inveniantur duae ex sequentibus *differentiis* (de quibus mox dicemus) quae competunt utrique naturae; licet in hac *differentia* (de qua nunc loquimur) actiones sint ex diametro oppositae. Calidum enim dat motum expansivum et dilatantem, Frigidum autem dat motum contractivum et coeuntem.

Secunda differentia est modificatio prioris; haec videlicet, quod calor sit motus expansivus sive versus circumferentiam; hac lege tamen, ut una feratur corpus sursum [214]. Dubium enim non est quin sint motus complures mixti. Exempli gratia; sagitta aut spiculum simul et progrediendo rotat, et rotando progreditur. Similiter et motus caloris simul est et expansivus et latio in sursum.

[214] In gases and liquids, the heated particles, being expanded, and so occupying more space in proportion to their density, ascend, while the particles not yet equally heated remain stationary, or descend. This mode of diffusion of heat is called Convection. See Tyndall's Heat a Mode of Motion, 3rd Ed., §§ 221, 222. There is, of course, no analogous phenomenon in the case of solids. Bacon's example of 'the tongs and poker' is purely fanciful, the idea having probably arisen from the fact that, in order to make them stand upright, they must be planted more firmly in the fire, and so exposed to a larger amount of heat, than when placed horizontally. Moreover, the heat radiated from the fire upwards in the direction of the chimney is usually much greater than that radiated sideways.

It will be seen from what is here said, that this second differentiation is delusive. [TF]

Haec vero *differentia* ostenditur in forcipe, aut bacillo ferreo immisso in ignem: quia si immittatur perpendiculariter tenendo manum superius, cito manum adurit; sin ex latere aut inferius, omnino tardius.

Conspicua etiam est in distillationibus per descensorium; quibus utuntur homines ad flores delicatiores, quorum odores facile evanescunt. Nam hoc reperit industria, ut collocent ignem non subter sed supra, ut adurat minus [215]. Neque enim flamma tantum vergit sursum, sed etiam omne calidum.

[215] Heat being propagated in liquids both by convection and conduction, and more in the former way than the latter, it will be plain from the last note that it ascends in them more quickly than it descends. Hence, a liquid will be warmed more slowly by a fire above than by a fire below. [TF]

Fiat autem experimentum hujus rei in contraria natura frigidi: viz. utrum frigus non contrahat corpus descendendo deorsum, quemadmodum calidum dilatat corpus ascendendo sursum. Itaque adhibeantur duo bacilla ferrea, vel duo tubi

vitrei, quoad caetera pares, et calefiant nonnihil; et ponatur spongia cum aqua frigida, vel nix, subter unam, et similiter super alteram. Existimamus enim celeriorem fore refrigerationem ad extremitates in eo bacillo ubi nix ponitur supra quam in eo ubi nix ponitur subter: contra ac fit in calido.

Tertia differentia ea est; ut calor sit motus, non expansivus uniformiter [216] secundum totum, sed expansivus per particulas minores [217] corporis; et simul cohibitus et repulsus et reverberatus, adeo ut induat motum alternativum [218] et perpetuo trepidantem et tentantem et nitentem et ex repercussione irritatum; unde furor ille ignis et caloris ortum habet.

[216] That is to say, some particles are heated before others, and, consequently, the whole mass is, at any given time, heated unequally in its different parts. This circumstance does not, however, prevent the expansion of the body as a whole,' which must be a necessary consequence of the expansion of even a portion of its constituent particles. See note 8 above. [TF]

[217] It is of importance to notice the precise expression employed here, 'particulas minores corrporis.' In the Quarta Differentia, just below, these 'particulae minores' or 'minutae' are clearly distinguished from the *ultimate* particles of matter ('non ad, extremam subtilitatem, sed quasi majusculae'). There is thus a considerable difference, not indeed of kind but of degree, between Bacon's statement of the Theory of Heat and that of more recent writers, like Tyndall. [TF]

[218] This description seems to be a remarkable anticipation of the Undulatory Theory of Heat. CP. Tyndall, Heat a Mode of Motion, 3rd Ed., § 339: 'Let us now revert for a moment to our fundamental conceptions regarding radiant heat. Its origin is an oscillatory motion of the ultimate particles of matter — a motion taken up by the ether, and propagated through it in waves. The particles of ether in these waves do not oscillate in the same manner as the particles of air, in the case of sound. The air-particles move to and fro, in the direction in which the sound travels; the ether particles move to and fro, *across* the line in which the light travels. The undulations of the air are longitudinal, those of the ether transversal. The ether waves resemble more the ripples of water than they do the aërial pulses which produce sound.' [TF]

Ista vero *differentia* ostenditur maxime in flamma et liquoribus bullientibus; quae perpetuo trepidant, et in parvis portionibus tument, et rursus subsidunt.

Ostenditur etiam in iis corporibus, quae sunt tam durae compagis ut calefacta ut ignita non intumescant aut dilatentur mole; ut ferrum ignitum [219], in quo calor est acerrimus.

[219] See note on Aphorism 18, Inst 10. [TF]

Ostenditur etiam in hoc, quod per frigidissimas tempestates focus ardeat acerrime [220].

[220] See note on Aphorism 13, Inst. 36.

Bacon's theory is in advance of his proofs. Most of the instances collected under this 'Third Differentia' are of little, if any, value towards proving the conclusion. [TF]

Ostenditur etiam in hoc, quod cum extenditur aër in vitro calendari absque impedimento aut repulsione, uniformiter scilicet et aequaliter, non percipiatur calor. Etiam in ventis conclusis, licet erumpant vi maxima, tamen non percipitur calor insignis; quia scilicet motus fit secundum totum, absque motu alternante in particulis. Atque ad hoc fiat experimentum, utrum flamma non urat acrius versus latera quam in medio flammae.

Ostenditur etiam in hoc, quod omnis ustio transigatur per minutos poros corporis quod uritur; adeo ut ustio subruat et penetret et fodicet et stimulet, perinde ac si essent infinitae cuspides acus. Itaque ex hoc illud etiam fit, quod omnes aquae fortes (si proportionatae sint ad corpus in quod agunt) edant opera ignis, ex natura sua corrodente et pungente.

Atque ista *differentia* (de qua nunc dicimus) communis est cum natura frigidi; in quo cohibetur motus contractivus per renitentiam expandendi; quemadmodum in calido cohibetur motus expansivus per renitentiam contrahendi.

Itaque sive partes corporis penetrent versus interius sive penetrent versus exterius, similis est ratio; licet impar admodum sit fortitudo; quia non habemus hic apud nos in superficie terrae aliquid quod sit impense frigidum. Vide Instant. 27. Tab. 9.

Quarta differentia est modificatio prioris: haec scilicet, quod motus ille stimulationis aut penetrationis debeat esse nonnihil rapidus et minime lentus; atque fiat etiam per particulas, licet minutas; tamen non ad extremam subtilitatem, sed quasi majusculas [221].

[221] This last qualification is, of course, erroneous, and seems to have been suggested by the fanciful contrast, drawn below, between time and fire. Heat is a motion of the ultimate particles of matter, whatever the nature of these particles may be. CP. note 17 above. [TF]

Ostenditur haec *differentia* in comparatione operum quae edit ignis cum iis quae edit tempus sive aetas. Aetas enim sive tempus arefacit, consumit, subruit, et

incinerat, non minus quam ignis; vel potius longe subtilius: sed quia motus ejusmodi est lentus admodum et per particulas valde exiles, non percipitur calor.

Ostenditur etiam in comparatione dissolutionum ferri et auri [222]. Aurum enim dissolvitur absque calore excitato; ferrum autem cum vehementi excitatione caloris, licet simili fere intervallo quoad tempus. Quia scilicet in auro, ingressus aquae separationis est clemens et subtiliter insinuans, et cessio partium auri facilis; at in ferro, ingressus est asper et cum conflictu, et partes ferri habent obstinationem majorem.

[222] He is here alluding to the instances given under Aphorisms II (19) and 12 (25), relating to the chemical dissolution of iron and gold respectively. [TF]

Ostenditur etiam aliquatenus in gangraenis nonnullis et mortificationibus carnium; quae non excitant magnum calorem aut dolorem, ob subtilitatem putrefactionis.

Atque haec sit *Prima Vindemiatio*, sive *Interpretatio inchoata* de Forma Calidi, facta per *Permissionem Intellectus*.

Ex *Vindemiatione* autem ista *Prima*, forma sive definitio vera [223] caloris (ejus qui est in ordine ad universum, non relativus tantummodo ad sensum) talis est, brevi verborum complexu: *Calor est motus expansivus, cohibitus, et nitens per partes minores*. Modificatur autem expansio: *ut expandendo in ambitum* [224], *nonnihil tamen inclinet versus superiora* [225]. Modificatur autem et nixus ille per partes; *ut non sit omnino segnis, sed incitatus et cum impetu nonnullo*.

[223] Notice that 'form' is here identified with definition. [TF]

[224] All round, in all directions. [TF]

[225] See note 14 above. [TF]

Quod vero ad Operativam attinet, eadem res est. Nam designatio est talis: *Si in aliquo corpore naturali poteris excitare motum ad se dilatandum aut expandendum; eumque motum ita reprimere et in se vertere, ut dilatatio illa non procedat aequaliter, sed partim obtineat, partim retrudatur; proculdubio generabis calidum*: non habita ratione, sive corpus illud sit elementare (ut loquuntur), sive imbutum a coelestibus [226]; sive luminosum, sive opacum; sive tenue, sive densum; sive localiter expansum, sive intra claustra dimensionis primae contentum; sive vergens ad dissolutionem, sive manens in statu; sive animal, sive vegetabile, sive minerale, sive aqua, sive oleum, sive aër, aut aliqua alia substantia quaecunque susceptiva motus praedicti. Calidum autem ad sensum res eadem est; sed cum analogia [227], qualis competit sensui. Nunc vero ad ulteriora auxilia procedendum est [228].

[226] Spectrum analysis has recently shown that 'celestial' and 'terrestrial' or 'elementary' bodies are of much the same chemical composition. The common opinion in Bacon's time, inherited from the Peripatetics (see De Coelo, I. 3, II. 7, and other places), was that the heavenly bodies are composed of an entirely different substance (a fifth essence, or element) from those which enter into the composition of sublunary bodies. Bacon, while opposing this opinion, admits that there is no doubt 'quin regiones sub luna positae et supra, una cum corporibus quae sub iisdem spatiis continentur, multis et magnis rebus differant.' See Descriptio Globi Intellectualis, Cap. 7 (Ellis and Spedding, Vol. III. p. 748, etc.).

On the expression '*imbutum* a coelestibus,' CP. what Bacon says on Astrology in De Augmentis Scientiarum, III. 4 (Ellis and Spedding, Vol. I. pp. 554-60). [TF]

[227] By this explanation he means that the 'calidum ad sensum' is simply the 'calidum in se' in its *relation* to our senses. 'Calor,' as perceived by us, is modified by the condition of the percipient. [TF]

[228] Mr. Ellis (pp. 266, 267) has an interesting note on various points connected with the 'Inquisitio de forma calidi.' It is too long to quote, but the student may refer to it with advantage, bearing in mind, however, that the dynamical theory of heat has gained considerably in evidence since the time at which Mr. Ellis wrote. Most of the points touched on in this note have been mentioned by me in the course of my own annotations.

The 'ulteriora auxilia' are designed for the purpose of perfecting the 'Exclusiva,' for which purpose the Tables alone are not supposed to be sufficient. The necessary imperfection of his method, in the present state of knowledge, and with the present modes of enquiry, is acknowledged by Bacon himself in Aphorism 19.

To the parenthetical character of the Aphorism just concluded I have already drawn attention in the extracts from Mr. Ellis' General Preface in note 96 above. [TF]

XXI.

Post Tabulas comparentiae primae et rejectionem sive exclusivam, nec non vindemiationem primam factam secundum eas, pergendum est ad reliqua auxilia intellectus circa interpretationem naturae et inductionem veram ac perfectam. In quibus proponendis, ubi opus erit tabulis, procedemus super calidum et frigidum; ubi autem opus erit tantum exemplis paucioribus, procedemus per alia omnia: ut nec confundatur inquisitio, et tamen doctrina versetur minus in angusto.

Dicemus itaque primo loco, de *Praerogativis Instantiarum* [229]: secundo [230], de *Adminiculis Inductionis*: tertio, de *Rectificatione Inductionis*: quarto, de *Variatione Inquisitionis pro Natura Subjecti*: quinto [231], de *Praerogativis Naturarum* quatenus ad inquisitionem, sive de eo quod inquirendum est prius et posterius: sexto, de *Terminis*

Inquisitionis, sive de synopsi omnium naturarum in universo: septimo, de *Deductione ad Praxin*, sive de eo quod est in ordine ad Hominem: octavo [232], de *Parascevis ad Inquisitionem*: postremo autem, de *Scala Ascensoria et Descensoria Axiomatum*.

[229] So called from the 'Tribus Praerogativa' which, being selected by lot, voted first in the 'Comitia Tributa' of the Romans, and thus afforded an indication of the mode in which the other tribes were likely to vote. Its vote also frequently exercised a considerable influence on the succeeding votes.

'By the prerogatives of instances,' says Sir John Herschel (Discourse on the Study of Natural Philosophy, § 190), 'Bacon understands characteristic phenomena, selected from the great miscellaneous mass of facts which occur in nature, and which, by their number, indistinctness, and complication, tend rather to confuse than to direct the mind in its search for causes and general heads of induction. Phenomena so selected on account of some peculiarly forcible way in which they strike the reason, and impress us with a kind of sense of causation or a particular aptitude for generalisation, he considers, and justly, as holding a kind of prerogative dignity, and claiming our first and especial attention in physical enquiries.'

On the more important of these 'praerogativae instantiarum' some excellent remarks and illustrations will be found in Herschel's Discourse, §§ 190-200, Playfair's Preliminary Dissertation to the Encyclopaedia Britannica, Section 2, and Dr. Hippus' Account of the Novum Organum, Part II, in 'the Library of Useful Knowledge (which, however, borrows largely from Playfair's Dissertation). From these sources, I shall, as we proceed, extract what appears to me most valuable.

In the 'General Preface to the Philosophical Works,' Mr. Ellis remarks that 'to the word instance Bacon gives a wide range of signification. It corresponds more nearly to observation than to any other term which is used in modern scientific language.' [TF]

[230] CP. the passage at the end of the book: 'Nunc vero ad *adminicular* et *rectificationes inductionis*, et deinceps ad concreta, et *latentes processus*, et *latmtes schematismos*, et reliqua, quae aphorismo 21. ordine proposuimus, pergendum.' In this passage 'ad concreta' seems to answer to the 'Variatio Inquisitionis pro Natura Subjecti of the text, and, perhaps, 'Latentes Processus et Latentes Schematismi ' to the 'Deductio ad Praxin,' though M. Bouillet refers these also to the Variatio Inquisitionis.

Mr. Ellis (General Preface, p. 43) observes that the practical utility of the prerogative instances would have been explained when Bacon came to speak of the Adminicula Inductionis. M. Bouillet, on the other hand, thinks that the 'Adminicula Inductionis' were to embrace the 'Ministratio ad Sensum' and 'Ministratio ad Memoriam,' mentioned in Aphorism 10. He refers to the conclusion of Aphorisms 42 and 43, and quotes from the Partis Secundae Delineatio the words 'ministratio ad rationem cui niinistrationes duae priores subministrant.' See Ellis and Spedding, Vol. III. p. 553.

In M. Bouillet's note on this Aphorism, there is an attempt to determine the exact character of these missing parts of the Novum Organum, and, where possible, to supply them from other portions of Bacon's works. The attempt is interesting and ingenious, but it is too conjectural, as well as too lengthy, to admit of being reproduced here. The reader, however, would do well to compare with this Aphorism the Partis Secundae Delineatio (Ellis and Spedding, Vol. III. pp. 547-57). [TF]

[231] He seems here to contemplate the arrangement of the simple natures, or, at least, the principal ones, in a kind of hierarchy, according to their relative importance, as in the sixth division he designs an exhaustive enumeration of them. [TF]

[232] Towards this division we have a contribution in the tract printed at the end of the first edition of the Novum Organum, entitled '*Parasceve*,' etc. Bacon expressly says in the Introduction to it: 'Huic autem rei locus proprius foret quum ad *Parasceuas* Inquisitionis ordine deventum fuerit. Hoc vero praevertere, nec locum proprium expectare, consuitius nobis videtur.' [TF]

XXII.

Inter *Praerogativas Instantiarum* [233], primo proponemus *Instantias Solitarias* [234]. Eae autem sunt *solitariae*, quae exhibent naturam de qua fit inquisitio in talibus subjectis, quae nil habent commune cum aliis subjectis, praeter illam ipsam naturam; aut rursus quae non exhibent naturam de qua fit inquisitio in talibus subjectis, quae sunt similia per omnia cum aliis subjectis, praeterquam in illa ipsa natura. Manifestum enim est quod hujusmodi instantiae tollant ambages, atque accelerent et roborent *exclusivam* [235]; adeo ut paucae ex illis sint instar multarum.

[233] In Aphorism 52, these Praerogativae Instantiarum are divided into such as are concerned 'circa partem informativam' (1-20, of which 1-15 'juvant intellectum,' 16-20 'juvant sensum'), and such as are concerned 'circa partem operativam' (21-27). For further subdivisions, see the Aphorism itself.

This portion of the Novum Organum, it must be confessed, is defective in arrangement, nor does it supply any systematic set of rules for the investigation of nature. It consists rather of a miscellaneous collection of remarks, hints, and directions, many of which are exceedingly valuable and suggestive, though often expressed in fanciful language and often illustrated by examples which we should now deem worthless and unscientific. Of Bacon's terminology, however, I may remark that it has at least been so felicitously selected, as in many cases to have left a permanent mark on the language, as, for example, in the expressions 'Crucial Instance,' 'Glaring Instance,' 'Clandestine Instance,' and the like.

In the Partis Secundae Delineatio (Ellis and Spedding, Vol. III. p. 556), the Praerogativa Instantiae together with the Praerogativa Inquisiti are described as constituting the 'inquisitionis contractio,' which has for its office 'ut non tantum in inviis via, sed in viis

compendium, et tanquam linea recta quae per ambages et flexus secet, ex indiciis nostris innotescat.' 'Itaque docebimus primo,' he goes on to say, 'quales sint illae instantiae, sive experimenta, quae ad illuminationem prae caeteris excellant, adeo ut paucae idem quod aliae plures praestent. Hoc enim et moli ipsius historiae, et discurrendi laboribus parcit.' [TF]

[234] Bacon could hardly have commenced with a more promising example of his 'prerogatives.' It is curious that the two divisions of the 'instantiae solitariae' correspond respectively with Mill's Methods of Agreement and Difference. To quote what I have said elsewhere (Inductive Logic, 4th Ed., p. 147): 'In the Method of Difference, the instances agree in everything, except in the possession of two circumstances which are present in the one instance and absent in the other. In the Method of Agreement, the various instances compared (for here we generally require more than two instances) agree in nothing, except in the possession of two circumstances which are common to all the instances.' Here, of course, the 'two circumstances' are the 'natura de qua fit inquisitio' and the assigned cause. The cogency of these methods is almost evident from the statement of them. 'The Method of Agreement,' says Mr. Mill, 'stands on the ground that whatever can be eliminated, is not connected with the phenomenon by any law. The Method of Difference has for its foundation that whatever can not be eliminated, is connected with the phenomenon by a law.' [TF]

[235] The second division, answering to the Method of Difference, does more than this. If its conditions were perfectly satisfied, it would demonstrate the truth of the assigned cause. [TF]

Exempli gratia: si fiat inquisitio de natura *Coloris* [236], *Instantiae Solitariae* sunt prismata, gemmae chrystallinae, quae reddunt colores non solum in se sed exterius supra parietam, item rores, etc. Istae enim nil habent commune cum coloribus fixis in floribus, gemmis coloratis, metallis, lignis, etc., praeter ipsum colorem. Unde facile colligitur, quod color nil aliud sit quam modificatio imaginis lucis immissae et receptae: in priore genere, per gradus diversos incidentiae; in posteriore, per texturas et schematismos varios corporis. Istae autem *Instantiae* sunt *Solitariae* quatenus ad similitudinem [237].

[236] Bacon is no less happy in his example than in his rule. 'He concludes,' says Professor Playfair, 'that colour is nothing else than a modification of the rays of light, produced, in the first case, by the different degrees of incidence; and, in the second, by the texture or constitution of the surfaces of bodies. He may be considered as very fortunate in fixing on these examples; for it was by means of them that Newton afterwards found out the composition of light.' [TF]

[237] It will be noticed that the very expressions 'Method of Agreement' and 'Method of Difference' all but occur in the Text. [TF]

Rursus in eadem inquisitione, venae distinctae albi et nigri in marmoribus, et

variegationes colorum in floribus ejusdem speciei, sunt *Instantiae Solitariae*. Album enim et nigrum marmoris, et maculae albi et purpurei in floribus garyophylli [238], conveniunt fere in omnibus praeter ipsum colorem. Unde facile colligitur, colorem non multum rei habere cum naturis alicujus corporis intrinsecis, sed tantum situm esse in positura partium crassiori et quasi mechanica. Istae autem *Instantiae* sunt *Solitariae*, quatenus ad discrepantiam. Utrunque autem genus *Instantias Solitarias* appellare consuevimus; aut *Ferinas* [239], sumpto vocabulo ab astronomis.

[238] More properly Caryophylla, from καρυόφυλλον. The name, with Bacon, probably designates pinks, carnations, and cloves. [TF]

[239] Dr. Kitchin gives up this word in despair. I have little doubt that Mr. Ellis is right in his conjecture that it is used (possibly by an accidental substitution) for *feralis*,' which is thus defined in the Lexicon Mathematicum of Hieronymus Vitalis, published at Paris in 1668: 'Feralis [S.C.] [239.1], apud Astronomos dicitur planeta, quando fuerit in loco, ubi nullam cum reliquis familiaritatem habet: quod quidem maximum est detrimentum, et potissime attenditur in Luna, quae proinde in eo casu appellatur Agrestis, cursu vacua,' etc. [TF]

[239.1] The abbreviation 'S.C.' has been used only once under the word 'Feralis' in Fowler's comments! I am not sure if it is the same as 'sc.' = "scilicet" = "it is permitted to know" ("namely") or not! [HJ]

XXIII.

Inter praerogativas instantiarum, ponemus secundo loco *Instantias Migrantes* [240]. Eae sunt, in quibus natura inquisita migrat ad generationem, cum prius non existeret; aut contra migrat ad corruptionem, cum prius existeret. Itaque in utraque antistrophe, instantiae tales sunt semper geminae [241]; vel potius una instantia in motu sive transitu, producta ad periodum adversam. At hujusmodi instantiae non solum accelerant et roborant *exclusivam*, sed etiam compellunt *affirmativam* sive *formam* ipsam in angustum. Necesse est enim ut forma rei sit quippiam, quod per hujusmodi *migrationem* indatur, aut contra per hujusmodi *migrationem* tollatur et destruatur. Atque licet omnis exclusio promoveat *affirmativam*, tamen hoc magis directe fit in subjecto eodem quam in diversis. Forma autem (ut ex omnibus quae dicta sunt manifesto liquet) prodens se in uno ducit ad omnia. Quo autem simplicior fuerit *migratio*, eo magis habenda est instantia in pretio. Praeterea *Instantiae Migrantes* magni sunt usus ad partem operativam; quia cum proponant formam copulatam cum efficiente aut privante, perspicue designant praxin in aliquibus; unde facilis etiam est transitus ad proxima. Subest tamen in illis nonnihil periculi, quod indiget cautione; hoc videlicet, ne formam nimis retrahant ad efficientem [242], et intellectum perfundant vel saltem perstringant falsa opinione de forma ex intuitu efficientis. Efficiens vero semper ponitur nil aliud esse quam vehiculum sive deferens formae. Verum huic rei, per exclusivam legitime factam, facile adhibetur remedium [243].

[240] CP. the Tabula Graduum of Aphorism 13, and Mill's Method of Concomitant Variations.

'Bacon's "travelling instances" are those in which the *nature* or quality under investigation "travels," or varies in degree; thus affording an indication of a cause by a gradation of intensity in the effect. One of his instances is very happy, being that of 'paper' [240.1], which is white when dry, but proves less so when wet, and comes nearer to the state of transparency upon the exclusion of the air, and admission of water. In reading this, and many other instances in the Novum Organum, one would almost suppose (had it been written) that its author had taken them from Newton's Optics.

[240.1] This was an unmatched apostrophe! [HJ]

'The travelling instances, as well as what Bacon terms "frontier in stances," are cases in which we are enabled to trace that general law which seems to pervade all nature — the law, as it is termed, of continuity, which is expressed in the well-known sentence, Natura non agit per saltum."' Herschel, §§ 198, 199.

Professor Playfair remarks: 'The mineral kingdom is the great theatre of the *instantiae migrantes*, where the same *nature* is seen in all gradations, from the most perfect state, till it become entirely evanescent. Such are the shells which we see so perfect in figure and structure in limestone, and gradually losing themselves in the finer marbles, till they can no longer be distinguished. The use, also, of one such fact to explain or interpret another, is nowhere so well seen as in the history of the mineral kingdom.'

It may be added, however, that the application of this method to comparative anatomy, to physiology, and to the comparative study of law, morals, politics, art, etc., is, at least, as interesting and instructive as its application to mineralogy. See my Inductive Logic under the head of 'Method of Concomitant Variations.'

At the instant when the phenomenon is actually generated, or actually vanishes, the instance falls under the Method of Difference. See note 48 below. [TF]

[241] That is, as one quality is making its appearance, the other is vanishing; thus, as transparency vanishes, whiteness appears, and vice versa. [TF]

[242] Here Bacon expressly distinguishes between the form and the efficient cause. The efficient conveys the forms, or superinduces it on any given material, but is not to be confounded with it. [TF]

[243] The effect (the 'nature' exhibiting the 'form') will often be found, where the efficient cause has ceased to operate. Hence, by the Method of Exclusion, the form and its efficient may be distinguished. Thus, long after we have ceased to apply friction, a body may remain heated beyond its ordinary temperature. [TF]

Proponendum itaque est jam exemplum *instantiae migrantis*. Sit natura inquisita Candor sive Albedo: instantia *migrans* ad generationem est vitrum integrum et vitrum pulverizatum. Similiter, aqua simplex et aqua agitata in spumam. Vitrum enim integrum et aqua simplex diaphana sunt, non alba; at vitrum pulverizatum et aqua in spuma, alba, non diaphana. Itaque quaerendum quid acciderit ex ista migratione vitro aut aquae [244]. Manifestum enim est formam albedinis deferri et invehi per istam contusionem vitri et agitationem aquae. Nihil autem reperitur accessisse, praeter comminutionem partium vitri et aquae, et aëris insertionem. Neque vero parum profectum est ad inveniendam formam albedinis, quod corpora duo per se diaphana, sed secundum magis et minus (aër scilicet et aqua, aut aër et vitrum), simul posita per minutas portiones exhibeant albedinem, per refractionem inaequalem radiorum lucis [245].

[244] This phenomenon arises from the great number of reflecting surfaces which cause a very much larger proportion of light to be reflected or scattered than transmitted. Another good instance of the phenomenon is to be seen in the globules of turpentine, when mixed with water and shaken in a bottle. [TF]

[245] It is not to the unequal refraction of the rays of light in the air and water, or air and glass, as the case may be, but to the repeated reflexion from so many surfaces, as pointed out in the last note, that the phenomenon of whiteness is due. This reflexion, of course, could not take place, unless the particles were mixed with air. It may be worth adding that Bacon notices the phenomena of Refraction, properly so called, in Sylva Sylvarum, Exps. 761, 762. [TF]

Verum hac in re proponendum est etiam exemplum periculi et cautionis, de quibus diximus. Nimirum facile hic occurret intellectui ab hujusmodi efficientibus depravato, quod ad formam albedinis aër semper requiratur, aut quod albedo generetur tantum per corpora diaphana; quae omnino falsa sunt, et per multas exclusiones convicta [246]. Quin potius apparebit (misso aëre et hujusmodi) corpora omnino aequalia (secundum portiones opticas) dare diaphanum; corpora vero inaequalia per texturam simplicem, dare album; corpora inaequalia secundum texturam compositam, sed ordinatam, dare reliquos colores, praeter nigrum; corpora vero inaequalia per texturam compositam, sed omnino inordinatam et confusam, dare nigrum [247]. Itaque de *instantia migrante* ad generationem in natura inquisita albedinis, propositum est jam exemplum. *Instantia* autem *migrans* ad corruptionem in eadem natura albedinis, est spuma dissoluta, aut nix dissoluta. Exuit enim albedinem et induit diaphanum aqua, postquam fit integrale sine aëre.

[246] In this passage, Bacon seems explicitly to recognise what we call the Plurality of Causes, namely, the fact that an event may be due to various causes or distinct sets of conditions. An argument might hence be deduced in favour of the position that by Form he invariably intends to express nature or essence rather than cause. As I have stated, however, in the Introduction, I believe that the word is employed by him in various shades of meaning in different places. Should it be said that the form is the set of

conditions *immediately* preceding the phenomenon, as it appears to us, and that this is *invariably* the same, it must be borne in mind that, even if we granted this to be the case, the difficulty connected with Plurality of Causes would recur with regard to the set of conditions immediately preceding this, or the set immediately preceding that, and so on; so that it would only be postponed, not eliminated. See my Inductive Logic, 4th ed., pp. 125, 126, n. 4. [TF]

[247] This explanation of the colour of bodies is mere guess-work. We have no sufficient evidence, at least as yet, for determining the conditions on which the absorption of colours by various bodies depends. In Newton's Optics, Book II. pt. III. there is a curious and interesting attempt to determine the same problem. Thus, for instance, Newton thinks that 'The Bigness of the Component Parts of Natural Bodies may be conjectured by their colours; ' that 'for the production of Black, the corpuscles must be less than any of those which exhibit colours;' and that 'microscopes may at length be improved to the discovery of the particles of bodies on which their colours depend, if they are not already in some measure arrived to that degree of perfection.'

There is a long passage on the theory of Colours in Valerius Terminus (Ellis and Spedding, Vol. III. p. 236, etc.). Notwithstanding much that is crude in Bacon's speculations, we have only to compare them with such a book as Telesius de Coloribus, to see on how much firmer ground the physicists of his age were treading than those of the previous generation. [TF]

Neque vero illud ullo modo praetermittendum est, quod sub *Instantiis Migrantibus* comprehendi debeant non tantum illae quae migrant ad generationem et privationem [248], sed etiam illae quae migrant ad majorationem et minorationem; cum illae etiam tendant ad inveniendam formam, ut per definitionem formae superius factam et *tabulam graduum* manifesto liquet. Itaque papyrus, quae sicca cum fuerit alba est, at madefacta (excluso aëre et recepta aqua) minus alba est et magis vergit ad diaphanum, similem habet rationem cum instantiis supradictis.

[248] I have drawn attention above (n. 40) to the correspondence between this 'Prerogative' and the Method of Concomitant Variations. But, strictly speaking, an instance which 'travels to generation or privation,' at least at the precise moment when it actually attains to either the one or the other (that is, when the phenomenon, not having existed before, is produced, or, having existed before, vanishes), falls under the head, not of the Method of Concomitant Variations, but of the Method of Difference. On the close relation of these two methods to each other, see my Inductive Logic, under the head of the Method of Concomitant Variations. [TF]

XXIV.

Inter praerogativas instantiarum, tertio loco ponemus *Instantias Ostensivas*, de quibus in *vindemiatione prima de Calido* mentionem fecimus; quas etiam *Elucescentias* [249], sive *Instantias Liberatas et Praedominantes*, appellare consuevimus. Eae sunt, quae

ostendunt naturam inquisitam nudam et substantivam, atque etiam in exaltatione sua aut summo gradu potentiae suae; emancipatam scilicet, et liberatam ab impedimentis, vel saltem per fortitudinem suae virtutis dominantem super ipsa, eaque supprimentem et coercentem. Cum enim omne corpus suscipiat multas naturarum formas copulatas [250] et in concreto, fit ut alia aliam retundat, deprimat, frangat, et liget; unde obscurantur formae singulae. Inveniuntur autem subjecta nonnulla in quibus natura inquisita prae aliis est in suo vigore, vel per absentiam impedimenti vel per praedominantiam virtutis. Hujusmodi autem *instantiae* sunt maxime *ostensivae* formae. Verum et in his ipsis instantiis adhibenda est cautio, et cohibedus impetus intellectus [251]. Quicquid enim ostentat formam, eamque trudit, ut videatur occurrere intellectui, pro suspecto habendum est, et recurrendum ad *exclusivam* severam et diligentem.

[249] Hence the common name for these instances, 'Glaring Instances.' CP. Aphorism 20 ad init. [TF]

[250] CP. Aphorism 17, and see my note upon the expression, as it occurs there. [TF]

[251] CP. I. 47. There is sometimes a danger lest these 'glaring instances' should produce an undue effect on the mind, to the prejudice of other instances less striking, but, perhaps, equally or more instructive; and hence the need of caution. This is all that Bacon seems to mean. [TF]

Exempli gratia; sit natura inquisita Calidum. *Instantia Ostensiva* motus expansionis, quae (ut superius dictum est) portio est praecipua [252] formae calidi, est vitrum calendare aëris [253]. Etenim flamma, licet manifesto exhibeat expansionem, tamen propter momentaneam extinctionem non ostendit progressum expansionis. Aqua autem fervens, propter facilem transitionem aquae in vaporem et aërem, non tam bene ostendit expansionem aquae in corpore suo. Rursus ferrum ignitum, et similia, tantum abest ut progressum ostendant, ut contra per retusionem et fractionem spiritus per partes compactas et crassas (quae domant et fraenant expansionem) ipsa expansio non sit omnino conspicua ad sensum [254]. At vitrum calendare clare ostendit expansionem in aëre, et conspicuam et progredientem et durantem, neque transeuntem [255].

[252] In Aphorism 20, 'motus expansivus' is given as the 'prima differentia' of heat. [TF]

[253] The thermometer, as exhibiting the expansive power of heat, is a good example of a glaring instance. I add some others.

'If the weight of the air were inquired into, the Torricellian experiment, or the barometer, affords an *ostensive instance*, where the circumstance which conceals the weight of the atmosphere in common cases, namely, the pressure of it in all directions, being entirely removed, that weight produces its full effect, and sustains the whole column of mercury in the tube. The barometer affords also an example of the *instantia migrans*, when the change is not total, but only partial or progressive. If it be the Weight of the air which supports the mercury in the tube of the barometer, when that weight is diminished, the

mercury ought to stand lower. On going to the top of a mountain, the weight of the incumbent air is diminished, because a shorter column of air is to be sustained; the mercury in the barometer ought therefore to sink, and it is found to do so accordingly.

'These are instances in which the action of certain principles is rendered visible by the removal of all the opposing forces. One may be given where it is the distinct and decisive nature of this fact which leads to the result.

'Suppose it were inquired, whether the present land had ever been covered by the sea. If we look at the stratified form of so large a portion of the earth's surface, we cannot but conclude it to be very probable that such land was formed at the bottom of the sea. But the decisive proof is afforded by the shells and corals, or bodies having the perfect shape of shells and corals and of other marine exuviae, which are found imbedded in masses of the most solid rock, and often on the tops of very high mountains.' Playfair, Preliminary Dissertation.

'The laws of crystallography were obscure, and its causes still more so, till Haüy fortunately dropped a beautiful crystal of calcareous spar on a stone pavement, and broke it. In piecing together the fragments, he observed their facets not to correspond with those of the crystal in its entire state, but to belong to another form; and, following out the hint offered by a "*glaring instance*" thus casually obtruded on his notice, he discovered the beautiful laws of the cleavage and the primitive forms of minerals.' Herschel's Discourse, etc., § 191.

In § 365 of the same book, Herschel adduces Magnetism as a 'glaring instance' of polarity, 'and that under circumstances which peculiarly adapt it for the study of this quality.' [TF]

[254] From these remarks, it almost looks as if he thought that ignited iron, etc., do undergo expansion, though the amount of it is imperceptible to us. CP. Aphorism 18, Inst. 10. [TF]

[255] 'And without passing beyond the condition of air;' as water, for instance, transcends its own condition, when it is converted into steam. [TF]

Rursus, exempli gratia, sit natura inquisita Pondus. *Instantia Ostensiva* ponderis est argentum vivum [256]. Omnia enim superat pondere magno intervallo, praeter aurum; quod non multo gravius est [257]. At praestantior instantia est ad indicandam formam ponderis argentum vivum quam aurum; quia aurum solidum est et consistens, quod genus referri videtur ad densum; at argentum vivum liquidum est et turgens spiritu, et tamen multis partibus exuperat gravitate diamantem, et ea quae putantur solidissima. Ex quo ostenditur formam gravis sive ponderosi dominari simpliciter in copia materiae, et non in arcta compage [258].

[256] Dr. Hippus (Account of the Novum Organum, in the Library of Useful Knowledge, pt. II. p. 16) points out that Bacon is not happy in his selection of this instance: 'for gold, which is heavier than quicksilver, becomes fluid also by the application of heat; and quicksilver is solid at a certain temperature.' [TF]

[257] Bacon commits the same mistake in the Historia Densi et Rari. He there makes the ratio of the Specific Gravity of Quicksilver to that of Gold as 19 Den. 9 Gr. to 2p Dem, that is as 19'375 to 20. (Ellis and Spedding, Vol. II. p. 245.) The true ratio is I3'59B to 19'258 of Cast Gold or 19'362 of Stamped Gold, taking the specific gravity of all these substances at zero, as compared with distilled water at 4X. The specific gravity of Platinum is still greater than that of gold. [TF]

[258] This conception of Weight is perfectly correct. Weight, which is the amount of the earth's attraction on a body, depends not on the consistency of the body, but on the amount of matter contained in it. And, as the amount of matter or mass depends partly on the volume and partly on the density, two bodies of equal volume will vary in weight according to their respective densities. [TF]

XXV.

Inter praerogativas instantiarum ponemus quarto loco *Instantias Clandestinas* [259], quas etiam *Instantias Crepusculi* appellare consuevimus. Eae sunt veluti oppositae *instantiis ostensivis*. Exhibent enim naturam inquisitam in infirma virtute, et tanquam in incunabulis et rudimentis suis; tentantem et tanquam primo experientem, sed sub contraria natura latentem et subactam. Sunt autem hujusmodi *instantiae* magni omnino momenti ad inveniendas formas; quia sicut *ostensivae* ducunt facile ad differentias, ita *clandestinae* ducunt optime ad genera [260]; id est, ad naturas illas communes, quarum naturae inquisitae nihil aliud sunt quam limitationes.

[259] 'The contrary of glaring are "clandestine instances," where "the nature sought is exhibited in its weakest and most imperfect state." Of this, Bacon himself has given an admirable example in the cohesion of fluids, as a *clandestine instance* of the "*nature* or quality of consistence, or solidity.'' Yet here, again, the same acute discrimination which enabled Bacon to perceive the analogy which connects fluids with solids, through the common property of cohesive attraction, would, at the same time, have enabled him to draw from it, if properly supported, every consequence necessary to forming just notions of the cohesive force; nor does its reference to the class of clandestine instances at all assist in bringing forward and maturing the final results. When, however, the final result is obtained,— when our induction is complete, and we would verify it,— this class of instances is of great use, being, in fact, frequently no other than that of extreme cases ^ such as we have already spoken of; which, by placing our conclusions, as it were, in violent circumstances, try their temper, and bring their vigour to the test' Herschel's Discourse, § 193.

‘An example of this instance may be given from hydrostatics. If the suspension of water in capillary tubes be inquired into, it becomes very useful to view that effect when it is least, or when the tube ceases to be capillary, and becomes a vessel of a large diameter. The column is then reduced to a slender ring of water, which goes all round the vessel; and this, though now so inconsiderable, has the property of being independent of the size of the vessel, so as to be in all cases the same when the materials are the same. As there can be no doubt that this ring proceeds from the attraction of the sides, and of the part immediately above the water, so there can be no doubt that the capillary suspension, in part at least, is derived from the same cause. An effect of the opposite kind takes place when a glass vessel is filled with mercury.’ Playfair’s Preliminary Dissertation.

I confess that, in the former quotation, I do not quite understand what Sir John Herschel means by saying that ‘its reference to the class of clandestine instances does not at all assist in bringing forward and maturing the final results.’ The mere act of calling it a ‘clandestine instance,’ of course, does not; , but, surely, the fact of noticing the circumstance of cohesion in this extreme case must have contributed largely to forming just notions of the nature and extent of the property. [TF]

[260] These instances, being on the extreme border, serve to determine the range of the genus, as the ‘glaring instances,’ exhibiting a property in its most striking form, serve to direct attention to the most characteristic features of the phenomenon, or, in other words, its differentiae. [TF]

Exempli gratia; sit natura inquisita Consistens, sive se determinans; cujus contrarium est Liquidum, sive fluens [261]. *Instantiae clandestinae* sunt illae quae exhibent gradum nonnullum debilem et infimum consistentis in fluido; veluti bulla aquae, quae est tanquam pellicula quaedam consistens et determinata, facta ex corpore aquae. Similiter stillicidia, quae, si adfuerit aqua quae succedat, producunt se in filum admodum tenue, ne discontinuetur aqua; at si non detur talis copia aquae quae succedere possit, cadit aqua in guttis rotundis, quae est figura quae optime aquam sustinet contra discontinuationem [262]. At in ipso temporis articulo, cum desinit filum aquae et incipit descensus in guttis, resilit ipsa aqua sursum ad evitandam discontinuationem. Quin in metallis, quae cum funduntur sunt liquida sed magis tenacia, recipiunt se saepe guttae liquefactae sursum, atque ita haerent. Simile quoddam est instantia speculorum puerilium, quae solent facere pueruli in scirpis ex saliva, ubi cernitur etiam pellicula consistens aquae. At multo melius se ostendit hoc ipsum in altero illo ludicro puerili, quando capiunt aquam, per saponem factam paulo tenaciorem, atque inflant eam per calamum cavum, atque inde formant aquam tanquam in castellum bullarum; quae per interpositionem aëris inducit consistentiam eo usque ut se projici nonnihil patiatur absque discontinuatione. Optime autem cernitur hoc in spuma et nive, quae talem induunt consistentiam ut fere secari possint; cum tamen sint corpora formata ex aëre et aqua, quae utraque sunt liquida [263]. Quae omnia non obscure innuunt Liquidum et Consistens esse notiones tantum plebeias, et ad sensum; inesse autem revera omnibus corporibus fugam et evitationem se discontinuandi; eam vero in corporibus homogeneis

[264] (qualia sunt liquida) esse debilem et infirmam, in corporibus vero, quae sunt composita ex heterogeneis, magis esse vividam et fortem; propterea quod admotio heterogenei constringit corpora, at subintratio homogenei solvit et relaxat.

[261] Bacon employs interchangeably the terms Fluid and Liquid, which, with us, stand respectively for the genus (including gases) and the species. By 'fluens' he means a liquid. Gases are by him included under 'corpora pneumatica,' as opposed to 'corpora tangibilia.' See Aphorism 40 and Historia Densi et Rari. [TF]

[262] The spheroidal shape is due to the cohesion of the molecules of the water. 'In large masses of liquids, the force of gravity overcomes that of cohesion. Hence liquids acted upon by the former force have no special shape; they take that of the vessel in which they are contained. But in smaller masses cohesion gets the upper hand, and liquids present then the spheroidal form. This is seen in the drops of dew on the leaves of plants; it is also seen when a liquid is placed: on a solid which it does not moisten; as, for example, mercury upon wood. The experiment may also be made with water, by sprinkling upon the surface of the wood some light powder, such as lycopodium or lampblack, and then dropping some water on it' Ganot's Physics, 12th Ed. of Translation, § 84. [TF]

[263] It must be remembered that Bacon was not aware that probably any body may, by a sufficient diminution or increase of temperature, be made solid, liquid, or gaseous. See n. 37 on Aphorism 33. [TF]

[264] Bacon was, of course, in error in supposing that liquids, as such, are more homogeneous than solids. The reason that cohesion is more strongly exerted in solids than in liquids is that its intensity decreases as the temperature increases, being counteracted by the repulsive force due to heat. So far from cohesion being greater in heterogeneous than in homogeneous bodies, it is precisely between molecules of the same nature that it exerts its force. [TF]

Similiter, exempli gratia; sit natura inquisita Attractio, sive Coitio Corporum. *Instantia* circa formam ejus *ostensiva* maxime insignis est magnes. Contraria autem natura attrahenti est non attrahens, licet in substantia simili. Veluti ferrum, quod non attrahit ferrum, quemadmodum nec plumbum plumbum, nec lignum lignum, nec aquam aqua. *Instantia* autem *clandestina* est magnes ferro armatus, vel potius ferrum in magnete armato. Nam ita fert natura, ut magnes armatus in distantia aliqua non trahat ferrum fortius quam magnes non armatus. Verum si admoveatur ferrum, ita ut tangat ferrum in magnete armato, tunc magnes armatus longe majus pondus ferri sustinet quam magnes simplex et inermis, propter similitudinem substantiae ferri versus ferrum [265]; quae operatio erat omnino *clandestina* et latens in ferro, antequam magnes accessisset. Itaque manifestum est formam coitionis esse quippiam quod in magnete sit vividum et robustum, in ferro debile et latens. Itidem notatum est sagittas parvas ligneas absque cuspide ferrea, emissas ex sclopetis grandibus, altius penetrare in materiam ligneam (puta latera navium, ut similia), quam easdem sagittas ferro acuminatas, propter

similitudinem substantiae ligni ad lignum, licet hoc ante in ligno latuerit [266]. Itidem, licet aër aërem aut aqua aquam manifesto non trahat in corporibus integris, tamen bulla approximata bullae facilius dissolvit bullam quam si bulla illa altera abesset, ob appetitum coitionis aquae cum aqua et aëris cum aëre [267]. Atque hujusmodi *Instantiae Clandestinae* (quae sunt usus nobilissimi, ut dictum est) in portionibus corporum parvis et subtilibus maxime se dant conspiciendas. Quia massae rerum majores sequuntur formas magis catholicas et generales; ut suo loco dicetur [268].

[265] The fact is true, but the reason purely fanciful. Mr, Ellis says: 'Before the Novum Organum was published, Galileo had shown' (? maintained) 'that the armature acts by producing a more perfect' contact.' He then refers to the Dialog! del Sistemi massimi, Giornata Terza, Florence Edition of Galileo's Works of 1842, Vol. I. p. 440, It should be pp. 440-2. The true reason why magnetic force is increased by armatures will be found in Ganot's Physics, 12th Ed., § 718.

It is needless to add that this example of a 'Clandestine Instance' is wholly delusive. [TF]

[266] It has been suggested to me by Professor Clifton that, if the facts are correctly stated by Bacon, they are probably due either to the greater velocity with which the wooden arrow would move, in consequence of its lightness, or to the windage in the 'sclopetum' being greater in the case of the tipped arrow than in that of the wooden arrow.

In Henschel's Edition of Du Cange, Paris, 1846, Sclopetum is defined as 'Tormentum bellicum manuale, Gall, escopette' (a 'carbine'). In the first edition of Du Cange, the word does not occur. [TF]

[267] The bursting, or, as is sometimes the case, the union of two bubbles in contact is probably due to a complexity of causes, of which capillary attraction is one. [TF]

[268] See Aphorism 48, Motus Septimus, i.e. 'Motus Congregationis Majoris.' [TF]

XXVI.

Inter praerogativas instantiarum ponemus quinto loco *Instantias Constitutivas* [269], quas etiam *Manipulares* appellare consuevimus. Eae sunt quae constituunt unam speciem naturae inquisitae tanquam Formam Minorem. Cum enim formae legitimae (quae sunt semper convertibiles cum naturis inquisitis) lateant in profundo nec facile inveniantur, postulat res et infirmitas humani intellectus ut formae particulares [270], quae sunt congregativae *Manipulorum* quorundam instantiarum (neutiquam vero omnium) in notionem aliquam communem, non negligantur, verum diligentius notentur. Quicquid enim unit naturam, licet modis imperfectis, ad inventionem formarum viam sternit. Itaque instantiae, quae ad hoc utiles sunt non sunt contemnendae potestatis, sed habent nonnullam praerogativam.

[269] These instances are neither more nor less than subordinate inductions made with the view of leading up to larger inductions, or afterwards employed for that purpose. Notice the expressions 'tanquam formam minorem,' 'formae particulares,' etc.

'"Collective instances,"' says Sir John Herschel, 'in Bacon's classification, are no other than general facts, or laws of some degree of generality, and are themselves the results of induction. But there is a species of collective instance which Bacon does not seem to have contemplated, of a peculiarly instructive character; and that is, where particular cases are offered to our observation in such numbers at once as to make the induction of their law a matter of ocular inspection. For example, the parabolic form assumed by a jet of water, spouted from a round hole, is a *collective* instance of the velocities and directions of the motions of all the particles which compose it *seen at once*, thus leading us, without trouble, to recognise the law of the motion of a projectile. Again, the beautiful figures exhibited by sand, strewed on regular plates of glass or metal set in vibration, are *collective instances* of an infinite number of points which remain at rest while the remainder of the plate vibrates; and in consequence afford us, as it were, a sight of the law which regulates their arrangement and sequence throughout the whole surface. The beautifully coloured lemniscates seen around the optic axes of crystals exposed to polarised light afford a superb example of the same kind, pointing at once to the general mathematical expression of the law which regulates their production. (See Phil. Trans. 1819.) Of such collective instances as these, it is easy to see the importance, and its reason. They lead us to a general law by an induction which offers itself spontaneously, and thus furnish advanced points in our enquiries; and, when we start from these, already a thousand steps are lost."

'A fine example of a collective instance is that of the system of Jupiter or Saturn with its satellites. We have here, in miniature, and seen at one view, a system similar to that of the planets about the sun; of which, from the circumstance of our being involved in it, and unfavourably situated for seeing it otherwise than in detail, we are incapacitated from forming a general idea but by slow progressive efforts of reason. Accordingly, the contemplation of the *circumjovial planets* (as they were called) most materially assisted in securing the admission of the Copernican system.' Discourse, etc., §§ 194-5,

Professor Playfair adduces as examples of 'Collective Instances' the three laws of Kepler, which subsequently, in the hands of Newton, led to the discovery of the great principle of Gravitation. 'These discoveries were all made before Bacon wrote, but he is silent concerning them; for the want of mathematical knowledge concealed from, his view some of the most splendid and interesting parts of science.'

'Astronomy is full of such collective instances, and affords them, indeed, of the second and third order, that is to say, two or three times generalised. The astronomer observes nothing but that a certain luminous disk, or perhaps merely a luminous point, is in a certain position, in respect of the planes of the meridian and the horizon, at a certain moment of time. By comparing a number of such observations, he finds that this luminous point moves in a certain plane, with a certain velocity, and performs a

revolution in a certain time. Thus, the periodic time of a planet is itself a collective fact, or a single fact expressing the result of many hundred observations. This holds with respect to each planet, and with respect to each element, as it is called, of the planet's orbit, every one of which is a general fact, expressing the result of an indefinite number of particulars. This holds still more remarkably of the inferences which extend to the distances of the planet from the earth, or from the sun. The laws of Kepler are therefore collective facts of the second, or even a higher order; or such as comprehend a great number of general facts, each of which is itself a general fact, including many particulars.' Preliminary Dissertation. [TF]

[270] These formae minores or particulares correspond with the axiomata infima or some of the lower degrees of the axiomata media of Book I. (see, for instance, I. 104). They might be described as the definitions of specific (though still general) exemplifications of the nature under examination. CP. the last paragraph of the Aphorism. [TF]

Verum in his diligens est adhibenda cautio, ne intellectus humanus, postquam complures ex istis formis particularibus adinvenerit atque inde partitiones sive divisiones naturae inquisitae confecerit, in illis omnino acquiescat, atque ad inventionem legitimam Formae Magnae se non accingat, sed praesupponat naturam velut a radicibus esse multiplicem et divisam, atque ulteriorem naturae unionem, tanquam rem supervacuae subtilitatis et vergentem ad merum abstractum, fastidiat et rejiciat.

Exempli gratia; sit natura inquisita Memoria [271], sive Excitans et Adjuvans memoriam. *Instantiae constitutivae* sunt, ordo sive distributio, quae manifesto juvat memoriam; item Loci in memoria artificiali, qui aut possunt esse loci secundum proprium sensum, veluti janua, angulus, fenestra, et similia, aut possunt esse personae familiares et notae, aut possunt esse quidvis ad placitum (modo in ordine certo ponantur), veluti animalia, herbae; etiam verba, literae, characteres, personae historicae, et caetera; licet nonnulla ex his magis apta sint et commoda, alia minus. Hujusmodi autem Loci memoriam insigniter juvant, eamque longe supra vires naturales exaltant. Item carmina facilius haerent et discuntur memoriter quam prosa. Atque ex isto *manipulo* trium instantiarum, videlicet ordinis, locorum artificialis memoriae, et versuum, constituitur species una auxilii ad Memoriam. Species autem illa *Abscissio Infiniti* [272] recte vocari possit. Cum enim quis aliquid reminisci aut revocare in memoriam nititur, si nullam praenotionem habeat aut perceptionem ejus quod quaerit, quaerit certe et molitur et hac illac discurrit, tanquam in infinito. Quod si certam aliquam praenotionem habeat, statim abscinditur infinitum, et fit discursus memoriae magis in vicino. In tribus autem illis instantiis quae superius dictae sunt, praenotio perspicua est et certa. In prima videlicet, debet esse aliquid quod congruat cum ordine; in secunda debet esse imago quae relationem aliquam habeat sive convenientiam ad illa loca certa; in tertia, debent esse verba quae cadant in versum. Atque ita abscinditur infinitum. Aliae autem instantiae dabunt hanc alteram speciem; ut quicquid deducat intellectuale ad feriendum sensum [273] (quae ratio etiam praecipue viget in artificiali memoria) juvet memoriam. Aliae instantiae dabunt hanc alteram speciem; ut quae faciunt impressionem in affectu forti, incutientia

scilicet metum, admirationem, pudorem, delectationem, juvent memoriam. Aliae instantiae dabunt hanc alteram speciem; ut quae maxime imprimuntur a mente pura et minus praeoccupata ante vel post, veluti quae discuntur in pueritia aut quae commentamur ante somnum [274], etiam primae quaeque rerum vices, magis haereant in memoria. Aliae instantiae dabunt hanc alteram speciem; ut multitudo circumstantiarum sive ansarum juvet memoriam, veluti scriptio per partes non continuatas, lectio, sive recitatio voce alta. Aliae denique instantiae dabunt hanc alteram speciem; ut quae expectantur et attentionem excitant melius haereant, quam quae praetervolant. Itaque si scriptum aliquod vicies perlegeris, non tam facile illud memoriter disces quam si illud legas decies, tentando interim illud recitare, et ubi deficit memoria inspiciendo librum. Ita ut sint veluti sex Formae Minores eorum quae juvant Memoriam; videlicet abscissio infiniti; deductio intellectualis ad sensibile; impressio in affectu forti; impressio in mente pura; multitudo ansarum; praeexpectatio.

[271] This example is interesting in connexion with I. 127, as shewing that Bacon did not confine his examples any more than the scope of his philosophical reform to what is usually called Natural Philosophy.

On his doctrine of Memory and the Aids to Memory, in general, see De Augmentis Scientiarum, Libro V. Cap. 5.

Most of the mental phenomena as well as the artificial aids to memory here described would now be explained by the doctrine of Association of Ideas. [TF]

[272] In the De Augmentis Scientiarum, the expression 'Praenotio' (which also occurs below) is put forward most prominently to describe this species. 'Praenotionem vocamus abscissionem quandam investigationis infinitae.' [TF]

[273] In the De Augmentis Scientiarum, this species is called 'Emblema,' and is described at greater length than here, as well as illustrated. See the end of Book V. [TF]

[274] The probable cause of this phenomenon (of which some striking instances will be found in Dr. Carpenter's Mental Physiology, Chapter 13) is that we repeatedly recur to these thoughts during sleep, though, on waking, we have forgotten that we did so. It belongs to the class of phenomena described by Leibnitz as 'obscure ideas,' by Hamilton as 'Latent Mental Modifications' by Dr. Carpenter as 'Unconscious Cerebration,' and more happily by Mr. Lewes as 'Subconsciousness.' Awaking at an appointed hour is a good and familiar instance of the power which the mind actually exerts during sleep, though all recollection of its exertion may have passed away. [TF]

Similiter, exempli gratia; sit natura inquisita Gustus, sive Gustatio. *Instantiae* quae sequuntur sunt *Constitutivae*: videlicet, quod qui non olfaciunt, sed sensu eo a natura destituti sunt, non percipiant aut gustu distinguant cibum rancidum aut putridum, neque similiter alliatum aut rosatum, aut hujusmodi [275]. Rursus, illi, qui per accidens nares habent per descensum rheumatis obstructas, non discernunt aut percipiunt aliquid

putridum aut rancidum aut aqua rosacea inspersum. Rursus, qui afficiuntur hujusmodi rheumate, si in ipso momento, cum aliquid foetidum aut odoratum habent in ore sive palato, emungant fortiter, in ipso instanti manifestam perceptionem habent rancidi vel odorati. Quae instantiae dabunt et constituent hanc speciem, vel partem potius gustus; ut sensus gustationis ex parte nihil aliud sit quam olfactus interior, transiens et descendens a narium meatibus superioribus in os et palatum [276]. At contra, salsum et dulce et acre et acidum et austerum et amarum, et similia, haec (inquam) omnia aeque sentiunt illi in quibus olfactus deest aut obturatur, ac quisquam alius; ut manifestum sit sensum gustus esse compositum quiddam ex olfactu interiori et tactu quodam exquisito [277]; de quo nunc non est dicendi locus.

[275] These instances are, perhaps, slightly exaggerated. But, so far as they are true, they are well explained by the following extract from Prof. Bain's 'Senses and Intellect,' 3rd Ed., pp. 158-9: 'Tastes, properly so called, affect only the gustatory nerves, and are therefore the same whether the nostrils are opened or closed. But many sapid bodies are also odorous. In the act of expiration accompanying mastication, especially the instant after degiution, the odorous particles are carried into the cavities of the nose, and affect the sense of smell, or make their odour apparent. This effect is what we term flavour. Some bodies, as cinnamon, have hardly any taste, but a flavour, in other words an odour, brought out by mastication.' [TF]

[276] It must be borne in mind, however, that, though the sensations of smell and taste are closely associated, and their organs are in close proximity, they are still perfectly distinct. [TF]

[277] In the case of both taste and smell, the precise mode of action on the organ is very obscure, but, in each case, it is probably chemical. Touch is, of course, a condition common to all the five external senses, various as they are in their characteristics, and impossible as it is to reduce them, one to the other. [TF]

Similiter, exempli gratia; sit natura inquisita Communicatio Qualitatis absque Commistione Substantiae. Instantia Lucis dabit vel constituet unam speciem communicationis; Calor vero et Magnes alteram. Communicatio enim lucis est tanquam momentanea, et statim perit, amota luce originali. At calidum et virtus magnetica, postquam tramissa fuerint vel potius excitata in alio corpore, haerent et manent ad tempus non parvum, amoto primo movente.

Denique magna est omnino praerogativa *instantiarum constitutivarum*, ut quae plurimum faciant et ad definitiones (praesertim particulares) et ad divisiones sive partitiones naturarum; de quo non male dixit Plato, *Quod habendus sit tanquam pro Deo, qui definire et dividere bene sciat* [278].

[278] See Phaedrus, 266 B: Τούτων δὴ ἔγωγε αὐτός τε ἐραστής, ὦ Φαῖδρε, τῶν διαιρέσεων καὶ συναγωγῶν, ἵν' οἷός τε ὦ λέγειν τε καὶ φρονεῖν" ἐάν τέ τιν' ἄλλον

ἡγήσωμαι δυνατὸν εἰς ἕν καὶ ἐπὶ πολλὰ πεφυκόθ᾽ ὁρᾶν, τοῦτον διώκω κατόπισθε μετ᾽ ἴχνιον ὥστε θεοῖο. [TF]

XXVII.

Inter praerogativas instantiarum ponemus sexto loco *Instantias Conformes* [279], sive *Proportionatas*; quas etiam *Parallelas*, sive *Similitudines Physicas*, appellare consuevimus. Eae vero sunt, quae ostendunt similitudines et conjugationes rerum, non in formis minoribus (quod faciunt *instantiae constitutivae*) sed plane in concreto [280]. Itaque sunt tanquam primi et infimi gradus ad unionem naturae. Neque constituunt aliquod axioma statim ab initio, sed indicant et observant tantum quendam consensum corporum [281]. Attamen licet non multum promoveant ad inveniendas formas, nihilominus magna cum utilitate revelant partium universi fabricam, et in membris ejus exercent veluti anatomiam quandam; atque proinde veluti manu ducunt interdum ad axiomata sublimia et nobilia, praesertim illa quae ad mundi configurationem pertinent, potius quam ad naturas et formas simplices [282].

[279] This very important class of instances consists of 'Analogies' drawn from objects or qualities in many respects dissimilar — at all times one of the most fertile sources of suggestion both for scientific discoveries and practical inventions. The imaginative and truly philosophical type of mind which is adapted to note these resemblances is well described by Bacon in I. 55.

Professor Playfair, giving examples of these instances, says: 'Such are the telescope and microscope, in the works of art, compared with the eye in the works of nature. This, indeed, is an analogy which goes much beyond the mere exterior; it extends to the internal structure, and to the principle of action, which is the same in the eye and in the telescope, — to the *latent schematism*, in the language of Bacon, as far as material substance is concerned. It was the experiment of the *camera obscura* which led to the discovery of the formation of the images of external objects in the bottom of the eye by the action of the crystalline lens and the other, humours of which the eye is formed.

'Among the instances of conformity, those are the most useful which enable us to compare productions of an unknown formation, with similar productions of which the formation is well understood. Such are basalt, and the other trap rocks, compared with the lava thrown out from volcanoes. They have a structure so exactly similar, that it is hardly possible to doubt that their origin is the same, and that they are both produced by the action of subterraneous fire. There are, however, amid their similarity, some very remarkable differences in the substances which they contain, the trap rocks containing calcareous spar, and the lava never containing any. On the supposition that they are both of igneous origin, is there any circumstance, in the conditions in which heat may have been applied to them, which can account for this difference? Sir James Hall, in a train of most philosophical and happily-contrived experiments, has explained the nature of those conditions, and has shown that the presence of calcareous spar, or the want of it, may arise from the greater or less compression under which the fusion of the basalt was

performed. This has served to explain a great difficulty in the history of the mineral kingdom.

'Comparative anatomy is full of analogies of this kind, which are most instructive and useful guides to discovery. It was by remarking in the blood-vessels a contrivance similar to the valves used in hydraulic engines, for preventing the counter-current of a fluid, that Harvey was led to the discovery of the circulation of the blood. The analogies between natural and artificial productions are always highly deserving of notice.' Preliminary Dissertation.

It is by the bold use of analogies of this kind that modern physicists have been able to trace the correlations of the various physical forces; that modern philologists have, been able to refer to the same families, languages of apparently the most dissimilar character; and that modern jurists and moralists have detected in laws, institutions, customs, and feelings amongst the most widely scattered races and at the most various stages of civilisation a common origin and a common meaning. Though the strict use of logical method is indispensable to demonstration and verification, it is the observation of analogies, and those often very remote ones, that generally sets us on the track of great discoveries. [TF]

[280] That is, they are concerned with individual observations, and not with inductive generalisations, as are the Instantiae Constitutivae. [TF]

[281] They serve to suggest axioms, rather than to establish them. See note 79. It is curious that considerations of this kind did not lead Bacon to attach greater importance to the office of the Imagination in scientific discovery. [TF]

[282] This is hardly the case. Analogy has played an important part in suggesting the laws of Light, Heat, Sound, Electricity, Gravitation, etc. [TF]

Exempli gratia; Instantiae Conformes sunt quae sequuntur: speculum, et oculus; et similiter fabrica auris, et loca reddentia echo. Ex qua conformitate, praeter ipsam observationem similitudinis, quae ad multa utilis est, proclive est insuper colligere et formare illud axioma; videlicet, organa sensuum et corpora quae pariunt reflexiones ad sensus esse similis naturae. Rursus ex hoc ipso admonitus intellectus non aegre insurgit ad axioma quoddam altius et nobilius. Hoc nimirum; nihil interesse inter consensus sive sympathias corporum sensu praeditorum, et inanimatorum sine sensu, nisi quod in illis accedat spiritus animalis [283] ad corpus ita [284] dispositum, in his autem absit. Adeo ut quot sint consensus [285] in corporibus inanimatis, tot possint esse sensus in animalibus, si essent perforationes in corpore animato ad discursum spiritus animalis in membrum rite dispositum, tanquam in organum idoneum. Et rursus, quot sint sensus in animalibus, tot sint proculdubio motus in corpore inanimato ubi spiritus animalis abfuerit; licet necesse sit multo plures esse motus in corporibus inanimatis quam sensus in animatis, propter paucitatem organorum sensus. Atque hujus rei ostendit se exemplum valde manifestum in doloribus. Etenim quum sint plura genera doloris in

animalibus, et tanquam varii illius characteres (veluti alius est dolor ustionis, alius frigoris intensi, alius puncturae, alius compressionis, alius extensionis, et similium), certissimum est omnia illa, quoad motum, inesse corporibus inanimatis; veluti ligno aut lapidi, cum uritur, aut per gelu constringitur, aut pungitur, aut scinditur, aut flectitur, aut tunditur, et sic de aliis; licet non subintrent sensus, propter absentiam spiritus animalis.

[283] See note on 'spiritus animalium' in Aphorism 13. Inst. 38, and the passage in the Historia Vitae et Mortis (Ellis and Spedding, Vol. II. pp. 214, 215) there referred to. In the latter passage. Bacon distinguishes between the 'spiritus mortuales,' and the 'spiritus vitalis' (or animatus) which is 'superadded' in all animated beings.

In II. 40 there are some extremely curious speculations on 'actio et motus spiritus, qui includitur in corporibus tangibilibus.' CP. also I. 50, with note 82. [TF]

[284] Dr. Kitchin proposes (I think needlessly) to read 'rite." 'Ita dispositum' means 'so disposed as to receive impressions,' 'disposed accordingly.' [TF]

[285] On 'Operationes per consensus aut fugas (qui sextus modus operandi est),' see II, 50. CP. also 'Aditus ad Historiam Sympathiae et Antipathiae Rerum" (Ellis and Spedding, Vol. II. p. 81), Sylva Sylvarum, Exps. 800—830. [TF]

Item *instantiae conformes* (quod mirum fortasse dictu) sunt radices et rami plantarum. Omne enim vegetabile intumescit, et extrudit partes in circumferentiam, tam sursum quam deorsum. Neque alia est differentia radicum et ramorum, quam quod radix includatur in terra, et rami exponantur aëri et soli [286]. Si quis enim accipiat ramum tenerum et vegetum arboris, atque illum reflectat in aliquam terrae particulam, licet non cohaereat ipsi solo, gignit statim non ramum, sed radicem. Atque vice versa, si terra ponatur superius, atque ita obstruatur lapide aut aliqua dura substantia, ut planta cohibeatur nec possit frondescere sursum, edet ramos in aërem deorsum.

[286] This is, of course, an error, but it is not entirely without excuse, 'In the young state there is no distinction between stem and root, as regards structure; both being cellular, and an extension of each other in opposite directions. The root is afterwards distinguished from the stem, by the want of a provision for the development of leaf-buds, and by increasing from above downwards. Such plants, however, as the Moutan Paeony, the Plum-tree, Pyrus Japonica, and especially Anemone Japonica, have a power of forming buds on their roots.' Balfour's Manual of Botany, § II9.

M. Bouillet, speaking of this example and of some of those given below, says: 'Ne trouve-t-on pas dans toutes ces indications le germe de deux théories qui ont été développées de nos jours avec un grand succés, celle des métamorphoses des organes des plantes, qu'ont defendues Goethe et M. de Candolle, et celle des analogues, qui a fait l'objet spécial des etudes de M. Geoffroy-St.-Hilaire?' [TF]

Item *instantiae conformes* sunt gummi arborum, et pleraeque gemmae rupium [287]. Utraque enim nil aliud sunt quam exudationes et percolationes succorum: in primo genere scilicet, succorum ex arboribus; in secundo, ex saxis; unde gignitur claritudo et splendor in utrisque, per percolationem nimirum tenuem et accuratam. Nam inde fit etiam, quod pili animalium non sint tam pulchri et tam vividi coloris quam avium plumae complures: quia succi non tam delicate percolantur per cutem quam per calamum.

[287] This is simply a fancy, and, like some of Bacon's other instances in this Aphorism, is an example of false rather than of true Analogy. Gems are due to Crystallisation. [TF]

Item *instantiae conformes* sunt scrotum in animalibus masculis, et matrix in femellis. Adeo ut nobilis illa fabrica per quam sexus differunt (quatenus ad animalia terrestria), nil aliud videatur esse, quam secundum exterius et interius [288]; vi scilicet majore caloris genitalia in sexu masculo protrudente in exterius, ubi in femellis nimis debilis est calor quam ut hoc facere possit; unde accidit quod contineantur interius.

[288] 'his remark seems to have been suggested by a similar passage in Telesius, De Rerum Natura, vi. 18: — "Masculo . . . . magnus datus est calor, qui et membrum genitale foras propellat et sanguinem multum beneque omnem compactum conficiat, etc. Foeminae autem . . . . languens inditus est calor, qui neque genitale vas foras propellere nec e semine spiritum educere queat." The doctrine however of this passage was first taught by Galen, from whom Telesius derived it. See Galen, *De Usu Partium*, XIV. 6.' Mr. Ellis' note. It hardly needs to be observed that this fancy has no foundation in fact. [TF]

Item *instantiae conformes* sunt pinnae piscium [289], et pedes quadrupedum, aut pedes et alae volucrum; quibus addidit Aristoteles quatuor volumina in motu serpentum [290]. Adeo ut in fabrica universi motus viventium plerunque videatur expediri per quaterniones artuum sive flexionum.

[289] This analogy, so far as birds, quadrupeds, and fishes are concerned, is a good one. It occurs both in Aristotle and Pliny. See Aristotle, Historia Animalium, I. 5 (Berlin Ed., p. 490 a. 26, etc.): Κινεῖται δὲ τὰ κινούμενα πάντα τέτταρσι σημείοις ἢ πλείοσι, τὰ μὲν ἔναιμα τέτταρσι μόνον, οἷον ἄνθρωπος μὲν χερσὶ δυσὶ καὶ ποσὶ δυσίν, ὄρνις δὲ πτέρυξι δυσὶ καὶ ποσὶ δυσί, τὰ δὲ τετράποδα καὶ ἰχθύες τὰ μὲν τέτταρσι ποσίν, οἱ δὲ τέτταρσι πτερυγίοις. "Oca δὲ δύο ἔχει πτερύγια ἢ ὅλως pH, οἷον ὄφις, τέτταρσι σημείοις οὐθὲν ἧττον" ai γὰρ καμπαὶ τέτταρες, ἢ δύο σὺν τοῖς πτερυγίοις. Ὅσα δ' ἄναιμα ὄντα πλείους πόδας ἔχει, εἴτε πτηνὰ εἴτε πεζά, σημείοις κινεῖται πλείοσιν, κιτιλ. CP. De Incessu Animalium, I. 7, 8 (Berlin Ed., pp. 707-8). See also Pliny, Naturalis Historia IX. Chapter 20 (sect. 73): 'Ideo pinnarum quoque fiunt discrimina, quae pedum vice sunt datae piscibus: nullis supra quaternas: quibusdam binae, aliquibus nullae. In Fucino tantum lacu piscis est, qui octonis pinnis natat.' [TF]

[290] See the two passages from Aristotle referred to in the last note. This is a 'glaring instance' of the tendency of the human mind 'supponere majorem ordinem et

aequalitatem in rebus quam invenit' et 'affingere paralleia et correspondentia et relativa quae non sunt.' [TF]

Item dentes in animalibus terrestribus, et rostra in avibus, sunt *instantiae conformes*; unde manifestum est, in omnibus animalibus perfectis fluere duram quandam substantiam versus os.

Item non absurda est similitudo et conformitas illa, ut homo sit tanquam planta inversa. Nam radix nervorum et facultatum animalium est caput; partes autem seminales sunt infirmae, non computatis extremitatibus tibiarum et brachiorum. At in planta, radix (quae instar capitis est) regulariter infimo loco collocatur; semina autem supremo. Denique illud omnino praecipiendum est et saepius monendum; ut diligentia hominum in inquisitione et congerie Naturalis Historiae deinceps mutetur plane, et vertatur in contrarium ejus quod nunc in usu est. Magna enim hucusque atque adeo curiosa fuit hominum industria in notanda rerum varietate atque explicandis accuratis animalium, herbarum, et fossilium differentiis; quarum pleraeque magis sunt lusus naturae quam seriae alicujus utilitatis versus scientias. Faciunt certe hujusmodi res ad delectationem, atque etiam quandoque ad praxin; verum ad introspiciendam naturam parum aut nihil. Itaque convertenda plane est opera ad inquirendas et notandas rerum similitudines et analoga, tam in integralibus quam partibus. Illae enim sunt quae naturam uniunt, et constituere scientias incipiunt [291].

[291] These remarks are hardly worthy of Bacon's penetration. To the successful investigation of science it is quite as essential to note the differences as the resemblances of things. His contrast of the two opposed mental types in I. 55 is far juster and sounder than this paragraph. [TF]

Verum in his omnino est adhibenda cautio gravis et severa; ut accipiantur pro *instantiis conformibus* et *proportionatis* illae, quae denotant similitudines (ut ab initio diximus) physicas; id est, reales et substantiales et immersas in natura, non fortuitas et ad speciem; multo minus superstitiosas aut curiosas, quales naturalis magiae scriptores [292] (homines levissimi, et in rebus tam seriis quales nunc agimus vix nominandi) ubique ostentant; magna cum vanitate et desipientia, inanes similitudines et sympathias rerum describentes atque etiam quandoque affingentes.

[292] CP. De Augmentis Scientiarum, III. 5, and Aditus ad Historiam Sympathiae et Antipathiae Rerum (Ellis and Spedding, Vol. II. p. 81). [TF]

Verum his missis, etiam in ipsa configuratione mundi in majoribus non sunt negligendae *instantiae conformes*; veluti Africa, et regio Peruviana cum continente se porrigente usque ad Fretum Magellanicum. Utraque enim regio habet similes isthmos et similia promontoria, quod non temere accidit [293].

[293] Bacon seems to be comparing the western or *corresponding* sides of the two continents. The conformity of the *opposite* sides is also remarkable, the projections on one side answering roughly to the recesses on the other. [TF]

Item Novus et Vetus Orbis; in eo quod utrique orbes versus septentriones lati sunt et exporrecti, versus austrum autem angusti et acuminati [294].

[294] Humboldt discusses these and similar phenomena at some length. See Col. Sabine's Translation of the Kosmos, Vol. I. p. 280, etc. While acknowledging that 'little can be ascertained by investigation respecting the causal connection of the great phenomena appertaining to the formation of our continents, and to the analogies and contrasts presented by their configuration,' he suggests two principal causes, acting in succession, which may have determined such configuration. 'Slight disturbances in the equilibrium of the elastic forces in the interior of our planet may have determined their action more towards the northern than the southern hemisphere, and have occasioned the elevation of the dry land in the eastern hemisphere in the form of a wide connected mass, having its major axis almost parallel to the equator,— and, in the western and more oceanic hemisphere, in a comparatively narrow band, following the direction of the meridian.' Again, 'Our Atlantic Ocean presents the characteristics of a valley. It is as if the flow of the waters had been directed first towards the north-east, then towards the north-west, and then again towards the north-east. The parallelism of the coasts north of 10° of South latitude, the projecting and re-entering angles, the convexity of Brazil opposite to the Gulf of Guinea, and the convexity of Africa to the Gulf of Mexico, all favour this view, which at first may seem too hazardous. In the Atlantic Valley, as is indeed usually the case in the form of large masses of land, coasts deeply indented and fringed with many islands are placed opposite to those of a contrary character.' [TF]

Item *instantiae conformes* nobilissimae sunt frigora intensa in media (quam vocant) aëris regione, et ignes acerrimi qui saepe reperiuntur erumpentes ex locis subterraneis; quae duae res sunt ultimitates et extrema; naturae scilicet frigidi versus ambitum coeli, et naturae calidi versus viscera terrae [295]; per antiperistasin [296], sive rejectionem naturae contrariae.

[295] It is true that the higher we ascend in the atmosphere, the colder it is, and the lower we descend into the interior of the earth, the warmer it is; but these two sets of facts depend on different causes, and hence they do not really constitute an Instantia Conformis.

On the internal heat of the earth and the causes- of volcanoes and earthquakes, see Lyell's Principles of Geology, Chapters on the Causes of Earthquakes and Volcanoes (12th Ed., Chapters 32, 33). [TF]

[296] CP. II. 12. Inst. 24. The word ἀντιπερίστασις is of not uncommon occurrence in Aristotle. See, for instance, Physics, VIII. 10 (p. 267 a. 16): διὸ καὶ ἐν ἀέρι καὶ ἐν ὕδατι γίνεται ἡ τοιαύτη κίνησις, ἣν λέγουσί τινες ἀντιπερίστασιν εἶναι. Meteorologica, I. 12 (p.

348 b. 2): ἀλλ᾽ ἐπειδὴ ὁρῶμεν ὅτι γίνεται ἀντιπερίστασις τῷ θερμῷ καὶ τῷ ψυχρῷ ἀλλήλοις. On the former passage, Bonitz quotes the following definition from Simplicius: ἀντιπερίστασίς ἐστιν, ὅταν ἐξωθουμένου τινὸς σώματος ἀνταλλαγὴ γένηται τῶν τόπων, καὶ τὸ μὲν ἐξωθῆσαν ἐν τῷ τοῦ ἐξωθηθέντος στῇ τοπῷ, τὸ δ᾽ ἐξωθηθὲν τὸ προσεχὲς ἐξωθῆ, ἕως ἂν τὸ ἔσχατον ἐν τῷ τόπῳ γένηται τοῦ πρώτου ἐξωθήσαντος. [TF]

Postremo autem in axiomatibus scientiarum [297] notatu digna est *conformitas instantiarum*. Veluti tropus rhetoricae, qui dicitur *Praeter Expectatum*, conformis est tropo musicae, qui vocatur *Declinatio Cadentiae* [298]. Similiter, postulatum mathematicum [299], ut *quae eidem tertio aequalia sunt etiam inter se sint aequalia*, conforme est cum fabrica syllogismi in logica, qui unit ea quae conveniunt in medio [301]. Denique multum utilis est in quamplurimis sagacitas quaedam in conquirendis et indagandis conformitatibus et similitudinibus physicis.

[297] These are the 'Axiomata quae particularium scientiarum non sint propria, sed pluribus earum in commune competant' which constitute one division of the Pliilosophia Prima. See De Augmentis Scientiarum, III. I. Aristotle employs the word ἀξιώματα in a similar, though not exactly the same sense, for the principles or pre-suppositions common to all sciences. See note on I. 7. A still nearer parallel would be the 'mathematical axioms,' so far as they are common to the sciences of arithmetic and geometry. [TF]

[298] 'Is not the trope of music, to avoid or slide from the close or cadence, common with the trope of rhetoric of deceiving expectation?' Advancement of Learning, Book II. (Ellis and Spedding, Vol. III. pp. 348-9). 'Tropus ille Musicus, a clausula aut cadentia (quam vocant), cum jamjam adesse videatur, placide elabendi, convenit cum tropo Rhetorico expectationem eiudendi.' De Augmentis Scientiarum III. I. The following note, communicated by Professor Sir F. A. Gore Ouseley, I borrow from Dr. Kitchin: 'At first I thought it meant a "Cadenza d' Inganno," or "false cadence;'' but I have now satisfied myself that such a thing was unknown in Bacon's time. I am rather inclined to think it refers to a species of false close, such as we find in the last bar but two of Tallis's Nunc dimittis in D, where the Harmony proceeds to $\frac{4}{5}$ and $\frac{5}{3}$ on A for a Bass, as though it were about to close immediately on the chord of D; when suddenly the Tenor strikes a C□, which necessitates a modulation into the chord of G, thus leading to a "Plagal Close." ' [TF]

[299] Generally, and more properly called an Axiom. [TF]

[301] 'Quae in eodem tertio conveniunt, et inter se conveniunt, regula est itidem ex Mathematicis; verum simul tarn potens in Logica, ut syllogismi sit fundamentum.' De Augmentis Scientiarum III. I. There, and in the corresponding passage of the Advancement of Learning, several other examples of these 'Axioms' are given.

The Mathematical Axiom that 'things which are equal to the same thing are equal to one another' is, strictly speaking, only applicable to Logic, if we quantify the predicate. But

the dictum de omni et nullo, the maxim 'nota notae est nota rei ipsius,' and syllogistic principles such as the 'Canon of Reasoning in the First Figure' which I have given in my Deductive Logic (9th Ed., p. 94), are analogous ('conformia') to it. In the passage in the text, this is all that Bacon's language implies.

The later examples in this Aphorism supply another illustration of I. 127. CP. Aphorisms 26, 35. [TF]

XXVIII.

Inter *praerogativas instantiarum*, ponemus septimo loco *Instantias Monodicas* [302]; quas etiam *Irregulares* sive *Heteroclitas* (sumpto vocabulo a grammaticis) appellare consuevimus. Eae sunt, quae ostendunt corpora in concreto, quae videntur esse extravagantia et quasi abrupta in natura, et minime convenire cum aliis rebus ejusdem generis. Etenim *instantiae conformes* sunt similes alterius, at instantiae monodicae sunt sui similes. Usus vero *instantiarum monodicarum* est talis qualis est instantiarum clandestinarum: viz. ad evehendam et uniendam naturam ad invenienda genera sive communes naturas, limitandas postea per differentias veras. Neque enim desistendum ab inquisitione donec proprietates et qualitates, quae inveniuntur in hujusmodi rebus quae possunt censeri pro miraculis naturae, reducantur et comprehendantur sub aliqua forma sive lege certa: ut irregularitas sive singularitas omnis reperiatur pendere ab aliqua forma communi; miraculum vero illud sit tandem solummodo in differentiis accuratis et gradu et concursu raro, et non in ipsa specie: ubi nunc contemplationes hominum non procedant ultra quam ut ponant hujusmodi res pro secretis et magnalibus naturae, et tanquam incausabilibus, et pro exceptionibus regularum generalium [303].

[302] Properly 'monadicas.' See note on I. 45. In the edition of the Novum Organura, published at Amsterdam in 1660, 'monadica' is read throughout the Second Book, though, curiously, the correction is not made in the First Book.

Comets, Double Stars, the occasional crescent-shape of Venus, of Mercury, and of the Moon, Earthquakes, Volcanoes, Cyclones, Meteoric Stones, the peculiarities in the relation between the expansion and temperature of water as well as of bismuth and the casting-metals generally, are all good examples of what Bacon means by these instances. Similarly, in law, we might adduce as 'monadic instances' Gavelkind and Borough English, or, in moral sentiment, Suttee, Duelling, the Levirate, etc. It is sometimes indifferent whether we refer an example to this head or the next of Instantiae Deviantes, as is the case with one or two of the examples given above. [TF]

[303] These remarks are truly philosophical. We ought never to rest till exceptions are explained, and, when explained, they will usually be found to fall under some general law of nature, or, in the case of moral and social phenomena, to be what Dr. Tylor has happily called 'survivals' of some state of things which was far more general in the past. The history of language, it may be noticed, is peculiarly rich in phenomena of this kind.

Sir John Herschel illustrates this instance as follows: 'The discovery of the magnetism of nickel, which, though inferior to that of iron, is still considerable; that of cobalt, yet feebler, and that of titanium, which is only barely perceptible, have effectually broken down the imaginary limit between iron and the other materials of the world, and established the existence of that general law of continuity which it is one chief business of philosophy to trace throughout nature. The more recent discoveries of M. Arago have completed this generalisation, by showing that there is no substance but which, under proper circumstances, is capable of exhibiting unequivocal signs of magnetic virtue. And to obliterate all traces of that line of separation which was once so broad, we are now enabled, by the great discovery of Oersted, to communicate at and during pleasure to a coiled wire of any metal indifferently all the properties of a magnet;-"its attraction, repulsion, and polarity; and that even in a more intense degree than was previously thought to be possible in the best natural magnets.' Discourse, etc., § 364. Appended to the later editions of Sir W. R. Grove's Correlation of Physical Forces is an admirable Address, delivered before the British Association, on the Law of Continuity. [TF]

Exempla *instantiarum monodicarum* sunt, sol et luna, inter astra; magnes, inter lapides; argentum vivum, inter metalla; elephas, inter quadrupedes; sensus veneris, inter genera tactus; odor venaticus in canibus, inter genera olfactus. Etiam S litera apud grammaticos, habetur pro monodica; ob facilem compositionem quam sustinet cum consonantibus, aliquando duplicibus, aliquando triplicibus [304]; quod nulla alia litera facit. Plurimi autem faciendae sunt hujusmodi instantiae; quia acuunt et vivificant inquisitionem, et medentur intellectui depravato a consuetudine et ab iis quae fiunt plerunque.

[304] An instance of the former case is to be found in the English word 'strap,' of the latter in the German word 'schwarz.' [TF]

XXIX.

Inter *praerogativas instantiarum*, ponemus loco octavo *Instantias Deviantes* [305]; errores scilicet naturae, et vaga, ac monstra: ubi natura declinat et deflectit a cursu ordinario. Differunt enim errores naturae ab *instantiis monodicis* in hoc; quod monodicae sint miracula specierum, at errores sint miracula individuorum. Similis autem fere sunt usus; quia rectificant intellectum adversus consueta, et revelant formas communes. Neque enim in his etiam desistendum ab inquisitione donec inveniatur causa hujusmodi declinationis [306]. Veruntamen causa illa non exurgit ad formam aliquam proprie, sed tantum ad *latentem processum* ad formam [307]. Qui enim vias naturae noverit, is *deviationes* etiam facilius observabit. At rursus, qui deviationes noverit, is accuratius vias describet [308].

[305] Dr. Kitchin truly remarks that 'Instances 7, 8, and 9 might have all come under one head, for *Mono[a]dicae* in Species are what *Deviantes* are in Individuals, and *Limitataneae* are offshoots of *Mono[a]dicae*, being those cases in which two species seem to have transgressed one another's limits.' Saturn's rings, the perturbations of the

planet Uranus, and the red flames which accompany a total eclipse of the Sun would fall under the head of Instantiae Deviantes. [TF]

[306] An admirable instance of an enquiry of this kind is that which led to the discovery of the planet Neptune, in consequence of the observed perturbations of Uranus. [TF]

[307] The meaning of this remark is not very obvious. For a true explanation of these 'monstra' ought to throw light on the nature of the species to which they belong. What Bacon had in mind probably was that 'deviating instances' are due to some arrest or modification of the process which would ordinarily result in the more usual form, and, hence, that their explanation throws light, not directly on the form, but on the process which leads to the form. Indirectly, however, it would illustrate the nature or form as well. [TF]

[308] The truth of these words is obvious, but the maxim is none the less important, and affords a happy example of Bacon's sagacity as well as his felicity of expression. [TF]

Atque in illo differunt etiam ab *instantiis monodicis*, quod multo magis instruant praxin et operativam. Nam novas species generare arduum admodum foret; at species notas variare, et inde rara multa ac inusitata producere, minus arduum [309]. Facilis autem transitus est a miraculis naturae ad miracula artis [310]. Si enim deprehendatur semel natura in variatione sua, ejusque ratio manifesta fuerit, expeditum erit eo deducere naturam per artem quo per casum aberraverit. Neque solum eo, sed et aliorsum; cum errores ex una parte monstrent et aperiant viam ad errores et deflexiones undequaque. Hic vero exemplis non est opus, propter eorundem copiam. Facienda enim est congeries sive historia naturalis particularis omnium monstrorum et partuum naturae prodigiosorum; omnis denique novitatis et raritatis et inconsueti in natura [311]. Hoc vero faciendum est cum severissimo delectu, ut constet fides. Maxime autem habenda sunt pro suspectis quae pendent quomodocunque a religione, ut prodigia Livii: nec minus, quae inveniuntur in scriptoribus magiae naturalis, aut etiam alchymiae, et hujusmodi hominibus; qui tanquam proci sunt et amatores fabularum. Sed depromenda sunt illa ex gravi et fida historia, et auditionibus certis.

[309] Familiar illustrations of this artificial process of variation are supplied by the cases of plants, dogs, pigeons, cattle, etc.

What man does, in comparatively brief periods of time, in the case of varieties, Mr. Darwin has shown that Nature probably does, throughout the lapse of long ages, in the case of species and even the higher classes. [TF]

[310] Κατὰ τρόπον twa περὶ τὰ αὐτά ἐστιν ἡ τύχη Κατὰ ἡ τέχνη, καθάπερ καὶ ᾽Αγάθων φησὶ

τέχνη τύχην ἔστερξε καὶ τύχη τέχνην.

Eth. Nic. vi. 4 (5).

A wonderful instance of the successful imitation of Nature by Art is the artificial production of marble, through fusion under violent pressure, by Sir James Hall, to which I have already referred (p. 350). [TF]

[311] Such are many of the 'experiments' in the Sylva Sylvarum. [TF]

XXX.

Inter *praerogativas instantiarum*, ponemus loco nono Instantias *Limitaneas* [312]; quas etiam *Participia* vocare consuevimus. Eae vero sunt, quae exhibent species corporum tales, quae videntur esse compositae ex speciebus duabus, vel rudimenta inter speciem unam et alteram. Hae vero instantiae inter *instantias monodicas* sive *heteroclitas* recte numerari possunt: sunt enim in universitate rerum rarae et extraordinariae. Sed tamen ob dignitatem seorsim tractandae et ponendae sunt; optime enim indicant compositionem et fabricam rerum, et innuunt causas numeri et qualitatis specierum ordinariarum in universo, et deducunt intellectum ab eo quod est, ad id quod esse potest [313].

[312] 'These Limiting Instances or "participia," (i.e. partakers of two or more kinds, just as the Participle in Grammar participates in the nature of Verb and Noun) exhibit a combination of two kinds, and so seem to stand between the Singular and the Deviating instances. Bacon's examples are not satisfactory. Moss is by no means inter putredinem et plantam," Some of the Zoophytes, or the Ornithorhyncus Paradoxus would be better examples. Neither Flying-fish nor Bats are "limiting" between two kinds, except in appearance.' Dr. Kitchin's note. The bat belongs to the Order of Cheiroptera in the Class Mammalia, though vulgarly supposed to be an abnormal sort of bird. The flying-fish, also, has no structural resemblance to a bird.

The late Professor Rolleston suggested to me that the best example in the animal world of the 'instantiae limitaneae' is the order Dipnoi, including the three species, Lepidosiren Paradoxa, Lepidosiren Annectens, and Keratodus. These animals have affinities to fishes in one set of organs, and to amphibia in another. [TF]

[313] The language of this paragraph seems almost to anticipate the theories of Evolution maintained by recent Naturalists. CP. I. 66, and the last Aphorism. [TF]

Harum exempla sunt: muscus, inter putredinem et plantam; cometae nonnulli, inter stellas et meteora ignita [314]; pisces volantes, inter aves et pisces; vespertiliones, inter aves et quadrupedes; etiam

'Simia quam similis turpissima bestia nobis [315];'

et partus animalium biformes et commisti ex speciebus diversis; et similia.

[314] Stars are seen in the heavens permanently; meteors only momentarily. Comets are seen for some time, and then disappear. This must have been the ground on which Bacon referred them to the 'Instantiae limitaneae.' [TF]

[315] Quoted from Ennius by Cicero, De Natura Deorum, i, 35. [TF]

XXXI.

Inter *praerogativas instantiarum* ponemus decimo loco *Instantias Potestatis*, sive *Fascium* [316] (sumpto vocabulo ab insignibus imperii), quas etiam *Ingenia*, sive *Manus Hominis* appellare consuevimus. Eae sunt opera maxime nobilia et perfecta, et tanquam ultima in unaquaque arte. Cum enim hoc agatur praecipue ut natura pareat rebus et commodis humanis; consentaneum est prorsus, ut opera, quae jampridem in potestate hominis fuerunt (quasi provinciae antea occupatae et subactae), notentur et numerentur; praesertim ea quae sunt maxime enucleata et perfecta: propterea quod ab istis proclivior et magis in propinquo sit transitus ad nova et hactenus non inventa. Si quis enim ab horum contemplatione attenta propositum acriter et strenue urgere velit, fiet certe ut aut producat illa paulo longius, aut deflectat illa ad aliquid quod finitimum est, aut etiam applicet et transferat illa ad usum aliquem nobiliorem.

[316] These instances are evidences of man's power, being 'the most noble and perfect and, as it were, consummate productions in each art' It would be endless to adduce recent examples, such as the steam engine, with its many applications, the electric telegraph, chloroform, photography, etc. [TF]

Neque hic finis. Verum quemadmodum ab operibus naturae raris et inconsuetis erigitur intellectus et elevatur ad inquirendas et inveniendas formas, quae etiam illorum sunt capaces [317], ita etiam in operibus artis egregiis et admirandis hoc usu-venit; idque multo magis; quia modus efficiendi et operandi hujusmodi miracula artis manifestus ut plurimum est, cum plerunque in miraculis naturae sit magis obscurus. Attamen in his ipsis cautio est adhibenda vel maxime, ne deprimant scilicet intellectum et eum quasi humo affigant.

[317] 'Which are capable of including them also.' He means that the study of these rare and unusual works of nature leads to a knowledge of the Forms, which they exemplify in a more or less peculiar manner. [TF]

Periculum enim est, ne per hujusmodi opera artis, quae videntur velut summitates quaedam et fastigia industriae humanae, reddatur intellectus attonitus et ligatus et quasi maleficiatus quoad illa, ita ut cum aliis consuescere non possit, sed cogitet nihil ejus generis fieri posse nisi eadem via qua illa effecta sunt, accedente tantummode diligentia majore et praeparatione magis accurata [318].

[318] CP. I. 6, 85. [TF]

Contra, illud ponendum est pro certo: vias et modos efficiendi res et opera, quae adhuc reperta sunt et notata, res esse plerunque pauperculas; atque omnem potentiam majorem pendere et ordine derivari a fontibus formarum, quarum nulla adhuc inventa est [319].

[319] CP. I. 75, II. 2, 17. De Augmentis Scientiarum, III. 4 (Ellis and Spedding, Vol. I. pp. 564-566). [TF]

Itaque (ut alibi diximus [320]) qui de machinis et arietibus, quales erant apud veteres, cogitasset, licet hoc fecisset obnixe atque aetatem in eo consumpsisset, nunquam tamen incidisset in inventum tormentorum igneorum operantium per pulverem pyrium. Neque rursus, qui in lanificiis et serico vegetabili observationem suam et meditationem collocasset, unquam per ea reperisset naturam vermis aut serici bombycini.

[320] See I. 109. [TF]

Quocirca omnia inventa, quae censeri possunt magis nobilia (si animum advertas), in lucem prodiere, nullo modo per pusillas enucleationes et extensiones artium, sed omnino per casum. Nihil autem repraesentat [321] aut anticipat casum (cujus mos est ut tantum per longa saecula operetur), praeter inventionem formarum [322].

[321] See note on this word at the end of I. 109. [TF]

[322] CP. II. 3 ad fin.: 'At qui formas novit, is naturae unitatem in materiis dissimillimis complectitur; itaque quae, adhuc facta non sunt, quaiia nee naturae vicissitudines, neque experimentales industriae, neque casus ipse, in actum unquam perduxissent, neque cogitationem humanam subitura fuissent, detegere et producere potest. Quare ex formarum invention sequitur contemplatio vera, et operatic libera.' [TF]

Exempla autem hujusmodi instantiarum particularia nihil opus est adducere, propter copiam eorundem. Nam hoc omnino agendum; ut visitentur et penitus introspiciantur omnes artes mechanicae, atque liberales etiam (quatenus ad opera), atque inde facienda est congeries sive historia particularis, tanquam magnalium et operum magistralium et maxime perfectorum in unaquaque ipsarum, una cum modis effectionis sive operationis.

Neque tamen astringimus diligentiam, quae adhibenda est in hujusmodi collecta, ad ea quae censentur pro magisteriis et arcanis alicujus artis tantum, atque movent admirationem. Admiratio enim proles est raritatis; siquidem rara, licet in genere sint ex vulgatis naturis, tamen admirationem pariunt.

At contra, quae revera admirationi esse debent propter discrepantiam quae inest illis in specie collatis ad alias species, tamen si in usu familiari praesto sint leviter notantur. Debent autem notari *monodica* artis, non minus quam *monodica* naturae; de quibus antea diximus [323]. Atque quemadmodum in *monodicis* naturae posuimus solem,

lunam, magnetem, et similia, quae re vulgatissima sunt sed natura tamen fere singulari: idem et de *monodicis* artis faciendum est.

[323] Aphorism 28. [TF]

Exempli gratia; instantia *monodica* artis est papyrus; res admodum vulgata. At si diligenter animum advertas, materiae artificiales aut plane textiles sunt per fila directa et transversa; qualia sunt pannus sericus, aut laneus, et linteus, et hujusmodi: aut coagmentantur ex succis concretis; qualia sunt later, aut argilla figularis, aut vitrum, aut esmalta [324], aut porcellana, et similia; quae si bene uniantur splendent, sin minus, indurantur certe, sed non splendent. Attamen omnia talia, quae fiunt ex succis concretis, sunt fragilia, nec ullo modo haerentia et tenacia. At contra, papyrus est corpus tenax, quod scindi et lacerari possit; ita ut imitetur et fere aemuletur pellem sive membranam alicujus animalis, aut folium alicujus vegetabilis, et hujusmodi opificia naturae. Nam neque fragilis est, ut vitrum; neque textilis, ut pannus; sed habet fibras certe, non fila distincta, omnino ad modum materiarum naturalium: ut inter artificiales materias vix inveniatur simile aliquod, sed sit plane *monodicum* [325]. Atque praeferenda sane sunt in artificialibus ea quae maxime accedunt ad imitationem naturae, aut e contrario eam potenter regunt et invertunt [326].

[324] 'Italian "smalto," "ismalto," enamel. The word is connected with the Anglo-Saxon "Myltan," to melt or smelt.' Dr. Kitchin's note. [TF]

[325] Mr. Ellis says: 'It is curious that Bacon should not have remarked that all the qualities here mentioned belong to felt as well as to paper.' [TF]

[326] Of this last class the lightning-conductor is an admirable example. [TF]

Rursus, inter *ingenia* et *manus hominis*, non prorsus contemnenda sunt praestigiae et jocularia [327]. Nonnulla enim ex istis, licet sint usu levia et ludicra, tamen informatione valida esse possunt.

[327] The remark is perfectly just, and can, perhaps, be more adequately appreciated in our own days than in Bacon's, Numbers of toys and tricks illustrate scientific principles, as well as mental habitudes.

In the Catalogus Historiarum Particularium, published at the end of the First Edition of the Novum Organum, are enumerated, '123, Historia Ludorum omnis generis; 124, Historia Praestigiatorum et Circuiatorum.' [TF]

Postremo, neque omnino omittenda sunt superstitiosa, et (prout vocabulum sensu vulgari accipitur) magica. Licet enim hujusmodi res sint in immensum obrutae grandi mole mendaciorum et fabularum, tamen inspiciendum paulisper si forte subsit et lateat in aliquibus earum aliqua operatio naturalis; ut in fascino, et fortificatione imaginationis,

et consensu rerum ad distans, et transmissione impressionum a spiritu ad spiritum non minus quam a corpore ad corpus, et similibus [328].

[328] CP. De Augmentis Scientiarum, Libro IV. Cap. 3 (Ellis and Spedding, Vol. I. pp. 608, 609), Sylva Sylvarum, Century X. (Ellis and Spedding, Vol. II. p. 640, Sic.), In Exp. 986, he relates the story of the dream which he had at Paris two or three days before his father's death.

This class of questions had an irresistible attraction for the men of Bacon's time, nor have they ceased to be discussed with interest by many scientific men even in our own.

Of the extravagant lengths to which the belief in the 'consensus rerum ad distans' and the 'transmissio impressionum' were sometimes earned, we have some very amusing instances in Dr. Glanvill's Scepsis Scientifica, a work published in 1665, forty-five years after the publication of the Novum Organum. I select two of these, and feel confident that the reader will require no apology for their length:

'Besides this' (sc. conference by means of sympathetic dials) 'there is another way of Secret Conveyance that's whisper'd about the World, the truth of which I vouch not, but the *possibility*: it is conference at distance by sympathized hands. For say the relatours of this strange secret: The hands of two friends being allyed by the transferring of Flesh from one into another, and the place of the Letters mutually agreed on; the least prick in the hand of one, the other will be sensible of, and that in the same part of his own. And thus the distant friend, by a new kind of Chiromancy, may read in his own hand what his correspondent had set down in his. F or instance, would I in London acquaint my intimate in Paris, that *I am well*: I would then prick that part where I had appointed the letter [I] and, doing so in another place to signifie that word was done, proceed to [A] thence to [M] and so on, till I had finisht what I intended to make known.'

'Then there is a Magnetick way of curing wounds by anointing the weapon, and that the wound is affected in like manner as is the extravenate blood by the Sympathetick medicine, as to matter of fact is with circumstances of good evidence asserted by the Noble Sir K, Digby in his ingenious discourse on the subject. The reason of this magnale he attempts by Mechanism, and endeavours to make it out by atomical aporrheas, which passing from the cruentate cloth or weapon to the wound, and being incorporated with the particles of the salve carry them in their embraces to the affected part: where the medicinal atomes, entering together with the effluviums of the blood, do by their subtle insinuation better effect the cure, than can be done by any grosser application. The particular way of their conveyance and their regular direction is handsomely explicated by that learned Knight, and recommended to the ingenious by most witty and becoming illustrations. It is out of my way here to enquire whether the Anima Mundi be not a better account than any Mechanical Solutions. The former is more desperate; the latter perhaps hath more of ingenuity than good ground of satisfaction. It is enough for me that *de facto* there is such an entercourse between the Magnetick ungunt and the vulnerated body, and I need not be solicitous of the cause.' [TF]

XXXII.

Ex iis, quae ante dicta sunt, patet quod quinque illa instantiarum genera de quibus diximus (viz. *instantiarum conformium, instantiarum monodicarum, instantiarum deviantium, instantiarum limitanearum, instantiarum potestatis*) non debeant reservari, donec inquiratur natura aliqua certa (quemadmodum instantiae reliquae, quas primo loco proposuimus, nec non plurimae ex iis quae sequentur, reservari debent); sed statim jam ab initio facienda est earum collectio, tanquam historia quaedam particularis; eo quod digerant ea quae ingrediuntur intellectum, et corrigant pravam complexionem intellectus ipsius, quem omnino necesse est imbui et infici et demum perverti ac distorqueri ab incursibus quotidianis et consuetis [329].

[329] These five instances are regarded rather as furnishing materials for a Natural History, and as instrumental in removing prejudices, than as directly suggesting inductive inferences. But, as Dr. Kitchin says, it is hard to see why, if they are merely preliminary, they should be inserted in this place. [TF]

Itaque adhibendae sunt eae instantiae tanquam praeparativum aliquod, ad rectificandum et expurgandum intellectum. Quicquid enim abducit intellectum a consuetis, aequat et complanat aream ejus ad recipiendum lumen siccum et purum notionum verarum.

Quin etiam hujusmodi instantiae sternunt et praestruunt viam ad operativam; ut suo loco dicemus, quando de *Deductionibus* ad *Praxin* [330] sermo erit.

[330] The seventh in order of the 'reliqua auxilia intellectus' (see Aphorism2i). This part of the Novum Organum Bacon never reached. [TF]

XXXIII.

Inter *praerogativas instantiarum* ponemus loco undecimo *Instantias Comitatus*, atque *Hostiles* [331]; quas etiam *Instantias Propositionum Fixarum* appellare consuevimus. Eae sunt instantiae, quae exhibent aliquod corpus sive concretum tale, in quo natura inquisita perpetuo sequatur tanquam comes quidam individuus: aut contra, in quo natura inquisita perpetuo fugiat atque ex comitatu excludatur, ut hostis et inimicus. Nam ex hujusmodi instantiis formantur propositiones certae et universales, aut *affirmativae* aut *negativae*; in quibus subjectum erit tale corpus in concreto, praedicatum vero natura ipsa inquisita. Etenim propositiones particulares omnino *fixae* non sunt, ubi scilicet natura inquisita reperitur in aliquo concreto fluxa et mobilis, viz. accedens sive acquisita, aut rursus recedens sive deposita. Quocirca particulares propositiones non habent *praerogativam* aliquam majorem, nisi tantum in casu *migrationis*; de quo antea dictum est. Et nihilominus, etiam particulares illae propositiones comparatae et collatae cum universalibus multum juvant; ut suo loco dicetur [332]. Neque tamen, etiam in

universalibus istis propositionibus exactam aut absolutam affirmationem vel abnegationem requirimus. Sufficit enim ad id quod agitur, etiamsi exceptionem nonnullam singularem aut raram patiantur [333].

[331] These instances are such as the nature in question is constantly associated with, or constantly dissociated from. The fact is expressed, in the one case, by an Universal Affirmative, and, in the other, by an Universal Negative Proposition. In both cases, the instance furnishes the subject of the proposition, and the nature in question the predicate. [TF]

[332] He alludes to the Instantiae Subjunctivae of the next Aphorism. [TF]

[333] But this exception must always be regarded as requiring explanation, shewing why it deviates from the general rule. The history of science is rich in explanations of this kind. [TF]

Usus autem *instantiarum comitatus* est ad angustiandam *affirmativam* formae. Quemadmodum enim in *instantiis migrantibus* angustiatur *affirmativa* formae; viz. ut necessario poni debeat forma rei esse aliquid quod per actum illum *migrationis* inditur aut destruitur; ita etiam in *instantiis comitatus* angustiatur *affirmativa* formae; ut necessario poni debeat forma rei esse aliquid quod talem concretionem corporis subingrediatur, aut contra ab eadem abhorreat; ut qui bene norit constitutionem aut schematismum hujusmodi corporis non longe abfuerit ab extrahenda in lucem forma naturae inquisitae [334].

[334] Thus, if the form required be that of heat, and we have observed that heat always accompanies flame, the 'form' or nature of heat may be detected by a careful examination of flame. Similarly, if the form required be that of transparency, and we have observed that malleability never accompanies transparency, the 'form' or nature of transparency must be something which is not to be found in malleable substances (or, at least, something which, if it is to be found in them, is counteracted by other properties). It is plain from the qualification, just given, how liable to error may be reasoning based solely on 'instantiae hostiles.' [TF]

Exempli gratia; sit natura inquisita Calidum. *Instantia comitatus* est flamma [335]. Etenim in aqua, aëre, lapide, metallo, et aliis quamplurimis, calor est mobilis, et accedere potest et recedere: at omnis flamma est calida, ita ut calor in concretione flammae perpetuo sequatur. At *instantia hostilis* calidi nulla reperitur apud nos. Nam de visceribus terrae nihil constat ad sensum; sed eorum corporum quae nobis nota sunt nulla prorsus est concretio quae non est susceptibilis caloris [336].

[335] Not only is flame always accompanied by heat, but, as Professor Playfair adds, 'the same degree of heat in a given substance is always accompanied with flame,' that is to say, there is always a given temperature at which any particular incandescent substance bursts into flame. [TF]

[336] This passage again shows Bacon's ignorance of the purely relative character of the expressions 'Hot' and 'Cold.' [TF]

At rursus, sit natura inquisita Consistens. *Instantia hostilis* est aër. Etenim metallum potest fluere, potest consistere; similiter vitrum; etiam aqua potest consistere, cum conglaciatur: at impossibile est ut aër unquam consistat, aut exuat fluorem [337].

[337] This was the opinion of scientific men even long after Bacon's time, and it is repeated, though in rather more cautious language, by Professor Playfair. But the experiments of Cailletet and Pictet (for an account of which I referred in my First Edition to the Academy of Jan. 12, 1878, and to Nature of Jan. 3 and 17 of the same year) have conclusively shown that even oxygen, hydrogen, and nitrogen admit of liquefaction, and, therefore, probably of solidification. A brief account of these experiments is given in Ganot's Physics, Translation, 12th Ed., § 382. Thus, the old distinction between permanent and non-permanent gases has been entirely effaced. By a legitimate analogy, it may be inferred, with a very high degree of probability, that all liquids admit of solidification. But some liquids, such as alcohol, ether, and bisulphide of carbon have hitherto resisted all attempts to solidify them, even at the lowest known temperature. See Ganot, § 343. [TF]

Verum de *instantiis* hujusmodi *propositionum fixarum* supersunt duo monita, quae utilia sunt ad id quod agitur. Primum, ut si defuerit plane universalis *affirmativa* aut *negativa*, illud ipsum diligenter notetur tanquam non-ens [338]; sicut fecimus de calido, ubi universalis negativa (quatenus ad entia quae ad nostram notitiam pervenerint) in rerum natura deest. Similiter, si natura inquisita sit aeternum aut incorruptibile, deest affirmativa universalis hic apud nos. Neque enim praedicari potest *Aeternum* aut *Incorruptibile* de aliquo corpore eorum quae infra coelestia sunt, aut supra interiora terrae [339]. Alterum monitum est, ut propositionibus universalibus, tam affirmativis quam negativis, de aliquo concreto, subjungantur [340] simul ea concreta quae proxime videntur accedere ad id quod est ex non-entibus [341]: ut in calore, flammae mollissimae et minimum adurentes; in incorruptibili, aurum, quod proxime accedit. Omnia enim ista indicant terminos naturae inter ens et non-ens; et faciunt ad circumscriptiones formarum, ne gliscant et vagentur extra conditiones materiae [342].

[338] Though expressed in scholastic language, the meaning of this caution is plain. If we are unable to establish an universal affirmative or an universal negative, the mere fact of such incapacity is worth the noting. [TF]

[339] In the Descriptio Globi Intellectualis (Ellis and Spedding, Vol. III. pp. 754-7) Bacon criticises severely the dogma of Aristotle and the Peripatetics, which affirms the immutability of the heavenly bodies. The same passage shows why he here brings the 'interiora terrae' into juxtaposition with 'coelestia.' 'Deinde si quis adhuc instet, negari tamen non posse quin in ipsa superficie orbis terrarum et partibus proximis infinitae fiant mutationes, in coelo non item: huic ita occurrimus; nec nos haec per omnia aequare, et

tamen si regiones (quas vocant) superiorem et mediain aëris pro superficie aut interiore tunica coeli accipiamus, quemadmodum spatium istud apud nos, quo aninialia, plantae, et mineralia continentur, pro superficie vel exteriore tunica terrae accipimus; et ibi quoque varias et multiformes generationes inveniri. Itaque tumultus fere omnis et conflictus et perturbatio in confiniis tantum coeli et terrae locum habere videtur; ut in rebus civilibus fit, in quibus illud frequenter usu venit, ut duorum regnorum fines continuis incursionibus et violentiis infestentur, dum interiores utriusque regni provinciae diutina pace fruuntur, et beilis tantum gravioribus et rarioribus commoventur.' [TF]

[340] See next Aphorism. [TF]

[341] Or, as we should say, which least exemplify the given proposition. [TF]

[342] He appears here to regard matter as limiting and checking the exhibition of the form. Hence, in certain cases, he conceives, the manifestation of the form is weak, and we must take care to state our general propositions, whether affirmative or negative, with due qualifications. [TF]

XXXIV.

Inter praerogativas instantiarum, ponemus loco duodecimo ipsas illas *Instantias Subjunctivas*, de quibus in superiori aphorismo diximus: quas etiam *Instantias Ultimitatis* sive *Termini* appellare consuevimus. Neque enim hujusmodi instantiae utiles sunt tantum, quatenus subjunguntur propositionibus fixis; verum etiam per se, et in proprietate sua [343]. Indicant enim non obscure veras sectiones naturae, et mensuras rerum, et illud *Quousque* natura quid faciat et ferat, et deinde transitus naturae ad aliud. Talia sunt, aurum, in pondere [344]; ferrum, in duritie; cete, in quantitate animalium; canis, in odore; inflammatio pulveris pyrii, in expansione celeri; et alia id genus. Nec minus exhibenda sunt ea quae sunt ultima gradu infimo, quam quae supremo; ut spiritus vini, in pondere; sericum, in mollitie; vermiculi cutis [345], in quantitate animalium; et caetera.

[343] Except in relation to the Instances described in the last Aphorism, it is difficult to see how this class of instances constitutes a distinct division. Surely, when regarded in themselves, out of relation to the others, they are merely the 'Glaring Instances' and 'Clandestine Instances' over again. [TF]

[344] Platinum is heavier than gold, ether is lighter than spirits of wine; the diamond is harder than iron; some detonating powders exceed gunpowder in their expansive force; and the whale, though larger than any other living animal, must yield to the geological monsters which the researches of recent geologists and anatomists have re-constructed for us. [TF]

[345] The ‘Vermiculi cutis' (to which Bacon refers again in Aphorism 43) are, as Dr. Kitchin observes, ‘not animal bodies, but only little vessels caused originally by the obstruction of the glands placed immediately under the skin, from which a minute pipe carries off the perspiration.' I am indebted to the late Professor Rolleston for the information that there is a minute microscopic animal, called Demodex folliculorum, discovered by a German physician, Dr. Simon, in the unctuous matter which collects within the oil-tubes of the skin. But, of course, Bacon could have had no means of observing it. [TF]

XXXV.

Inter *praerogativas instantiarum*, ponemus loco decimo tertio *Instantias Foederis* sive *Unionis* [346]. Eae sunt, quae confundunt et adunant naturas, quae existimantur esse heterogeneae, et pro talibus notantur et signantur per divisiones receptas.

[346] An instance of Alliance is an instance which exhibits the identity or similarity of natures which are supposed to be heterogeneous, and thus leads from the consideration of the differentiae to that of the genus.

An excellent example would be the fall of detached bodies to the earth, which is said to have suggested to Newton that there is a common explanation of terrestrial gravitation and of the force which retains the planets in their orbits. [TF]

At *instantiae foederis* ostendunt operationes et effectus, quae deputantur alicui ex illis heterogeneis ut propria, competere etiam aliis ex heterogeneis; ut convincatur ista heterogenia (quae in opinione est) vera non esse aut essentialis, sed nil aliud esse quam modificatio naturae communis. Optimi itaque sunt usus ad elevandum et evehendum intellectum a differentiis ad genera; et ad tollendum larvas et simulachra rerum, prout occurrunt et prodeunt personatae in substantiis concretis.

Exempli gratia: sit natura inquisita Calidum. Omnino videtur esse divisio solennis et authentica, quod sint tria genera caloris; viz. calor coelestium, calor animalium, et calor ignis [347]; quodque isti calores (praesertim unus ex illis comparatus ad reliquos duos) sint ipsa essentia et specie, sive natura specifica, differentes et plane heterogenei: quandoquidem calor coelestium et animalium generet et foveat, at calor ignis contra corrumpat et destruat [348]. Est itaque *instantia foederis* experimentum illud satis vulgatum, cum recipitur ramus aliquis vitis intra domum ubi sit focus assiduus, ex quo maturescunt uvae etiam mense integro citius quam foras; ita ut maturatio fructus etiam pendentis super arborem fieri possit, scilicet ab igne, cum hoc ipsum videatur esse opus proprium solis [349]. Itaque ab hoc initio facile insurgit intellectus, repudiata heterogenia essentiali, ad inquirendum quae sint differentiae illae quae revera reperiuntur inter calorem solis et ignis, ex quibus fit ut eorum operationes sint tam dissimiles, utcunque illi ipsi participent ex natura communi.

[347] This is even still, a vulgar division of the different kinds of heat. Telesius had anticipated Bacon in criticising it. See De Rerum Natura, vi. 20, a passage which Bacon had evidently read. [TF]

[348] See Aristotle, De Generatione Animalium, II. 3 (Berlin Ed., p. 737 a. I, κ.τ.λ.): διὸ πῦρ μὲν οὐθὲν γεννᾷ ζῷον, οὐδὲ φαίνεται συνιστάμενον μυομένους μένοις οὔτ᾽ ἐν ὑγροῖς οὔτ᾽ ἐν ξηροῖς οὐθέν' ἡ δὲ τοῦ ἡλίου θερμότης καὶ ἡ τῶν ζῴων οὐ μόνον ἡ διὰ τοῦ σπέρματος, ἀλλὰ κἄν τι περίττωμα τύχῃ τῆς φύσεως ὂν ἕτερον, ὅμως ἔχει καὶ τοῦτο ζωτικὴν ἀρχήν. ὅτι μὲν οὖν ἡ ἐν τοῖς ζῴοις θερμύτης οὔτε πῦρ οὔτε ἀπὸ πυρὸς ἔχει τὴν ἀρχήν, ἐκ τῶν τοιούτων ἐστὶ φανερόν. [TF]

[349] 'The regular use of artificial heat in green-houses and conservatories was not known in Bacon's time. In the *Maison Champêre* an encyclopaedia of gardening and agriculture published in 1607, nothing is said of it; nor is there anything on the subject in the writings of Porta, though in his *Nat, Mag.* he has spoken of various modes of accelerating the growth of fruits and flowers. In the *Sylva Sylvarum* (412), however, Bacon speaks of housing hot-country plants to save them, and, in the *Essay on Gardens*, of stoving myrtles. The idea of what are now called green-houses was introduced into England from Holland about the time of the Revolution. The orangery at Heidelberg, formed, I believe, about the middle of the seventeenth century, is said to be the earliest conservatory on record.

'It is related that Albertus Magnus, entertaining the emperor at Cologne during the winter, selected for the place of entertainment the garden of his monastery. Everything was covered with snow, and the guests were much inclined to be discontented; but, when the feast began, the snow cleared away; the trees put forth, first leaves, then blossoms, then fruit; and the climate became that of summer. This glorious summer, which had thus abruptly succeeded to the winter of their discontent, lasted only to the conclusion of the feast, when everything resumed its former aspect. It would be a fanciful explanation, and I know not whether it has ever been suggested, to say that Albertus Magnus really entertained the emperor in a conservatory, and only led his guests through the garden. See, for the story, Grimm's Deutsche Sagen.' Mr. Ellis' note. [TF]

Quae differentiae reperientur quatuor: viz. primo, quod calor solis respectu caloris ignis sit gradu longe clementior et lenior; secundo, quod sit (praesertim ut defertur ad nos per aërem) qualitate multo humidior; tertio (quod caput rei est), quod sit summe inaequalis, atque accedens et auctus, et deinceps recedens et diminutus; id quod maxime confert ad generationem corporum. Recte enim asseruit Aristoteles [350] causam principalem generationum et corruptionum, quae fiunt hic apud nos in superficie terrae, esse viam obliquam solis per zodiacum [351]; unde calor solis, partim per vicissitudines diei et noctis, partim per successiones aestatis et hyemis, evadit miris modis inaequalis. Neque tamen desinit ille vir id quod ab eo recte inventum fuit statim corrumpere et depravare. Nam ut arbiter scilicet naturae (quod illi in more est) valde magistraliter assignat causam generationis accessui solis, causam autem corruptionis

recessui; cum utraque res (accessus videlicet solis et recessus) non respective, sed quasi indifferenter, praebeat causam tam generationi quam corruptioni; quandoquidem inaequalitas caloris generationi et corruptioni rerum, aequalitas conservationi tantum ministret. Est et quarta differentia inter calorem solis et ignis, magni prorsus momenti: viz. quod sol operationes suas insinuet per longa temporis spatia, ubi operationes ignis (urgente hominum impatientia) per breviora intervalla ad exitum perducantur. Quod si quis id sedulo agat, ut calorem ignis attemperet et reducat ad gradum moderatiorem et leniorem (quod multis modis facile fit), deinde etiam inspergat et admisceat nonnullam humiditatem, maxime autem si imitetur calorem solis in inaequalitate, postremo si moram patienter toleret (non certe eam quae sit proportionata operibus solis, sed largiorem quam homines adhibere solent in operibus ignis), is facile missam faciet heterogeniam illam caloris, et vel tentabit vel exaequabit vel in aliquibus vincet opera solis, per calorem ignis. Similis *instantia foederis* est resuscitatio papilionum ex frigore stupentium et tanquam emortuarum, per exiguum teporem ignis; ut facile cernas non magis negatum esse igni vivificare animantia quam maturare vegetabilia. Etiam inventum illud celebre Fracastorii [352] de sartagine acriter calefacta, qua circundant medici capita apoplecticorum desperatorum, expandit manifeste spiritus animales ab humoribus et obstructionibus cerebri compressos et quasi extinctos, illosque ad motum excitat, non aliter quam ignis operatur in aquam aut aërem, et tamen per consequens vivificat. Etiam ova aliquando excluduntur per calorem ignis, id quod prorsus imitatur calorem animalem; et complura ejusmodi; ut nemo dubitare possit quin calor ignis in multis subjectis modificari possit ad imaginem caloris coelestium et animalium.

[350] Meteorologica, I. 14 (p. 351a. 30, κ.τ.λ.): τῇ δὲ γῇ τοῦτο (sc. ἀκμὴν ἔχειν καὶ γῆρας) γίγνεται κατὰ μέρος διὰ ψύξιν καὶ θερμότητα. Ταῦτα μὲν οὖν αὔξεται καὶ φθίνει διὰ τὸν ἥλιον καὶ τὴν περιφοράν, διὰ δὲ ταῦτα καὶ τὴν δύναμιν τὰ μέρη τῆς γῆς λαμβάνει διαφέρουσαν, ὥστε μέχρι τινὸς ἔνυδρα δύναται διαμέ- νειν, εἶτα ξηραίνεται καὶ γηράσκει πάλιν" ἕτεροι δὲ τόποι βιώσκονται καὶ ἔνυδροι γίγνονται κατὰ μέρος.

De Generatione et Corruptione, II. 10 (p. 336 a, b). It is to this latter passage that the words ‘Nam ut arbiter,’ etc. refer. See 336 b. 17, etc,: ὁρῶμεν yap ὅτι προσιόντος μὲν τοῦ ἡλίου γένεσίς ἐστιν, ἀπιόντος δὲ φθίσις, καὶ ἐν ἴσῳ χρόνῳ ἑκάτερον" ἴσος γὰρ ὁ χρόνος τῆς φθορᾶς καὶ τῆς γενέσεως τῆς κατὰ φύσιν. [TF]

[351] ἡ κατὰ τὸν λοξὸν κύκλον φορά. De Gen. et Corr. II. 10. [TF]

[352] It is related of this distinguished physician (born at Verona 1483, died 1553) that, apoplexy having deprived him of the use of speech, he made a sign to his servants to apply cupping-glasses to his head; but, not being understood, he died in a few hours.

Cupping is effected by rarefying the air within the vessel, and thus partially removing the atmospheric pressure from the surface of the skin, which accordingly rises. This operation is generally followed by making incisions on the raised surface, by means of a scarificator, after which the cup is again applied, for the purpose of drawing out the blood. [TF]

Similiter sint naturae inquisitae Motus et Quies. Videtur esse divisio solennis atque ex intima philosophia, quod corpora naturalia vel rotent, vel ferantur recta, vel stent sive quiescant. Aut enim est motus sine termino, aut statio in termino, aut latio ad terminum. At motus ille perennis rotationis videtur esse coelestium proprius; statio sive quies videtur competere globo ipsi terrae; at corpora caetera (gravia quae vocant et levia, extra loca scilicet connaturalitatis suae sita) feruntur recta ad massas sive congregationes similium; levia sursum, versus ambitum coeli; gravia deorsum, versus terram. Atque ista pulchra dictu sunt [353].

[353] This is the ordinary Peripatetic account of what is called motion of translation' (φορά), and is stated almost in the words of Aristotle himself. See, amongst other places, De Coelo, I. 2 (pp. 268 b-269 b), from which I extract the following passage (p. 268 b, 17, κ.τ.λ.): Πᾶσα δὲ κίνησις ὅση κατὰ τόπον, ἣν καλοῦμεν φοράν, ἢ εὐθεῖα ἢ κύκλῳ ἢ ΕΚ τούτων μικτή" ἁπλαῖ yap αὗται δύο μόναι. Αἴτιον δ᾽ ὅτι καὶ τὰ μεγέθη ταῦτα ἁπλᾶ μόνον,ἥ τ᾽ εὐθεῖα καὶ ἡ περι- φερής. Κύκλῳ μὲν οὖν ἐστὶν ἡ περὶ τὸ μέσον, εὐθεῖα δ᾽ ἡ ἄνω καὶ κάτω. Λέγω δ᾽ ἄνω μὲν τὴν ἀπὸ τοῦ μέσου, κάτω δὲ τὴν ἐπὶ τὸ μέσον. "Ωστ᾽ ἀνάγκη πᾶσαν εἶναι τὴν ἁπλῆν φορὰν τὴν μὲν ἀπὸ τοῦ μέσου, τὴν δ᾽ ἐπὶ τὸ μέσον, τὴν δὲ περὶ τὸ μέσον. The Other parts of the doctrine occur or are implied in the same chapter: CP. also Phys. VIII. 9 (265 a, b).

It is not quite plain from Bacon's words at the end of the paragraph, whether he implicitly accepted this account, or not. From Aphorism 48, 'Motus decimus septimus,' it would seem as if he did do so, whereas, in the Descriptio Globi Intellectualis (Ellis and Spedding, Vol. III. pp. 754-5), he calls in question the dogmas of both the circular and the eternal motion of the heavenly bodies (cp., with regard to the former, Novum Organum I. 45). This treatise must have been written about 1612, so that, unless we suppose that, in the two passages of the Novum Organum, he is merely stating the commonly received opinion, without thinking it necessary to criticise it, we must admit some inconsistency .in his treatment of this subject.

The establishment of the true nature and laws of motion belongs to the period subsequent to Bacon, beginning with the discoveries of Galileo and ending with those of Newton. See Whewell's History of the Inductive Sciences. [TF]

At *instantia foederis* est cometa aliquis humilior; qui cum sit longe infra coelum, tamen rotat [354]. Atque commentum Aristotelis [355] de alligatione sive sequacitate cometae ad astrum aliquod jampridem explosum est; non tantum quia ratio ejus non est probabilis, sed propter experientiam manifestam discursus et irregularis motus cometarum per varia loca coeli.

[354] The comets being as much 'heavenly bodies' as the planets, this instance has, of course, no significance for us.

There is another respect, however, as Dr. Kitchin observes, in which comets afford a good example of an Instantia Foederis. Notwithstanding the apparent irregularity of their orbits, they illustrate the Law of Gravity equally with the planets, whose orbits are apparently regular, and hence their motions contribute to establish the universality of that Law. [TF]

[355] See Meteorologica, I. 7 (p. 344). It is not, however, with regard to all comets that Aristotle propounds this theory. Ὅταν μὲν οὖν ἐν αὐτῷ τῷ κάτω τόπῳ ἡ ἀρχὴ τῆς συστάσεως ἢ, καθ᾽ ἑαυτὸν φαίνεται κομήτης" ὅταν δ᾽ ὑπὸ τῶν ἄστρων τινός, ἢ τῶν ἀπλανῶν ἢ τῶν πλανήτων, ὑπὸ τῆς κινήσεως συνιστῆται ἡ ἀναθυμίασις, τότε κομήτης γίγνεται τούτων TLS᾽ οὐ γὰρ πρὸς αὐτοῖς ἡ κόμη γίγνεται τοῖς ἄστροις, ἀλλ᾽ ὥσπερ αἱ ἅλῳ περὶ τὸν ἥλιον φαίνονται καὶ τὴν σελήνην παρακολουθοῦσαι, καίπερ μεθισταμένων τῶν ἄστρων, ὅταν οὕτως ἢ πεπυκνωμένος ὁ ἀὴρ ὥστε τοῦτο γίγνεσθαι τὸ πάθος ὑπὸ τὴν τοῦ ἡλίου πορείαν, οὕτω καὶ ἡ κόμη τοῖς ἄστροις οἷον ἅλως ἐστίν. Πλὴν ἡ μὲ ν γίγνεται δι᾽ ἀνάκλασιν τοιαύτη τὴν χρόαν, ἐκεῖ δ᾽ ἐπ᾽ αὐτῶν τὸ χρῶμα φαινόμενόν ἐστιν. Ὅταν μὲν οὖν κατ᾽ ἀστέρα γένηται ἡ τοιαύτη σύγκρισις, τὴν αὐτὴν ἀνάγκη φαίνεσθαι φορὰν κινούμενον τὸν κομήτην ἥνπερ φέρεται ὁ ἀστήρ᾽ ὅταν δὲ συστῇ καθ᾽ αὐτόν, τότε ὑπολειπόμενοι φαίνονται. (p. 344 a. 33 — b. II.) On Aristotle's theory of comets generally, as well as the opinions of previous philosophers, see Meteorologica 1. 6, 7. [TF]

At rursus alia *instantia foederis* circa hoc subjectum est motus aëris; qui intra tropicos (ubi circuli rotationis sunt majores) videtur et ipse rotare ab oriente in occidentem [356].

[356] Bacon is alluding to the Trade-Winds, which, when not interfered with by local causes, blow, speaking roughly, from east to west. On the causes of these winds, see Herschel's Outlines of Astronomy, loth Ed., § 239, etc. or Tyndall's Heat a Mode of Motion, § 206, etc. (3rd Ed.), or almost any manual of Physical Geography.

The 'circuli rotationis,' of which Bacon speaks, must be those of the winds, or of the heavens; for, in the Tractate de Fluxu et Refluxu Maris (Ellis and Spedding, Vol. III. p. 53), he speaks of the theory of the earth's rotation as 'satis licenter excogitatum, quoad rationes physicas,' language which is in accordance with what he invariably says elsewhere, when the question is definitely before him. See Introduction, pp. 34-37, and my notes there referred to. [TF]

Et alia rursus *instantia* foret fluxus et refluxus maris, si modo aquae ipsae deprehendantur ferri motu rotationis (licet tardo et evanido) ab oriente in occidentem; ita tamen ut bis in die repercutiantur [357]. Itaque, si haec ita se habeant, manifestum est motum istum rotationis non terminari in coelestibus, sed communicari aëri et aquae.

[357] Bacon does not seem to have suspected the true theory of the semidiurnal tides, namely, that they are caused by the combined, or sometimes opposed, attractions of the sun and moon, heaping up, as it were, the waters nearest to them, as well as those most remote from them. The foundations of this theory were first laid in calculation by

Newton, though the influence of the sun and moon, or of the sun or moon, on the tides had often been previously suggested, in a more or less vague way. Bacon's own theory seems to have been that the waters, under the influence of the sun, move naturally from east to west, but that they are driven back by striking on the coasts of America. See his Tractate de Fluxu et Refluxu Maris, and the Introduction to it by Mr. Ellis (Ellis and Spedding, Vol. III. p. 39, etc.). This idea was probably suggested by the Gulf Stream, which, under the influence of the Trade-Winds, flows, in the early part of its course, westwards, from the coast of Africa to that of America, On Bacon's varying opinions as to the cause of the semi-menstrual, or spring and neap, tides, see notes on Aphorism 36 (i) and Aphorism 45. [TF]

Etiam ista proprietas levium, nimirum ut ferantur sursum, vacillat nonnihil [358]. Atque in hoc sumi potest pro *instantia foederis* bulla aquae. Si enim aër fuerit subter aquam, ascendit rapide versus superficiem aquae, per motum illum *plagae* [359] (quam vocat Democritus), per quam aqua descendens percutit et attollit aërem sursum; non autem per contentionem aut nixum aëris ipsius. Atqui ubi ad superficiem ipsam aquae ventum fuerit, tum cohibetur aër ab ulteriore ascensu [360], per levem resistentiam quam reperit in aqua non statim tolerante se discontinuari: ita ut exilis admodum sit appetitus aëris ad superiora.

[358] Bacon, we must recollect, was ignorant of the true explanation of the phenomena which we designate 'light' and 'heavy.' [TF]

[359] 'Declinat, inquit, atomus. Primum cur? aliam quandam viam motus habebunt a Democrito impulsionis, quam plagam ille appellat: a te, Epicure, gravitatis et ponderis.' Cicero, De Fato, Cap. 20. Δημόκριτος φύσει ἀκίνητα λέγων τὰ ἄτομα πληγῇ κινεῖσθαί φησιν. Simplic. ad Aristot, Phys. fol. 96, as quoted by Mullach. On this subject, see Mullach, Democriti Abderitae Operum Fragmenta, pp. 383-5. 'Epicurus in corporum insecabilium pondere motus naturalis principium esse voluit: contra, Democritus atomos natura sua immotas esse ratus violentum iis atque aeternum motum attribuit, ita ut non interna vi cierentur, sed extrinsecus percussae externo pulsu agitarentur. Hujus poslerioris motus, qui et ipse vibratione et vertigine fit, propria est, ni fallor, mutua Impulsio ἀλληλοτυ- πία, ἀντιτυπία, ἀντώθησις ἡ πρὸς ἄλληλα, quam Cicero de fato cap. 20 a Democrito πληγήν nominatam esse testatur,' etc.

Bacon also refers to this 'motus *plagae*' in Novum Organum II. 48 (3), and in Syiva Sylvarum, Exp. 24. In the latter passage, he says: 'But as for the swift ascent of the air, while it is under the water, that is a motion of percussion from the water; which itself descending driveth up the air; and no motion of levity in the air. And this Democritus called *motus plagae*.' It is almost needless to observe that Bacon's explanation is false. The lighter particles, of course, necessarily rise to the surface, being displaced by the heavier particles which sink to the bottom. [TF]

[360] This fact is due to the force of cohesion in the particles of water, but, when that force is overcome by the efforts of the air to escape, the bubble bursts. [TF]

Similiter sit natura inquisita Pondus. Est plane divisio recepta, ut densa et solida ferantur versus centrum terrae, rara autem et tenuia versus ambitum coeli; tanquam ad loca sua propria. Atque loca quod attinet, (licet in scholis hujusmodi res valeant) plane inepta et puerilis cogitatio est, locum aliquid posse [361]. Itaque nugantur philosophi cum dicant quod, si perforata esset terra, corpora gravia se sisterent quando ventum esset ad centrum [362]. Esset enim certe virtuosum plane et efficax genus nihili, aut puncti mathematici, quod aut alia afficeret, aut rursus quod alia appeterent [363]: corpus enim non nisi a corpore patitur. Verum iste appetitus ascendendi et descendendi aut est in schematismo corporis quod movetur, aut in sympathia sive consensu cum alio corpore [364]. Quod si inveniatur aliquod corpus densum et solidum, quod nihilominus non feratur ad terram [365], confunditur hujusmodi divisio. At si recipiatur opinio Gilberti [366], quod magnetica vis terrae ad alliciendum gravia non extendatur ultra orbem virtutis suae (quae operatur semper ad distantiam certam, et non ultra), hocque per aliquam instantiam verificetur; ea demum erit *instantia foederis* circa hoc subjectum [367]. Neque tamen occurrit impraesentiarum aliqua instantia super hoc certa et manifesta. Proxime videntur accedere cataractae coeli [368], quae in navigationibus per Oceanum Atlanticum versus Indias utrasque saepe conspiciuntur. Tanta enim videtur esse vis et moles aquarum quae per hujusmodi cataractas subito effunditur, ut videatur collectio aquarum fuisse ante facta, atque in his locis haesisse et mansisse; et postea potius per causam violentam dejecta et detrusa esse, quam naturali motu gravitatis cecidisse; adeo ut conjici possit, corpoream molem densam atque compactam in magna distantia a terra fore pensilem tanquam terram ipsam, nec casuram nisi dejiciatur. Verum de hoc nil certi affirmamus. Interim in hoc et in multis aliis facile apparebit, quam inopes simus historiae naturalis; cum loco instantiarum certarum nonnunquam suppositiones afferre pro exemplis cogamur.

[361] Bacon's own theory evidently being that it is not place, but 'sympathia sive consensus cum alio corpore,' which determines the motion of light things upwards and heavy things dovm wards. See a striking passage, which is exactly to the point, in the beginning of the Thema Coeli (Ellis and Spedding, Vol. III. p. 769): ' Videtur itaque natura rerum, in dispertitione materiae, disclusisse tenuia a crassis; atque globum terrae crassis, omnia vero ab ipsa superficie terrae et aquarum ad ultima coeli usque tenuibus sive pneumaticis assignasse; tanquam geminis rerum classibus primariis, non aequis scilicet sed convenientibus portionibus, Neque vero vel aqua in nubibus haerens vel ventus in terra conclusus naturalem et propriam rerum collocationem confundit. Haec vero differentia tenuis vel pneumatici et crassi vel tangibilis oinnino primordialis est, et ea qua maxime utitur *systema universi*. Sumpta autem est ex rerum conditione omnium simplicissima, hoc est copia et paucitate materiae pro exporrectione sua.' [TF]

[362] While men remained ignorant of the laws of accelerating forces, this consequence was a necessary inference from the Peripatetic doctrine that heavy bodies tend downwards. It would also follow from the thesis propounded by Gilbert: 'Centrum Virtutum magneticarum in tellure, est telluris centrum.' De Magnete, Libro h. Cap. 27.

The true account is that, if a tube were bored through the centre of the earth, a body would oscillate between the point on the surface or within the tube from which it was dropped and the corresponding point on the opposite surface or within the opposite part of the tube; and, if there were no resisting medium, this oscillation would go on for ever. See Price's Infinitesimal Calculus, Vol. III. § 233. The theorem is there proved of a homogeneous sphere, but, though the earth is not homogeneous, heterogeneity on one side of the centre is approximately balanced by corresponding heterogeneity on the other, and hence the conclusion is approximately true. Taking into account, however, the influence of a resisting medium, the body would, after an enormous number of oscillations, ultimately rest at the centre.

Galileo states this case, and resolves it rightly. See Dialogo dei Massimi Sistemi, Giornata Seconda, Florence Ed. of 1842, Vol. I. pp. 251-2 (Sir Thomas Salusbury's Translation, pp. 203-4). [TF]

[363] The sentence is ironical, 'For it would certainly be a very powerful and efficacious kind of nothing, or mathematical point, which could either affect Other things, or again which other things might seek.'

It seems strange that Bacon did not perceive that the position which he criticises would be quite in accordance with any interpretation which could be put on the 'sympathia sive consensus' of which he speaks below, and that it would be no real exception to the rule 'corpus non nisi a corpore patitur.' [TF]

[364] CP. Aphorism 36 (3) and notes. It will be noticed that the words 'iste appetitus ascendendi et descendendi ' imply the notion of positive levity. [TF]

[365] It is curious here to notice how far Bacon was from seeing that the moon was exactly a case in point, or from divining the true bond of connexion ('foederis sive unionis') between its revolution round the earth and the phenomena of falling bodies. [TF]

[366] See De Magnete, Libro II. Cap. 7. The expression 'orbis virtutis,' as applied both to the earth and to ordinary magnets, is common throughout the book, and is defined, at the beginning, as 'totum illud spatium, per quod quaevis magnetis virtus extenditur.'

The phenomena of gravitation, it must be recollected, are explained by Gilbert as cases of magnetism. [TF]

[367] Both this and the next case, Bacon conceived, would afford examples of Instantiae Foederis, by proving that heavy bodies, though left free, may be at rest. They show how immature were his conceptions of motion, as well as of gravity. [TF]

[368] On the phenomena of Whirlwinds, Waterspouts, and Dust-Storms, see Sir John Herschel's Meteorology, pp. 241-7. After describing Whirlwinds, he says: 'They are often

terminated by heavy falls of rain, a very obvious consequence of the sudden transfer of a great mass of air nearly saturated with vapour at the surface of the earth to a much higher level' He then continues: 'Whirlwinds of this kind taking place at sea give rise to waterspouts (trombes de mer), which are very singular and sometimes dangerous phenomena. Tall columns, apparently of cloud, and reaching from the sea to the clouds, are seen moving majestically along, often several at once, sometimes straight and vertical, at others inclined and tortuous, but always, when approached, perceived to be in rapid rotation. At their bases the sea is violently agitated, and heaped up with a leaping or boiling motion. Indeed, water would seem, at least in some cases, to be actually carried up in considerable quantity, and scattered round from a great height, as solid bodies are on land. Hence they have been supposed by some to draw water from the sea by suction, a thing obviously impossible.'

It is needless to point out how crude is both Bacon's account and his explanation of these phenomena. [TF]

Similiter sit natura inquisita Discursus Ingenii. Videtur omnino divisio vera, rationis humanae et solertiae brutorum. Attamen sunt nonnullae instantiae actionum quae eduntur a brutis, per quas videntur etiam bruta quasi syllogizare [369]: ut memoriae proditum est de corvo, qui per magnas siccitates fere enectus siti conspexit aquam in trunco cavo arboris [370]; atque cum non daretur ei intrare propter angustias, non cessavit jacere multos lapillos, per quos surgeret et ascenderet aqua ut bibere posset; quod postea cessit in proverbium.

[369] The observations and speculations of Mr. Darwin, Mr, Herbert Spencer, and others, have placed in an entirely new light the comparative psychology of man and the brute animals, and shown that here, as in the rest of nature, there is much less of discontinuity than was formerly imagined. In this, as in so many other places, Bacon seems to anticipate modem theories. [TF]

[370] In Sir Roger L'Estrange's Collection of Fables, under the head of Avianus' Fables, this story is told of 'A Crow and a Pitcher,' and the moral drawn is, 'There is a Natural Logick in Animals, over and above the Instinct of their kinds.' In Mr. Robinson Ellis' Edition of the Fables of Avianus, this Fable occurs as No. XXVII. [TF]

Similiter sit natura inquisita Visibile. Videtur omnino esse divisio vera et certa, lucis, quae est visibile originale et primam copiam facit visui, et coloris, qui est visibile secundarium et sine luce non cernitur, ita ut videatur nil aliud esse quam imago aut modificatio lucis [371]. Attamen ex utraque parte circa hoc videntur esse instantiae foederis; scilicet, nix [372] in magna quantitate, et flamma sulphuris [373]; in quarum altera videtur esse color primulum lucens, in altera lux vergens ad colorem.

[371] Mr. Ellis refers here to Telesius, De Rerum Natura, Libro VII. Cap. 31, the title of the chapter being 'Non colorem, sed lucem proprium esse visus sensile.' The correspondence between his language and Bacon's is not very close, though it is quite

possible that, by reflecting on this and other chapters of Book vii, Bacon's optical theories may have been suggested to him. [TF]

[372] This is not really an 'instantia foederis.' Snow, like other white bodies, reflects all the light thrown on it, and is, therefore, more easily visible than bodies which absorb part of the light; but it is not, in any sense, an independent source of light, like the sun or a flame. [TF]

[373] All flames, not merely that of sulphur, appear coloured, the particular tint depending partly on the nature and proportion of the various substances in combustion, partly on the medium through which the flame is seen. Thus, flame, being both a source of light and also itself a coloured object, might properly be regarded as an 'instantia foederis.' [TF]

XXXVI.

Inter *praerogativas instantiarum*, ponemus loco decimo quarto *Instantias Crucis* [374]; translato vocabulo a *Crucibus*, quae erectae in biviis indicant et signant viarum separationes. Has etiam *Instantias Decisorias* et *Judiciales*, et in casibus nonnullis *Instantias Oraculi* et *Mandati*, appellare consuevimus. Earum ratio talis est. Cum in inquisitione naturae alicujus intellectus ponitur tanquam in aequilibrio, ut incertus sit utri naturarum e duabus, vel quandoque pluribus, causa naturae inquisitae attribui aut assignari debeat, propter complurium naturarum concursum frequentem et ordinarium [375], *instantiae crucis* ostendunt consortium unius ex naturis (quoad naturam inquisitam) fidum et indissolubile, alterius autem varium et separabile; unde terminatur quaestio, et recipitur natura illa prior pro causa, missa altera et repudiata. Itaque hujusmodi instantiae sunt maximae lucis, et quasi magnae authoritatis; ita ut curriculum interpretationis quandoque in illas desinat, et per illas perficiatur. Interdum autem *Instantiae Crucis* illae occurrunt et inveniuntur inter jampridem notatas [376]; at ut plurimum novae sunt, et de industria atque ex composito quaesitae et applicatae, et diligentia sedula et acri tandem erutae.

[374] These are far the most celebrated of Bacon's 'Praerogativae Instantiarum.' A 'crucial instance' has become a household word in the English language, and is, perhaps, far more widely used than any other technical term of the Inductive Logic. According to the metaphor, there are two or more ways before us, and the observation or experiment in question acts as a 'guide-post' (crux) in determining us which to take. We have two or more rival hypotheses, which equally well accord with the facts hitherto observed, and then we think of some decisive experiment or observation, which, by according with one of the theories, and that only, will enable us summarily to reject the others. One of the simplest and most familiar examples is to be found in chemical processes, as where we employ a *test* for the purpose of determining the nature of a particular substance or of detecting the presence of a particular poison.

In logical classification, all crucial instances may be regarded as applications of the Method of Difference. All other circumstances being the same, the appearance or disappearance, the existence or non-existence of some one circumstance, or combination of circumstances, enables us to determine the question at issue.

Various examples of Mnstantiae crucis' are adduced by myself in my Inductive Logic (4th Ed., pp. 149-152), by Professor Playfair in his Preliminary Dissertation, by Sir John Herschel in his Discourse on the Study of Natural Philosophy (§§ 196, 197, 218, 246), and by Dr. Hippus in his account of the Novum Organum, published by the Society for the Diffusion of Useful Knowledge. To these I must refer the reader, as I have space for one example only, which I take from Sir John Herschel:

'The discovery of Torricelli was, however, at first much misconceived, and even disputed, till the question was finally decided by appeal to a *crucial instance*, one of the first, if not the very first on record in physics, and for which we are indebted to the celebrated Pascal. His acuteness perceived that if the weight of the incumbent air be the direct cause of the elevation of the mercury, it must be measured by the amount of that elevation, and therefore that, by carrying a barometer up a high mountain, and so ascending into the atmosphere above a large portion of the incumbent air, the pressure, as well as the length of the column sustained by it, must be diminished; while, on the other hand, if the phenomenon were due to the cause originally assigned, no difference could be expected to take place, whether the observation were made on a mountain or on the plain. Perhaps the decisive effect of the experiment which he caused to be instituted for the purpose on the Puy de Dôme, a high mountain in Auvergne, while it convinced every one of the truth of Torricelli's views, tended more powerfully than any thing which had previously been done in science to confirm, in the minds of men, that disposition to experimental verification which had scarcely yet taken full and secure root.' Discourse, etc., § 246.

Dr. Hippus draws a very useful distinction between tests or experimenta crucis which are decisive both ways and those which are what he calls unilateral:

'Thus, if a flame burns in any gas submitted to experiment, we may roughly (though only roughly) conclude that such gas contains oxygen; hut, if the flame is extinguished, we cannot, therefore, conclude that the gas contains no oxygen, for the oxygen present may be in too close combination with some other substance, to enable it to support combustion. But a perfect test would be weighing any gas; for if it be heavier than common air, in the ratio of 1,435 to 1.2, it is oxygen; if lighter or heavier, it is not. Thus, too, in discussing whether a given writing be innocent or libellous, that is, maliciously composed, or composed with any improper motive of any kind, the truth is a unilateral test; for if the allegations be false, there must be malice; but there may be malice also, though the matter stated be true. There would arise very great distinctness in argumentation, were we to adopt this convenient phrase of a complete and an incomplete or unilateral test — many of the errors in reasoning, especially upon moral subjects, arising from mistaking incomplete for complete tests.' Account, Etc., pt. II. p.

20. I have been compelled, for the sake of clearness, to alter the phraseology of the first sentence. [TF]

[375] In other words, on account of the difficulty of disentangling from the mass of antecedents the one which stands in the relation of cause to the given effect. [TF]

[376] As, for instance, among the 'instantiae solitariae,' 'instantiae ostensivae,' etc. In fact, as already noticed, Bacon's 'instances' are, by no means, mutually exclusive, and a 'crucial instance, always falls under the head of 'solitary instances,' and generally under some other head as well. Most crucial instances, however, are specially invented for the purpose of enabling us to decide between rival hypotheses, and hence, under whatever other head they may fall, they are primarily crucial instances. They are made, not found. This is what Bacon appears to mean by the next clause. [TF]

(1) Exempli gratia; sit natura inquisita Fluxus et Refluxus Maris, ille bis repetitus in die atque sexhorarius in accessibus et recessibus singulis, cum differentia nonnulla quae coincidit in motum lunae [377]. Bivium circa hanc naturam tale est.

[377] For Bacon's views as to the influence of the moon on the spring and neap tides, see my note on the following passage in Aphorism 45: 'Rursus, si sit aliqua vis magnetica, quae operetur per consensum * * * inter globum lunae et aquas iiiaris (quae maxime credibilis videtur in fluxibus et reduxibus semi-menstruis)d The semi-menstrual and semi-diurnal phenomena of the tides were at this time frequently explained on distinct principles. [TF]

Necesse prorsus est ut iste motus efficiatur, vel ab aquarum progressu et regressu, in modum aquae in pelvi agitatae [378], quae quando latus unum pelvis alluit, deserit alterum; vel a sublatione et subsidentia aquarum e profundo, in modum aquae ebullientis et rursus subsidentis [379]. Utri vero causae fluxus et refluxus ille assignari debeat, oritur dubitatio. Quod si recipiatur prior assertio, necesse est ut cum sit fluxus in mari ex una parte, fiat sub idem tempus alicubi in mari refluxus ex alia. Itaque ad hoc reducitur inquisitio. Atqui observavit Acosta, cum aliis nonnullis (diligenti facta inquisitione), quod ad litora Floridae et ad litora adversa Hispaniae et Africae [380], fiant fluxus maris ad eadem tempora, et refluxus itidem ad eadem tempora; non contra, quod cum fluxus fit ad littora Floridae, fiat refluxus ad littora Hispaniae et Africae. Attamen adhuc diligentius attendenti, non per hoc evincitur motus attolens, et abnegatur motus in progressu. Fieri enim potest, quod sit motus aquarum in progressu, et nihilominus inundet adversa littora ejusdem alvei simul; si aquae scilicet illae contrudantur et compellantur aliunde, quemadmodum fit in fluviis, qui fluunt et refluunt ad utrumque littus horis iisdem, cum tamen iste motus liquido sit motus in progressu, nempe aquarum ingredientium ostia fluminum ex mari. Itaque simili modo fieri potest, ut aquae venientes magna mole ab Oceano Orientali Indico compellantur et trudantur in alveum Maris Atlantici, et propterea inundent utrumque latus simul. Quaerendum itaque est, an sit alius alveus per quem aquae possint iisdem temporibus minui et refluere. Atque

praesto est Mare Australe [381], Mari Atlantico neutiquam minus, sed potius magis latum et extensum, quod ad hoc sufficere possit.

[378] This view was maintained by Galileo. See Dialog! dei Massimi Sistemij Giornata IV. He refers the alternate ebb and flow of the waters to the composition of the annual and diurnal motions of the earth. 'It being therefore presupposed that there are such contrarieties of motions in the parts of the terrestrial surface, whilst it turneth round upon its own centre, it is necessary that, in conjoyning this diurnal motion with the other annual, there do result an absolute motion for the parts of the said terrestrial superficies, one while very accelerate, and another while as slow again. * * * * * * * We will conclude, therefore, that like as it is true the motion of the whole globe, and of each of its parts, would be equal and uniforme, in case they did move with one single motion, whether it were the meet annual or the single diurnal revolution, so it is requisite that, mixing those two motions together, there do result thence for the parts of the said globe irregular motions, one while accelerated, and another while retarded, by means of the additions or subtractions of the diurnal conversion from the annual circulation. So that, if it be true (and most true it is, as experience proves) that the acceleration and retardation of the motion of the vessel makes water contained therein to run to and again the long wayes of it, and to rise and fall in its extreames, who will make scruple of granting that the said effect may, nay ought to succeed in the sea-waters, contained within their vessels, subject to such like alterations, and especially in those that distend themselves long-wayes from West to East, which is the course that the motion of those same vessels steereth? Now this is the most potent and primary cause of the ebbing and flowing, without the which no such effect would ensue.' Sir Thomas Salusbury's Translation, pp. 389-390. See Florence Ed. of 1842, Vol. I. pp. 462-4. The idea that the tides are due to the influence of the moon is alluded to and ridiculed by Galileo a few pages above. See p. 455 (Sir Thomas Salusbury's Translation, p. 383). It is noticed by Mr. Ellis (Ellis and Spedding, Vol. III. p. 44) that Galileo's theory was first propounded in a letter to Cardinal Orsino, dated 1616. This letter is to be found in the Florence Edition of Galileo's Works, Vol. II. pp. 387-406. [TF]

[379] From what follows, it is plain that Bacon, had he adopted this alternative, would have explained it by a magnetic force, attracting the waters. But, as Mr. Ellis says (E, and Vol. III. p, 41), 'One theory, that of Telesius and Patricius, compares the sea to the water in a caldron; that is to say, it rises and tends to boil over when its natural heat is called forth under the influence of the sun, moon, and stars, and then after a while subsides.' On this, and the other curious theories by which the action of the tides was explained by Bacon's predecessors and contemporaries, see the very interesting preface, prefixed by Mr. Ellis to the Tract De Fluxu et Refluxu Maris, Bacon's Works, Vol. III. pp. 39-46.

To this Preface and to some good account of the theory and phenomena of the tides, such as may be found in the Encyclopaedia Britannica, the student must be, once for all, referred for further information on this subject. It would be a waste of labour to attempt here to criticise or correct Bacon's remarks in detail. It may be sufficient to state generally that he confounds throughout currents and derivative tides with tides proper.

With, what Bacon says on the tides in this Aphorism, we should compare the passage in Aphorism 35, and also that on the phenomena of spring and neap tides in Aphorism 45, referred to in note 77 above. See also my notes on both these passages. [TF]

[380] Mr. Ellis says: 'I have not been able to find this statement in Acosta, who speaks of the synchronism of the tides on the opposite sides of South America, as shewn by the meeting of the tidal waves in the Straits of Magellan (iii. 14).' For further information on the observations and theories of Acosta, see Mr. Ellis' Preface to the De Fluxu et Refluxu Maris, Vol. III. pp. 45-6. [TF]

[381] Including what we now call the Southern and Pacific Oceans. [TF]

Itaque jam tandem perventum est ad *instantiam crucis* circa hoc subjectum. Ea talis est: si pro certo inveniatur, quod cum fit fluxus ad littora adversa tam Floridae quam Hispaniae in Mari Atlantico, fiat simul fluxus ad littora Peruviae et juxta dorsum Chinae in Mari Australi; tum certe per hanc *instantiam decisoriam* abjudicanda est assertio quod fluxus et refluxus maris, de quo inquiritur, fiat per motum progressivum [382]: neque enim relinquitur aliud mare aut locus, ubi possit ad eadem tempora fieri regressus aut refluxus. Commodissime autem hoc sciri possit, si inquiratur ab incolis Panamae et Limae (ubi uterque Oceanus, Atlanticus et Australis, per parvum Isthmum separantur), utrum ad contrarias Isthmi partes fiat simul fluxus et refluxus maris, an e contra. Verum haec decisio sive abjudicatio certa videtur, posito quod terra stet immobilis. Quod si terra rotet [383], fieri fortasse potest ut ex inaequali rotatione (quatenus ad celeritatem sive incitationem) terrae et aquarum maris, sequatur compulsio violenta aquarum in cumulum sursum, quae sit fluxus: et relaxatio earundem (postquam amplius cumulari non sustinuerint) in deorsum, quae sit refluxus [384]. Verum de hoc facienda est inquisitio separatim. Attamen etiam hoc supposito, illud aeque manet fixum, quod necesse sit fieri alicubi refluxum maris ad eadem tempora quibus fiunt fluxus in aliis partibus.

[382] These facts, if established, would certainly have disproved the theory in question. [TF]

[383] On the disputed question of the rotation of the earth or the heavens, see the next section of this Aphorism, and CP. Introduction, pp. 33-36. [TF]

[384] Compare the theory of Galileo, noticed above, connecting the phenomenon of the tides with the rotation of the earth. [TF]

Similiter, sit natura inquisita posterior ille motus ex duobus quos supposuimus, videlicet motus maris se attollens et rursus subsidens; si forte ita acciderit ut (diligenti facto examine) rejiciatur motus alter, de quo diximus, progressivus. Tum vero erit trivium circa hanc naturam tale. Necesse est ut motus iste, per quem aquae in fluxibus et refluxibus se attollunt et rursus relabuntur, absque aliqua accessione aquarum aliarum quae

advolvuntur, fiat per unum ex his tribus modis; vel quod ista aquarum copia emanet ex interioribus terrae et rursus in illa se recipiat [385]; vel quod non sit aliqua amplior moles aquarum, sed quod eaedem aquae (non aucto quanto suo) extendantur sive rarefiant, ita ut majorem locum et dimensionem occupent, et rursus se contrahant [386]; vel quod nec copia accedat major nec extensio amplior, sed eaedem aquae (prout sunt tam copia quam densitate aut raritate) per vim aliquam magneticam [387] desuper eas attrahentem et evocantem, et per consensum, se attollant et deinde se remittant. Itaque reducatur (si placet) jam inquisitio (missis duobus illis motibus prioribus) ad hunc ultimum; et inquiratur si fiat aliqua talis sublatio per consensum sive vim magneticam. Atqui primo manifestum est universas aquas, prout ponuntur in fossa sive cavo maris, non posse simul attolli, quia defuerit quod succedat in fundo; adeo ut si foret in aquis aliquis hujusmodi appetitus se attollendi, ille ipse tamen a nexu rerum, sive (ut vulgo loquuntur) ne detur vacuum [388], fractus foret et cohibitus. Relinquitur, ut attollantur aquae ex aliqua parte, et per hoc minuantur et cedant ex alia. Enimvero rursus necessario sequetur ut vis illa magnetica, cum super totum operari non possit, circa medium operetur intensissime; ita ut aquas in medio attollat, illae vero sublatae latera per successionem deserant et destituant.

[385] 'Dubitatur etiamnum quibus ex causis intumescat Oceanus, vel quatenus, cum superfluus sibi fuerit, rursus in se residat. Nec in obscuro est, plura pro ingeniis differentium, potius quam pro veritatis fide expressa. Sed omisso ancipiti concurrentium quaestionum has opiniones probatissimas invenimus. Physici aiunt, mundum animal esse, eumque, ex variis elementorum corporibus conglobatum, moveri spiritu, regi mente: quae utraque diffusa per membra omnia aetemae molis vigorem exerceant. Sicut ergo in corporibus nostris commercia sunt spiritalia, ita in profundi Oceaninares quasdam mundi constitutas, per quas emissi anhelitus, vel reducti, modo inflent maria, modo revocent. At hi, quisiderum sequuntur disciplinam, contendunt meatus istos commoveri lunae cursibus: adeo utvicissitudines inter maciem aquarum et plenitudinem respiciant adauctus ejus vel eliquia: neque eodem semper tempore, sed prout ilia aut minuatur, aut crescat, variari alternantes recursus.' Solini Polyhistor. Cap. xxiii. ad fin, CP. with the latter opinion (which is to be found in the Pseudo-Aristotelian treatise, Περὶ Κόσμον, ch, 4. p. 396 a. 25-7), Pliny, Naturalis Historia II. 97 (99), sect. 212, etc., who refers the tides to the joint action of the Sun and Moon. [TF]

[386] This would be the opinion of Telesius and Patricias, referred to above in note 79. The same theory is maintained by Campanelia. [TF]

[387] See Gilbert, De Magnete, Libro II. Cap. 16 ad fin. From him Bacon may have taken the idea, which, if we compare the passage on attraction in Aphorism 45, he evidently seems inclined to adopt in reference to the phenomena of spring and neap tides.

In Kepler's Epitome Astronomiae Copernicanae, published in 1618, we find the following passage: ' Quemadmodum igitur, ut Magnes Magnetem aut ferrum trahat, cognatio corporum efficit: sic etiam de Luna non est incredibile, ut ilia moveatur a Terrae cognato corpore: licet nec hie nec illic intercedat aliquis contactus corporum. Adeoque quid

miruin, Lunam a terra moveri, cum videamus vicissim et Lunam transitu suo super vertices locorum causare fluxum Oceani reciprocum in Tellure? Nonne satis evidens hoc est documentuni communicationis motuum inter haec duo corpora?'

Gassendi, in his account of the various opinions on the causes of the tides (Physicae, Sectio III. Membrum Prius, Libro I. Cap. 4), says; 'Plurimi recurrunt ad Magneticam, seu tractoriam vim, qua nimirum Luna, supra mare transiens, ipsius aquas ad se alliciat, post transitum retro relaxet; sicque mare cogens intumescere detumescereque, Affluxum et Refluxum Creet.' [TF]

[388] We have seen already (ii. 8 ad init.) that Bacon denies the possibility of a vacuum. See also Aphorism 48, Motus Secundus, and the conclusion of the same Aphorism. As remarked by Mr. Ellis in his Preface to the Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 238), Bacon's opinions on this subject must have undergone a decided change after the time of his writing the Cogitationes de Rerum Natura and the Fable of Cupid. [TF]

Itaque jam tandem perventum est ad *instantiam crucis* circa hoc subjectum. Ea talis est: si inveniatur quod in refluxibus maris aquarum superficies in mari sit arcuata magis et rotunda, attollentibus se scilicet aquis in medio maris et deficientibus circa latera, quae sunt litora; et in fluxibus eadem superficies sit magis plana et aequa, redeuntibus scilicet aquis ad priorem suam positionem [389]; tum certe per hanc *instantiam decisoriam* potest recipi sublatio per vim magneticam, aliter prorsus abjudicanda est. Hoc vero in fretis per lineas nauticas non difficile est experiri [390]; videlicet utrum in refluxibus versus medium maris, mare non sit magis altum sive profundum quam in fluxibus. Notandum autem est, si hoc ita sit, fieri (contra ac creditur) ut attollant se aquae in refluxibus, demittant se tantum in fluxibus, ita ut littora vestiant et inundent.

[389] This is the case, though we know it to be so rather as a deduction from the theory of the tides than an induction from the observation of facts. The curvature is greatest when the tide is high, and least when it is low. [TF]

[390] 'In fretis' the tides are derivative, and, consequently, the experiment would not be conclusive. [TF]

(2) Similiter, sit natura inquisita Motus Rotationis spontaneus [391]; et speciatim, utrum Motus Diurnus, per quem sol et stellae ad conspectum nostrum oriuntur et occidunt, sit motus rotationis verus in coelestibus, aut motus apparens in coelestibus, verus in terra. Poterit esse instantia crucis super hoc subjectum talis. Si inveniatur motus aliquis in oceano ab oriente in occidentem, licet admodum languidus et enervatus; si idem motus reperiatur paulo incitatior in aëre, praesertim intra tropicos, ubi propter majores circulos est magis perceptibilis; si idem motus reperiatur in humilioribus cometis, jam factus vivus et validus; si idem motus reperiatur in planetis, ita tamen dispensatus et graduatus ut quo proprius absit a terra sit tardior, quo longius celerior, atque in coelo demum stellato sit velocissimus: tum certe recipi debet motus diurnus pro vero in coelis, et abnegandus est motus terrae; quia manifestum erit, motum ab oriente in occidentem

esse plane cosmicum et ex consensu universi, qui in summitatibus coeli maxime rapidus gradatim labascat, et tandem desinat et extinguatur in immobili, videlicet terra [392].

[391] Of this 'motus rotationis spontaneus' we shall hear more in Aphorism 48, Motus xvii. See also Aphorism 5, ad fin. These passages show how far Bacon was from having formed any true conception of the nature of Motion. [TF]

[392] If the heavens revolved with an uniform motion round the earth, it is plain that the more remote a point is from the earth, the more rapid would be its motion. But, suppose the earth to revolve on its axis, we should have exactly the same set of appearances as on the former supposition, and, if we were ignorant of the fact of the earth's rotation, we should imagine a distant point to move with much greater rapidity than a point which is near. Hence the conditions of this so-called Crucial Instance, even if satisfied, would equally well suit either hypothesis. But they are evidently complicated by the consideration of the proper motions of the planets and comets.

Dr. Whewell, who comments at some length on this example (History of the Inductive Sciences, 3rd Ed., Additions, Vol. I. pp. 388-390), adduces it as showing that Bacon, at least in his later years, was not so much opposed, as is commonly thought, to the Copernican theory. 'With regard to the diurnal motion of the earth,' he says, ' it would seem as if Bacon himself had a leaning to believe it when he wrote this passage; for neither is he himself, nor are any of the Anti-Copernicans, accustomed to assert that the immensely rapid motion of the sphere of the Fixed Stars graduates by a slower and slower motion of Planets, Comets, Air and Ocean, into the immobility of the Earth. So that the conditions are not satisfied on which he hypothetically says, "turn abnegandus est motus terrae." I must confess, however, that I cannot take so favourable a view. See Aphorism 46, where, speaking of the enormous velocity implied by the diurnal motion of the heavens, he says, 'quae etiam viros graves ita obstupefecit, ut mallent credere motum terrae,' evidently regarded as an extreme supposition. CP. also the end of the next paragraph of that Aphorism, and Aphorism 35, where, in discussing rest and motion, he says, 'statio, sive quies, videtur competere globo ipsi terrae.'

In the Introduction, Section 6, Bacon's attitude to the Copernican theory is discussed at some length. We must, of course, distinguish the passages in which he speaks of the diurnal from those in which he speaks of the annual motion of the earth. But that Whewell's argument, as derived from the passage in the text, is delusive, is plain from comparing a corresponding passage in the De Fluxu et Refluxu Maris (Ellis and Spedding, Vol. III. p. 53), where Bacon states dogmatically that it is an invariable rule that, the nearer a body approaches the earth, the slower is its motion of rotation.

It may be worth noticing that Telesius (De Rerum Natura, I. 3) insists on the motion of the air, resting the position partly on authority and partly on the sound produced by putting the hand or a horn to the ear. Bacon recurs to the motion of the air and water in II. 48 (17), where he seems to entertain no doubt on the subject. [TF]

Similiter, sit natura inquisita Motus Rotationis ille alter apud astronomos decantatus, renitens et contrarius Motui Diurno, videlicet ab occidente in orientem [393]; quem veteres astronomi attribuunt planetis, etiam coelo stellato [394], at Copernicus et ejus sectatores terrae quoque [395]; et quaeratur utrum inveniatur in rerum natura aliquis talis motus, an potius res conficta sit et supposita, ad compendia et commoditates calculationum, et ad pulchrum illud, scilicet de expediendis motibus coelestibus per circulos perfectos. Neutiquam enim evincitur iste motus esse in supernis verus et realis, nec per defectum restitutionis planetae in motu diurno ad idem punctum coeli stellati, nec per diversam politatem zodiaci, habito respectu ad polos mundi; quae duo nobis hunc motum pepererunt. Primum enim phaenomenon per anteversionem et derelictionem optime salvatur; secundum per lineas spirales; adeo ut inaequalitas restitutionis et declinatio ad tropicos possint esse potius modificationes motus unici illius diurni, quam motus renitentes aut circa diversos polos. Et certissimum est, si paulisper pro plebeiis nos geramus (missis astronomorum et scholae commentis, quibus illud in more est ut sensui in multis immerito vim faciant, et obscuriora malint), talem esse motum istum ad sensum [396], qualem diximus; cujus imaginem per fila ferrea (veluti in machina) aliquando repraesentari fecimus.

[393] 'The astronomers,' Bacon often says, 'insist on explaining the retardation of the inferior orbs by giving them a proper motion of their own, opposite to that which they derive from the starry heaven: surely it would be simpler to say that all the orbs move in the same direction with unequal velocities; the inequality depending on their remoteness from the prime mover.' Mr. Ellis' Preface to the Descriptio Globi Intellectualis, Ellis and Spedding, Vol. III. p, 720. To this Preface, to the Descriptio Globi Intellectualis and Thema Coeli themselves, to the De Augmentis Scientiarum, III. 4, to the De Fluxu et Refluxu Maris, and to the De Principiis atque Originibus, I must, once for all, refer the reader who is interested in ascertaining the peculiar astronomical theories to which Bacon inclined. Any elaborate examination of his views, or even of the present passage, would carry me far beyond the objects of this edition. Towards the end of the Thema Coeli (Ellis and Spedding, Vol. III. p. 779) he distinctly denies the reality of the motion from W. to E., and refers the phenomena of planetary motion to differences of speed. [TF]

[394] He is probably referring to those systems (cp, note 6 on Book I. Aphorism 60) which made the coelum stellatum distinct from the primum mobile. See Gassendi, Physicae Sectio 11. Libro III. Cap. 2 ad fin. Speaking of Fracastorius, who proposed the most complicated of all the systems of Concentrics, Gassendi says: 'At sphaerae Aplane, Stellarum Inerrantium istis omnibus' (i. e. the planetary spheres) 'superiori super extruxisse motibus ipsius variandis quinque alias, quibus adhuc fuerit Mobile Primum superponendum, adeo proinde, ut sphaeras statuerit septuaginta duas, aut saltern septuaginta.' [TF]

[395] For the old notion that the heavens revolve from E. to W., Copernicus substituted the hypothesis that the earth itself revolves from W. to E. [TF]

[396] ‘on his assertion,' says Dr. Whewell (in the passage referred to above), ‘that the motion of each separate planet is, to sense, a spiral, we may remark that it is certainly true: but that the business of science, here, as elsewhere, consists in resolving the complex phenomenon into simple phenomena; the complex spiral motion into simple circular motions.’ Bacon, both here and elsewhere, when he has occasion to treat of astronomical questions (see, for instance, De Augmentis Scientiarum, III. 4), depreciates the importance of mathematical calculations as applied to the motions of the heavenly bodies. And yet, without the aid of mathematics, where would have been the modern science of Astronomy? The simultaneous discovery of the planet Neptune by Adams and Le Verrier, as a result of the most elaborate mathematical investigations (to say nothing of the more familiar case of the prediction of eclipses), is alone a sufficient refutation of Bacon’s view. Formal Astronomy, or the consideration of the apparent motions of the heavenly bodies in Space and Time, was an essential prelude to Physical Astronomy, or the reference of these motions to their causes in Force and Matter. But, though Bacon went too far in depreciating Formal Astronomy, we must not forget that he was one of the first to point out the importance of Physical Astronorny, as well as of establishing a closer union between both branches of the science: ‘Quamobrem hanc partem Astronomiae, quae Physica est, desiderari statuimus. Eam Astronomiam Vivam nominabimus, ad differentiam bovis illius Promethei suffarcinati, et solummodo figura tenus bovis.’ De Augmentis Scientiarum, III. 4. CP. Descriptio Globi Intellectualis, Cap. 5. See also Introduction, pp. 38, 39. [TF]

Verum *instantia crucis* super hoc subjectum poterit esse talis. Si inveniatur in aliqua historia fide digna, fuisse cometam aliquem vel sublimiorem vel humiliorem [397] qui non rotaverit cum consensu manifesto (licet admodum irregulariter) motus diurni, sed potius rotaverit in contrarium coeli [398]; tum certe hucusque judicandum est posse esse in natura aliquem talem motum. Sin nihil hujusmodi inveniatur, habendus est pro suspecto, et ad alias *instantias crucis* circa hoc confugiendum.

[397] The distinction of higher and lower comets may be found in Seneca, Nat. Quaest. VII. 6, 7, and is there referred to Epigenes. Bacon, in the De FIuxu et Refluxu Maris (Ellis and Spedding, Vol. III. p. 53), speaks of the ‘lower comets’ as being lower than the orb of the moon. By many ancient philosophers, all comets were regarded as sublunar. It is needless to remark that, on the other hand, all true comets belong to the solar, and not to the terrestrial system. In reading ancient authors, however, it must always be borne in mind that they often designated mere atmospheric meteors by the name of comets. [TF]

[398] Whereas the planets and their satellites, with the sole known exception of the satellites of Uranus, revolve with what is called a direct motion, that is, from W. to E., the comets seem to be almost equally divided between those which have z. direct motion, from W. to E., and those which have a retrograde motion, from E., to W. But what Bacon desiderated was a comet whose proper motion from W. to E. more than compensated for the apparent diurnal motion of the heavens from E. to W., so that it might visibly move in the opposite direction to the heavens. This discovery, it appears, would have

convinced him that there is a motion of rotation from W. to E., and that this motion, which he regarded as feigned simply for the purpose of facilitating the calculations of astronomers ('res conficta et supposita,' ete.), is not merely a modification of the diurnal motion. If no such instance can be found, then, he says, we must continue to suspect the theory, till we can find some other crucial instance to settle the question. [TF]

(3) Similiter, sit natura inquisita Pondus sive Grave [399]. Bivium circa hanc naturam tale est. Necesse est ut gravia et ponderosa vel tendant ex natura sua ad centrum terrae, per proprium schematismum; vel ut a massa corporea ipsius terrae, tanquam a congregatione corporum connaturalium, attrahantur et rapiantur, et ad eam per consensum ferantur. At posterius hoc si in causa sit, sequitur ut quo propius gravia appropinquant ad terram, eo fortius et majore cum impetu ferantur ad eam; quo longius ab ea absint, debilius et tardius (ut fit in attractionibus magneticis); idque fieri intra spatium certum; adeo ut si elongata fuerint a terra tali distantia ut virtus terrae in ea agere non possit, pensilia mansura sint, ut et ipsa terra, nec omnino decasura.

[399] This paragraph does great credit to Bacon's sagacity, and is one of those which give him a claim to be regarded as a pioneer of science as well as a reformer of method. 'Voltaire,' says Mr. Ellis, 'cites the passage in the text in support of his remark that "le plus grand service, peut-être, que F. Bacon ait rendu à la philosophie a ètè de deviner l'attraction." But in reality the notion of attraction in one form or other (e, g. the attraction of the sea by the moon) sprang up in the infancy of physical speculation; and it cannot be affirmed that Bacon's ideas on the subject were as clear as those of his predecessor William Gilbert.' This criticism, I think, does Bacon scant justice. Even if the idea was suggested to him by the work of Gilbert, he ought, at least, to obtain the credit of having detached the conception of attraction from that of magnetism. Cp., however, p. 488, n. 31. [TF]

Itaque talis circa hanc rem poterit esse *instantia crucis*. Sumatur horologium [401] ex iis quae moventur per pondera plumbea, et aliud ex iis quae moventur per compressionem laminae ferreae; atque vere probentur, ne alterum altero velocius sit aut tardius; deinde ponatur horologium illud movens per pondera super fastigium alicujus templi altissimi, altero illo infra detento; et notetur diligenter si horologium in alto situm tardius moveatur quam solebat, propter diminutam virtutem ponderum. Idem fiat experimentum in profundis minerarum alte sub terra depressarum, utrum horologium hujusmodi non moveatur velocius quam solebat, propter auctam virtutem ponderum. Quod si inveniatur virtus ponderum minui in sublimi, aggravari in subterraneis [402], recipiatur pro causa ponderis attractio a massa corporea terrae.

[401] By this 'horologium' he must have meant a fly-clock, pendulum clocks not being yet known. [TF]

[402] Ingenious as the proposed experiment is, it shews an ignorance of — what, indeed, Bacon could not be expected to know— the difference in the law of attraction above, on, and below the earth's surface. For, while the attraction of a homogeneous sphere on

a particle external to it varies inversely as the square of the distance from the centre, the attraction of the same sphere on a particle upon or below its surface varies directly as the distance from the centre. Hence, the force of attraction reaches a maximum on the surface, and diminishes as we descend a mine, or as we ascend upwards from the surface of the earth. In other words, a clock moved by weights ought to go slower and slower, both the higher we ascend a mountain and the lower we descend a mine. In the former part of his supposition, therefore (which, taken by itself, furnishes a sufficient Crucial Instance), Bacon is right, in the latter wrong.

On the whole of this passage, the student should refer to Herschel's Discourse on the Study of Natural Philosophy, § 196. I have also noticed it in my Introduction, pp. 39, 40. [TF]

(4) Similiter, sit natura inquisita Verticitas Acus Ferreae, tactae magnete. Circa hanc naturam tale erit bivium. Necesse est ut tactus magnetis vel ex se indat ferro verticitatem ad septentriones et austrum; vel ut excitet ferrum tantummodo et habilitet, motus autem ipse indatur ex praesentia terrae; ut Gilbertus opinatur, et tanto conatu probare nititur [403]. Itaque huc spectant ea, quae ille perspicaci industria conquisivit. Nimirum quod clavus ferreus, qui diu duravit in situ versus septentriones et austrum, colligat mora diutina verticitatem, absque tactu magnetis [404]: ac si terra ipsa, quae ob distantiam debiliter operatur (namque superficies aut extima incrustatio terrae virtutis magneticae, ut ille vult, expers est), per moram tamen longam magnetis tactum suppleret, et ferrum exciret, deinde excitum conformaret et verteret. Rursus, quod ferrum ignitum et cadens, si in extinctione sua exporrigatur inter septentriones et austrum, colligat quoque verticitatem absque tactu magnetis: ac si partes ferri in motu positae per ignitionem, et postea se recipientes, in ipso articulo extinctionis suae magis essent susceptivae et quasi sensitivae virtutis manantis a terra quam alias, et inde fierent tanquam excitae. Verum haec, licet bene observata, tamen non evincunt prorsus quod ille asserit.

Instantia crucis autem circa hoc subjectum poterit esse talis. Capiatur terrella ex magnete, et notentur poli ejus; et ponantur poli terrellae versus orientem et occasum, non versus septentriones et austrum, atque ita jaceant; deinde superponatur acus ferrea intacta, et permittatur ita manere ad dies sex aut septem. Acus vero (nam de hoc non dubitatur) dum manet super magnetem, relictis polis mundi, se vertet ad polos magnetis; itaque quamdiu ita manet, vertitur scilicet ad orientem et occidentem mundi. Quod si inveniatur acus illa, remota a magnete et posita super versorium, statim se applicare ad septentriones et austrum, vel etiam paulatim se eo recipere, tum recipienda est pro causa, praesentia terrae; sin aut vertatur (ut prius) in orientem et occidentem, aut perdat verticitatem, habenda est illa causa pro suspecta, et ulterius inquirendum est [405].

[403] See Gilbert, De Magnete, throughout, and especially Libro Vol. Cap. I. There can now be no doubt of the truth of the latter alternative. The earth may be regarded as a vast magnet, whose poles are at some distance from the terrestrial poles, the angle

which the magnetic makes with the geographical meridian being known as the declination or variation of the magnetic needle. [TF]

[404] De Magnete, III. 12. The same chapter also contains an account of the next observation. [TF]

[405] The former alternative, of course, represents the facts. A needle, however magnetised, will, when allowed to turn freely, and removed from the influence of any other magnet, direct itself north and south. [TF]

(5) Similiter, sit natura inquisita Corporea Substantia Lunae [406]: an sit tenuis, flammea, sive aërea, ut plurimi ex priscis philosophis opinati sunt; an solida et densa, ut Gilbertus [407] et multi moderni, cum nonnullis ex antiquis, tenent. Rationes posterioris istius opinionis fundantur in hoc maxime, quod luna radios solis reflectat; neque videtur fieri reflexio lucis nisi a solidis [408].

[406] The nature of the substance of the heavenly bodies generally is considered in the Descriptio Globi Intellectualis, Cap. 7, and in the Thema Coeli. [TF]

[407] This must be an allusion to Gilbert's known opinions, not to his writings. For the posthumous book De Mundo nostro Sublunari, which contains his speculations on this subject, was not published till 1651. It may, however, have been read by Bacon in manuscript (see note on the words 'eosque particulares' in Aphorism 48 (8)). In this work, Libro II. capp. 13-16, Gilbert passes in review the various opinions of the ancients, and himself arrives at the following conclusion: 'Luna, diversa natura a Sole, est solida absque lumine substantia, diversa in eminentiis; non provenit unquam ab inspissatione imaginatae quintae essentiae, adeo ut densior pars sit sphaerae nugatoriae: sed astrum est, sicut tellus, suis spatiis motum habens. Tellus vero etiam sicut altera Luna est, quae etiam a Sole accepto lumine versus Lunam relucet, sicut Luna conceptum a Sole lumen in tellurem remittit; omne enim solidum lumen remittit.' For Aristotle's fifth element (quintessence), or aether, which he regarded as having a circular motion, and as extending ἄνω καὶ μέχρι σελήνης, see, amongst other places, Meteorologica, I. 3, De Coelo, I. 3, De Animalium Generatione, II. 3, and the spurious treatise De Mundo, Chapter 2, In the last passage, which I'epresents the doctrines of the Peripatetic school, the writer says: οὐρανοῦ δὲ καὶ ἄστρων οὐσίαν μὲν αἰθέρα καλοῦμεν, . . . στοιχεῖον οὖσαν ἕτερον τῶν τεττάρων, ἀκήρατόν τε καὶ θεῖον. In the De Animalium Generatione, III. ii (p. 761 b. 21,22), Aristotle speaks of the moon as composed of fire: ἀλλὰ δεῖ τὸ τοιοῦτον γένος (sc. τὸ τοῦ πυρός) ζητεῖν ἐπὶ τῆς σελήνης" αὕτη γὰρ φαίνεται κοινωνοῦσα τῆς τετάρτης ἀποστάσεως. [TF]

[408] This is certainly not Gilbert's argument, as it appears in his book. He argues quite rightly (Libro II. Cap. 13) to the opacity and solidity of the moon from the fact that, in a Solar Eclipse, it does not transmit any of the light of the Sun: 'Videmus enim in deliquiis solaribus, tanquam opacissima mole, Solis lumen sisti et averti.' So far from stating that

light is reflected only from solid bodies, he refers, in the course of his discussion, to the very familiar fact of the reflexion of light from water. [TF]

Itaque *instantiae crucis* circa hoc subjectum eae esse poterint (si modo aliquae sint) quae demonstrent reflexionem a corpore tenui, qualis est flamma, modo sit crassitiei sufficientis [409]. Certe causa crepusculi, inter alias, est reflexio [410] radiorum solis a superiore parte aëris. Etiam quandoque reflecti videmus radios solis temporibus vespertinis serenis a fimbriis nubium roscidarum, non minori splendore, sed potius illustriori et magis glorioso, quam qui redditur a corpore lunae [411]; neque tamen constat eas nubes coaluisse in corpus densum aquae. Etiam videmus aërem tenebrosum pone fenestras noctu reflectere lucem candelae, non minus quam corpus densum [412]. Tentandum etiam foret experimentum immissionis radiorum solis per foramen super flammam aliquam subfuscam et caeruleam. Sane radii aperti solis, incidentes in flammas obscuriores, videntur eas quasi mortificare, ut conspiciantur magis instar fumi albi quam flammae. Atque haec impraesentiarum occurrunt, quae sint ex natura *instantiarum crucis* circa hanc rem [413]; et meliora fortasse reperiri possunt. Sed notandum semper est, reflexionem a flamma non esse expectandam, nisi a flamma alicujus profunditatis; nam aliter vergit ad diaphanum. Hoc autem pro certo ponendum, lucem semper in corpore aequali [414] aut excipi et transmitti, aut resilire.

[409] All bodies, which are not absolutely black or absolutely transparent, reflect light, though, of course, in the most varying degrees. A flame is simply an ignited gas. [TF]

[410] Refraction, as well as Reflexion, enters into the explanation of this and similar phenomena. [TF]

[411] Mr. Ellis remarks that the comparison of the brightness of the moon in the daytime with that of a cloud was ingeniously applied by Bouguer to determine the ratio of the moon's light to the sun's. [TF]

[412] 'Bacon's reason for this phenomenon is wrong. It is really the polished surface of the glass which reflects the rays: and this is always the case, but is only visible to us when there is neither light nor object on the other side to destroy the image created.' Dr. Kitchin's note. [TF]

[413] All that these Instances prove is that other than solid bodies reflect light, and hence it follows that, because the moon reflects light, we cannot infer that it is a solid body. But, though they dispose of the argument, they do not dispose of the conclusion. How little Bacon anticipated that the time would come, when we should be able to weigh the moon, to know something of its chemical constituents, and to map out its surface with perfect accuracy!

The question whether other than solid bodies reflect light is a good example of an *unilateral* test (see the end of the first note on this Aphoism). If decided one way, it proves that the moon is a solid body; if decided the other way, it proves nothing. [TF]

[414] CP. Aphorism 23. There, he says, f corpora omnino aequalia (secundum portiones opticas) dare diaphanum.' The optical generalisation that every ray of light incident on a surface is either reflected, or transmitted, or absorbed, or disposed of in all or some of these ways, was, of course, unknown to Bacon. [TF]

(6) Similiter, sit natura inquisita Motus Missilium, veluti spiculorum, sagittarum, globulorum, per aërem. Hunc motum Schola (more suo) valde negligenter expedit; satis habens, si eum nomine motus violenti a naturali [415] (quem vocant) distinguat; et quod ad primam percussionem sive impulsionem attinet, per illud, *quod duo corpora non possint esse in uno loco, ne fiat penetratio dimensionum*, sibi satisfaciat; et de processu continuato istius motus nihil curet. At circa hanc naturam bivium est tale: aut iste motus fit ab aëre vehente et pone corpus emissum se colligente, instar fluvii erga scapham aut venti erga paleas; aut a partibus ipsius corporis non sustinentibus impressionem, sed ad eandem laxandam per successionem se promoventibus. Atque priorem illum recipit Fracastorius [416], et fere omnes qui de hoc motu paulo subtilius inquisiverunt: neque dubium est, quin sint aëris partes in hac re nonnullae; sed alter motus proculdubio verus est, ut ex infinitis constat experimentis [417]. Sed inter caeteras, poterit esse circa hoc subjectum *instantia crucis* talis; quod lamina, aut filum ferri paulo contumacius, vel etiam calamus sive penna in medio divisa, adducta et curvata inter pollicem et digitum exiliant. Manifestum enim est, hoc non posse imputari aëri se pone corpus colligenti, quia fons motus est in medio laminae vel calami, non in extremis [418].

[415] See notes on I. 66, II, 35. [TF]

[416] De Sympatbia et Antipathia, Cap. 4: 'Projecta quoqiie per eandem rarefactionem et condensationem portantur per aerem, partibus quidem, quae ante sunt, viam quodammodo aperientibus, et propellentibus undationem, iis vero, quae circa et a tergo, successive addensatis et rarefactis una post aliam, et projectum vehentibus non aliter ac per undam,' etc. He then attempts to account for the motion being slow at first, quicker afterwards, and ultimately ceasing altogether.

Mr. Ellis refers, for similar explanations, to Plato's Timaeus, p. 80 (Add. p. 79), and to Plutarch, Quaest. Platon. (Reiske's Plutarch, Vol. x. p. 177, 8 cc.). Of projectiles the latter, developing the Platonic doctrine, says: τὰ δὲ ῥιπτούμενα βάρη τὸν ἀέρα σχίζει μετὰ πληγῆς ἐκπεσόντα, καὶ διΐΐστησιν. ὁ δὲ περιῤῥέων ὀπίσω, τῷ φύσιν ἔχειν ἀεὶ τὴν ἐρημουμένην χώραν διώκειν καὶ ἀναπληροῦν, συνέπεται τῷ ἀφιεμένῳ, τὴν κίνησιν συνεπιταχύνων. He gives a similar account of lightning, cupping glasses, sounds, swallowing, and several other phenomena.

Aristotle also regards the motion of a projectile as maintained by the air. See Physics, IV. 8 (p. 215 a), VIII. 10 (pp. 266 b, 267 a). In the former passage, he says: ἔτι νῦν μὲν κινεῖται Ta ῥιπτούμενα TOD ὥσαντος οὐχ ἁπτομένου, ἢ OC ἀντιπερίστασιν, ὥσπερ ἔνιοί φασιν, ἢ διὰ τὸ ὠθεῖν τὸν ὠσθέντα ἀέρα θάττω κίνησιν τῆς τοῦ ὠσθέντος φορᾶς, ἣν φέρεται

εἰς τὸν οἰκεῖον τόπον. The latter passage, which is far the more elaborate, is too long to quote. On the former, Mr. Lewes comments in his work on Aristotle, pp. 132, 133.

To criticise this and similar theories of motion would be unduly to tax the patience of the reader. These very dark places of the ancient and mediaeval physics are at once illuminated by the simplicity of the First Law of Motion. [TF]

[417] Bacon did not see that the two cases which he had put were by no means exhaustive. Nor had he stated the problem rightly. The difficulty, as we now know, is not to account for the continued motion of a projectile, but for the cessation of its motion. [TF]

[418] He seems here, notwithstanding having drawn the distinction above, to mistake the question at issue, which was not as to the origin of the motion of a projectile, but as to its continuance. And even if his instance were to the point, it would only be decisive against the one theory, not in favour of the other.

In the Cogitationes De Natura Rerum, Cap. 8 (Ellis and Spedding, Vol. III. pp. 28-31), he treats this subject at greater length and adds other experiments, which are, however, no more decisive than the one given here. [TF]

(7) Similiter sit natura inquisita motus ille rapidus et potens Expansionis Pulveris Pyrii in flammam [419]; unde tantae moles subvertuntur, tanta pondera emittuntur, quanta in cuniculis majoribus et bombardis videmus. Bivium circa hanc naturam tale est. Aut excitatur iste motus a mero corporis appetitu se dilatandi, postquam fuerit inflammatum; aut ab appetitu mixto spiritus crudi, qui rapide fugit ignem, et ex eo circumfuso, tanquam ex carcere, violenter erumpit. Schola autem et vulgaris opinio tantum versatur circa priorem illum appetitum. Putant enim homines se pulchre philosophari, si asserant flammam ex forma elementi necessitate quadam donari locum ampliorem occupandi quam idem corpus expleverat cum subiret formam pulveris, atque inde sequi motum istum. Interim minime advertunt, licet hoc verum sit, posito quod flamma generetur, tamen posse impediri flammae generationem a tanta mole, quae illam comprimere et suffocare queat; ut non deducatur res ad istam necessitatem de qua loquuntur. Nam quod necesse sit fieri expansionem, atque inde sequi emissionem aut remotionem corporis quod obstat, si generetur flamma, recte putant. Sed ista necessitas plane evitatur, si moles illa solida flammam supprimat antequam generetur. Atque videmus flammam, praesertim in prima generatione, mollem esse et lenem, et requirere cavum in quo experiri et ludere possit. Itaque tanta violentia huic rei per se assignari non potest. Sed illud verum; generationem hujusmodi flammarum flatulentarum, et veluti ventorum igneorum, fieri ex conflictu duorum corporum, eorumque naturae inter se plane contrariae; alterius admodum inflammabilis, quae natura viget in sulphure; alterius flammam exhorrentis, qualis est spiritus crudus qui est in nitro; adeo ut fiat conflictus mirabilis, inflammante se sulphure quantum potest (nam tertium corpus, nimirum carbo salicis, nil aliud fere praestat, quam ut illa duo corpora incorporet et commode uniat), et erumpente spiritu nitri quantum potest, et una se dilatante (nam

hoc faciunt et aër, et omnia cruda, et aqua, ut a calore dilatentur), et per istam fugam et eruptionem interim flammam sulphuris, tanquam follibus occultis, undequaque exufflante.

[419] This question is also treated in the Cogitationes De Natura Rerum. See Cap. 9. Bacon's solution of the difficulty by referring the explosion to the 'conflict of two bodies,' and his language about the 'crude spirit which is in nitre,' are thoroughly characteristic both of his own chemical views and, generally, of those of his time. Chemistry, we must recollect, had hardly as yet put on a scientific form, and, moreover, it was peculiarly encumbered by the use of a fanciful and metaphorical language.

As to the true explanation of the great explosive power of gunpowder, it 'is due to the sudden development of a large volume of gaseous bodies, chiefly consisting of nitrogen and carbonic anhydride, which, at the ordinary temperature of the air, would occupy a space equal to about 300 times the bulk of the powder used; but, from the intense heat developed at the moment of the explosion, the dilation amounts to at least 500 times the volume of the gunpowder employed.' Miller's Elements of Chemistry, Part II. pp. 399-400. The principle of this explanation was first demonstrated by Jean Bernoulli. See Hoefer, Histoire de la Chimie, tome II. pp. 264-265. [TF]

Poterant autem esse *instantiae crucis* [420] circa hoc subjectum duorum generum. Alterum eorum corporum quae maxime sunt inflammabilia, qualia sunt sulphur, caphura, naphtha, et hujusmodi, cum eorum misturis; quae citius et facilius concipiunt flammam quam pulvis pyrius, si non impediantur: ex quo liquet appetitum inflammandi per se effectum illum stupendum non operari. Alterum eorum quae flammam fugiunt et exhorrent, qualia sunt sales omnes. Videmus enim, si jaciantur in ignem, spiritum aqueum erumpere cum fragore antequam flamma concipiatur; quod etiam leniter fit in foliis paulo contumacioribus, parte aquea erumpente antequam oleosa concipiat flammam. Sed maxime cernitur hoc in argento vivo, quod non male dicitur aqua mineralis. Hoc enim, absque inflammatione, per eruptionem et expansionem simplicem vires pulveris pyrii fere adaequat; quod etiam admixtum pulveri pyrio ejus vires multiplicare dicitur.

[420] These 'crucial instances' dispose of the rival hypothesis, but they do not establish Bacon's own. To state, exhaustively the various possible explanations in an example of this kind implies a far more scientific conception of the subject, than either Bacon or his contemporaries had yet attained. [TF]

(8) Similiter sit natura inquisita, Transitoria Natura Flammae, et Extinctio ejus Momentanea. Non enim videtur natura flammea hic apud nos figi et consistere, sed singulis quasi momentis generari, et statim extingui. Manifestum enim est in flammis, quae hic continuantur et durant, istam durationem non esse ejusdem flammae in individuo, sed fieri per successionem novae flammae seriatim generatae, minime autem manere eandem flammam numero; id quod facile perspicitur ex hoc, quod, subtracto alimento sive fomite flammae, flamma statim pereat. Bivium autem circa hanc naturam

tale est. Momentanea ista natura aut fit remittente se causa quae eam primo genuit, ut in lumine, sonis, et motibus (quos vocant) violentis; aut quod flamma in natura sua possit hic apud nos manere, sed a contrariis naturis circumfusis vim patiatur et destruatur [421].

[421] The extinction of a flame is, of course, due to the supply of one or other of the gases, by the combination of which it is produced, being cut off. So far is atmospheric air from being inimical to flame that, in by very far the great majority of cases, the oxygen which is contained in air is one of the gases by the combination of which flame is generated. At the same time, when oxygen is carried to the very heart of a flame, it instantly consumes the other gas, and so may extinguish the flame by destroying one of its constituents.

On the nature of flame (of which Bacon was quite ignorant), see Tyndall's Heat a Mode of Motion, 3rd Ed., § 49, etc., or Watts' Dictionary of Chemistry, article 'Combustion.' [TF]

Itaque poterit esse circa hoc subjectum *instantia crucis* talis. Videmus flammas in incendiis majoribus, quam alte in sursum ascendant. Quanto enim basis flammae est latior, tanto vertex sublimior. Itaque videtur principium extinctionis fieri circa latera, ubi ab aëre flamma comprimitur et male habetur. At meditullia flammae, quae aër non contingit sed alia flamma undique circumdat, eadem numero manent, neque extinguuntur donec paulatim angustientur ab aëre per latera circumfuso. Itaque omnis flamma pyramidalis est basi circa fomitem largior, vertice autem (inimicante aëre, nec suppeditante fomite) acutior. At fumus angustior circa basin ascendendo dilatatur, et fit tanquam pyramis inversa; quia scilicet aër fumum recipit, flammam (neque enim quispiam somniet aërem esse flammam accensam, cum sint corpora plane heterogenea [422]) comprimit [423].

[422] Here we may observe the influence of the old doctrine of the four elements, of which air and fire were two. [TF]

[423] The pyramidal form of flame is due to the fact that, while one of its constituents (oxygen) is equally diffused, the other has a definite source. The nearer this latter (which, in its pure condition, constitutes the 'unburnt core') is to its source, the larger is its volume; for the further it recedes from its source, the larger is the amount of it which is consumed. Smoke, on the other hand, not entering into combination or conflict with any other body, is able to diffuse itself freely, and, hence, assumes the form described in the text. In a certain sense, therefore, Bacon is right in ascribing the form of flame to its contact with the surrounding air. [TF]

Accuratior autem poterit esse *instantia crucis* ad hanc rem accommodata, si res forte manifestari possit per flammas bicolores. Capiatur igitur situla parva ex metallo, et in ea figatur parva candela cerea accensa; ponatur situla in patera, et circumfundatur spiritus vini in modica quantitate, quae ad labra situlae non attingat; tum accende spiritum vini. At spiritus ille vini exhibebit flammam magis scilicet caeruleam, lychnus candelae autem

magis flavam. Notetur itaque utrum flamma lychni (quam facile est per colorem a flamma spiritus vini distinguere; neque enim flammae, ut liquores, statim commiscentur) maneat pyramidalis, an potius magis tendat ad formam globosam, cum nihil inveniatur quod eam destruat aut comprimat [424]. At hoc posterius si fiat, manere flammam eandem numero, quamdiu intra aliam flammam concludatur nec vim inimicam aëris experiatur, pro certo ponendum est.

[424] A full account of this experiment is given in Sylva Sylvarum, Exp. 31. Mr. Ellis there remarks: 'The explanation of this experiment is simply that in impure air flames increase in size because the heated vapour of which they are composed diffuses itself before it meets with sufficient oxygen for complete combustion.'

Bacon may, perhaps, be credited with having seen, in a dim sort of way, that air had some connection with flame, but the whole of this speculation, like the two preceding ones, is wide of the mark. [TF]

Atque de *instantiis crucis* haec dicta sint. Longiores autem in iis tractandis ad hunc finem fuimus, ut homines paulatim discant et assuefiant de natura judicare per *instantias crucis* et experimenta lucifera, et non per rationes probabiles [425].

[425] Bacon, then, regarded these Instances as affording certainty, and, supposing the various alternatives to be stated exhaustively and the observations or experiments to be properly selected and rightly conducted, they would do so. [TF]

XXXVII.

Inter *praerogativas instantiarum* ponemus loco decimo quinto *Instantias Divortii*; quae indicant separationes naturarum earum quae ut plurimum occurrunt [426]. Differunt autem ab instantiis quae subjunguntur *instantiis comitatus* [427]; quia illae indicant separationes naturae alicujus ab aliquo concreto cum quo illa familiariter consuescit, hae vero separationes naturae alicujus ab altera natura [428]. Differunt etiam ab *instantiis crucis*; quia nihil determinant, sed monent tantum de separabilitate unius naturae ab altera. Usus autem earum est ad prodendas falsas formas, et dissipandas leves contemplationes ex rebus obviis orientes; adeo ut veluti plumbum et pondera intellectui addant [429].

[426] I think these words must mean: 'which for the most part occur *together*.' [TF]

[427] The reference is probably not to the Instantiae Subjunctivae of Aphorism 34, but to the Instantiae Hostiles of Aphorism 33. [TF]

[428] These instances seem to differ from the 'Instantiae Hostiles' of Aphorism 33 only in form. There a 'nature' is adduced as 'hostile' to or dissociated from some particular kind of concrete body; here one 'nature' is adduced as dissociated in certain cases, or in certain kinds of bodies, from some other nature. But the difference seems to consist

solely in the mode of stating the propositions, abstract terms or ‘natures’ being employed both in subject and predicate in tire one case, and, in the other, an abstract term or ‘nature’ being denied of some concrete body.

It might be said, by way of suggesting a difference, that the ‘Instantiae Divortii’ are exceptions to general rules, but then the ‘Instantiae Hostiles,’ so far as we can make out from the examples, seem to have this character as well. [TF]

[429] CP. i. 104. [TF]

Exempli gratia: sint naturae inquisitae quatuor naturae illae, quas *Contubernales* vult esse Telesius [430], et tanquam ex eadem camera; viz. calidum, lucidum, tenue, mobile sive promptum ad motum. At plurimae inveniuntur *instantiae divortii* inter ipsas. aër enim tenuis est et habilis ad motum, non calidus aut lucidus; luna lucida, absque calore; aqua fervens calida, absque lumine; motus acus ferreae super versorium pernix et agilis, et tamen in corpore frigido, denso, opaco; et complura id genus.

[430] See Telesius, De Rerum Natura, passim; especially Libro I. capp. I, 2, Thus, of the Sun, he says: 'omnino calidus, tenuis, candidus, mobilisque est Sol: Terra contra, frigida, crassa, immobilis, tenebricosaque.’ [TF]

Similiter sint naturae inquisitae Natura Corporea et Actio Naturalis. Videtur enim non inveniri actio naturalis, nisi subsistens in aliquo corpore. Attamen possit fortasse esse circa hanc rem *instantia* nonnulla *divortii*. Ea est actio magnetica, per quam ferrum fertur ad magnetem, gravia ad globum terrae [431]. Addi etiam possint aliae nonnullae operationes ad distans. Actio siquidem hujusmodi et in tempore fit, per momenta non in puncto temporis, et in loco, per gradus et spatia. Est itaque aliquod momentum temporis, et aliquod intervallum loci, in quibus ista virtus sive actio haeret in medio inter duo illa corpora quae motum cient. Reducitur itaque contemplatio ad hoc; utrum illa corpora quae sunt termini motus disponant vel alterent corpora media, ut per successionem et tactum verum labatur virtus a termino ad terminum, et interim subsistat in corpore medio; an horum nihil sit, praeter corpora et virtutem et spatia? Atque in radiis opticis et sonis et calore et aliis nonnullis operantibus ad distans, probabile est media corpora disponi et alterari [432]: eo magis, quod requiratur medium qualificatum ad deferendam operationem talem. At magnetica illa sive coitiva virtus admittit media tanquam adiaphora, nec impeditur virtus in omnigeno medio. Quod si nil rei habeat virtus illa aut actio cum corpore medio, sequitur quod sit virtus aut actio naturalis ad tempus nonnullum et in loco nonnullo subsistens sine corpore; cum neque subsistat in corporibus terminantibus, nec in mediis. Quare actio magnetica poterit esse *instantia divortii* circa naturam corpoream et actionem naturalem. Cui hoc adjici potest tanquam corollarium aut lucrum non praetermittendum: viz. quod etiam secundum sensum philosophanti [433] sumi possit probatio quod sint entia et substantiae separatae et incorporeae [434]. Si enim virtus et actio naturalis, emanans a corpore, subsistere possit aliquo tempore et aliquo loco omnino sine corpore; prope est ut possit etiam emanare in origine sua a substantia incorporea. Videtur enim non minus requiri

natura corporea ad actionem naturalem sustentandam et devehendam, quam ad excitandam aut generandum.

[431] CP. last Aphorism, Example (3), where, on the other hand, he appears undoubtedly to distinguish between magnetic attraction and the attraction exercised by the earth. Possibly, in the present place, he may be using the word 'magnetic' only in a vague and general sense, as — attractive. Notice the words 'sive coitiva' below.

Bacon's idea appears to have been that magnetism and terrestrial attraction (which he here seems, at least, to speak of as if they were the same) act without affecting the intermediate bodies (air, ether, or whatever they may be); that they act in time; and, hence, that 'the natural action' or 'virtue' is, as it were, for a while suspended between the acting body and the body acted upon. From these circumstances he infers that 'natural action' may be detached from any 'corporeal nature.'

The manner in which gravitation acts is still unknown. We know the fact and the law, but all the rest is mere matter of speculation. Whether the force does or does not require a material medium for its propagation, and whether it is or is not transmitted in time, are questions which have not yet been resolved and which, perhaps, admit of no solution. It was calculated by Laplace that, if its velocity be measurable at all, it must be, at least, fifty millions of times greater than the velocity of light. As to the medium, though there are grounds for believing in the existence of a subtle and elastic ether pervading all space, there is no positive evidence for connecting with this medium the phenomena of gravitation.

Similarly, there is no evidence to shew whether magnetic and electrical *attraction* require time for their transmission, and a medium in which to act. The velocity of *conducted* electricity has been calculated, for various media, by Wheatstone and others. See Ganot's Physics, 12th Ed. of Transl., §796. [TF]

[432] Bacon ought, perhaps, to have some credit for having so far divined the conditions of the action of heat, light, and sound. [TF]

[433] That is, even to the Natural Philosopher. The same expression occurs, and I think in the same sense, in De Augmentis Scientiarum IV. 3 ad init. (Ellis and Spedding, Vol. I. p. 605). [TF]

[434] The reasoning by which Bacon arrives at this conclusion is, it must be confessed, of a very fanciful character, and, in fact, the whole of this discussion is marked by an excess of subtlety with which we do not often meet in Bacon's writings. As to the conclusion itself, it is of some importance as bearing on the *quaestio vexata* of Bacon's theological views. CP. Locke's Essay, Book IV. Chapter 10. § 19: 'We cannot conceive how anything but Impulse of Body can move body; and yet that is not a reason sufficient to make us deny it possible, against the constant experience we have of it in ourselves in all our voluntary motions, which are produced in us only by the free action or Thought

of our own minds, and are not nor can be the effects of Impulse or Determination of the motion of blind matter in or upon our bodies * * * 'Tis an over-valuing ourselves to reduce all to the narrow measure of our capacities; and to conclude all things impossible to be done, whose manner of doing exceeds our comprehension. This is to make our Comprehension infinite or God finite, when what he can do is limited to what we can conceive of it.' In Book II. Chapter 23. § 32, and elsewhere, he maintains that it is ^no more a contradiction, that Thinking should exist separate and independent from Solidity, than it is a contradiction, that Solidity should exist separate and independent from Thinking * * * and, having as clear and distinct ideas in us of Thinking as of Solidity, I know not why we may not as well allow a thinking thing without Solidity, i. e. *immaterial*, to exist, as a solid thing without Thinking, i. e. *matter*, to exist.' Hobbes, on the other hand, regarded the expressions 'incorporeal spirit,' 'incorporeal substance,' etc., as contradictions in terms, and seems to have thought that they had no meaning, even when applied to God. See Leviathan, Part I. Chapter 12, Part III. Chapter 34, and other places. [TF]

XXXVIII.

Sequuntur quinque ordines instantiarum, quas uno vocabulo generali *Instantias Lampadis* [435] sive *Informationis Primae* appellare consuevimus. Eae sunt quae auxiliantur sensui. Cum enim omnis *interpretatio naturae* incipiat a sensu [436], atque a sensuum perceptionibus recta, constanti, et munita via ducat ad perceptiones intellectus, quae sunt notiones verae et axiomata; necesse est ut, quanto magis copiosae et exactae fuerint repraesentationes sive praebitiones ipsius sensus, tanto omnia cedant facilius et foelicius.

[435] The 'Instances' thus far described have for their office to assist the Understanding; the next five, called generically 'Instances of the Lamp,' serve to inform or supply the defects of the Senses. [TF]

[436] CP. I. 1, 19, 69, etc. [TF]

Harum autem quinque *instantiarum lampadis*, primae roborant, ampliant, et rectificant actiones sensus immediatas; secundae deducunt non-sensibile ad sensibile; tertiae indicant processus continuatos sive series earum rerum et motuum quae (ut plurimum) non notantur nisi in exitu aut periodis; quartae aliquid substituunt sensui in meris destitutionibus; quintae excitant attentionem sensus et advertentiam, atque una limitant subtilitatem rerum. De his autem singulis jam dicendum est.

XXXIX.

Inter *praerogativas instantiarum* ponemus loco decimo sexto *Instantias Januae* sive *Portae*: eo enim nomine eas appellamus quae juvant actiones sensus immediatas. Inter sensus autem manifestum est partes primas tenere Visum, quoad informationem; quare

huic sensui praecipue auxilia conquirenda. Auxilia autem triplicia esse posse videntur: vel ut percipiat non visa; vel ut majore intervallo; vel ut exactius et distinctius.

Primi generis sunt (missis bis-oculis [437] et hujusmodi, quae valent tantum ad corrigendam et levandam infirmitatem visus non bene dispositi, atque ideo nihil amplius informant) ea quae nuper inventa sunt perspicilla [438]; quae latentes et invisibiles corporum minutias, et occultos schematismos et motus (aucta insigniter specierum magnitudine) demonstrant; quorum vi, in pulice, musca, vermiculis, accurata corporis figura et lineamenta, necnon colores et motus prius non conspicui, non sine admiratione cernuntur. Quinetiam aiunt lineam rectam calamo vel penecillo descriptam, per hujusmodi perspicilla inaequalem admodum et tortuosam cerni: quia scilicet nec motus manus, licet per regulam adjutae, nec impressio atramenti aut coloris revera aequalia existant; licet illae inaequalitates tam minutae sint ut sine adjumento hujusmodi perspicillorum conspici nequeant. Etiam superstitiosam quandam observationem in hac re (ut fit in rebus novis et miris) addiderunt homines: viz. quod hujusmodi perspicilla opera naturae illustrent, artis dehonestent. Illud vero nihil aliud est quam quod texturae naturales multo subtiliores sint quam artificiosae. Perspicillum enim illud ad minuta tantum valet: quale perspicillum si vidisset Democritus, exiluisset forte, et modum videndi atomum (quem ille invisibilem [439] omnino affirmavit) inventum fuisse putasset. Verum incompetentia hujusmodi perspicillorum, praeterquam ad minutias tantum (neque ad ipsas quoque, si fuerint in corpore majusculo), usum rei destruit. Si enim inventum extendi posset ad corpora majora [440], aut corporum majorum minutias, adeo ut textura panni lintei conspici posset tanquam rete, atque hoc modo minutiae latentes et inaequalitates gemmarum, liquorum, urinarum, sanguinis, vulnerum, et multarum aliarum rerum, cerni possent [441], magnae proculdubio ex eo invento commoditates capi possent.

[437] Spectacles. Their invention, like that of the Microscope and Telescope, has been ascribed to Roger Bacon. But, however this may be (and there are many other claimants), the invention of what are ordinarily called ‘spectacles’ may be traced back at least as far as the end of the thirteenth century. See Encyclopaedia Britannica (9th Ed.), arts.' on Spectacles and the Microscope (Simple). [TF]

[438] Microscopes. It seems plain from the context that Bacon had not seen one. He speaks of them as lately invented. Supposing Roger Bacon to have described rather what he thought might be than what actually was constructed, we may, perhaps, refer the actual invention of compound microscopes to Zacharias Jansen of Middelburg, about 1590. ‘Jansen gave one of his microscopes to the Archduke, who gave it to Cornelius Drebbel, a salaried mathematician at the court of our James I.’ See life of Galileo, Chapter 6, in Library of Useful Knowledge. See also Enc. Br., art. on the Microscope; Montucla, Histoire des Mathématiques, Part IV. liv. IV. [HJ] [TF]

[HJ] It is not clear to me if “liv.” Stands for “LIV.” or for “Livre”. I need to clarify this later.

[439] Aristotle (De Generatione et Corruptione, I. 8), speaking of Leucippus, says: ἀλλ᾽ εἶναι τὸ τοιοῦτον οὐχ ἕν, ἀλλ᾽ ἄπειρα τὸ πλῆθος καὶ ἀόρατα διὰ σμικρότητα τῶν ὄγκων. [TF]

[440] This object is effected by means of the solar microscope. [TF]

[441] CP. New Atlantis (Ellis and Spedding, Vol. III. p. 162). It is needless to say that, with modern microscopes of high magnifying power', this is the case. [TF]

Secundi generis sunt illa altera perspicilla [442] quae memorabili conatu adinvenit Galilaeus; quorum ope, tanquam per scaphas aut naviculas, aperiri et exerceri possint propiora cum coelestibus commercia [443]. Hinc enim constat, galaxiam esse nodum sive coacervationem stellarum parvarum, plane numeratarum et distinctarum; de qua re apud antiquos tantum suspicio fuit [444]. Hinc demonstrari videtur, quod spatia orbium (quos vocant) planetarum non sint plane vacua aliis stellis, sed quod coelum incipiat stellescere antequam ad coelum ipsum stellatum ventum sit; licet stellis minoribus quam ut sine perspicillis istis conspici possint. Hinc choreas illas stellarum parvarum circa planetam Jovis (unde conjici possit esse in motibus stellarum plura centra) intueri licet. Hinc inaequalitates luminosi et opaci in luna distinctius cernuntur et locantur; adeo ut fieri possit quaedam seleno-graphia. Hinc maculae in sole, et id genus [445]: omnia certe inventa nobilia, quatenus fides hujusmodi demonstrationibus tuto adhiberi possit [446]. Quae nobis ob hoc maxime suspectae sunt, quod in istis paucis sistatur experimentum, neque alia complura investigatu aeque digna eadem ratione inventa sint.

[442] Telescopes. The merit of the invention of these instruments has been more hotly disputed than even that of single lenses and microscopes. A very interesting popular account of the controversy is given in the Life of Galileo above referred to, and the student may also consult Montucla, Histoire des Mathématiques, Pt. IV. liv. IV [442.1]. Delambre disposes of the claims of Fracastorius, Astronomie du Moyen Age, tome I. pp. 388-9. An exhaustive account of the construction, and a very full account of the history, of the Telescope, is to be found in the article on ‘Telescope’ recently contributed to the Encyclopaedia Britannica (9th Ed.), where the palm of invention is awarded to Hans Lippershey, Spectacle-maker of Middelburg, in 1608.

[442.1] It is not clear to me if “liv.” Stands for “LIV.” or for “Livre”. I need to clarify this later. More probably it stands for “Livre”. [HJ]

Though Galileo was not the actual inventor of the Telescope, he seems to have been the first who turned it to scientific uses, and it was, undoubtedly, through his discoveries by means of it that it first became celebrated. For a long time, also, the best telescopes were only to be procured from Galileo or his scholars. The first telescope constructed by him was presented to the Doge of Venice in 1609. [TF]

[443] ‘Compare this passage with that in the Descriptio Globi Intellectual is (c. v.), where Bacon speaks of Galileo’s invention and discoveries (the first-fruits of which had just been

announced) in a strain of more sanguine expectation: “Atque hoc inceptum et fine et aggressii nobile quoddam et humano genere dignum esse existimamus: eo magis quod hujusmodi ho- mines et ausu laudandi sint et fide; quod ingenue et perspicue proposuerunt, quomodo singula illis constiterint. Superest tantum constantia, cum magna judicii severitate, ut et instrumenta mutent, et testium numerum augeant, et singula et saepe experiantur, et varie; denique tit et sibi ipsi objiciant et aliis patefaciant quid in contrarium objici possit, et tenuissimum quemque scrupulum non spernant; ne forte illis eveniat, quod Democrito et aniculae suae evenit circa ficus mellitas, ut vetula esset philosopho prudentior, et magnae et admirabilis speculationis causae subesset error quispiam tenuis et ridiculus.” From this passage, written eight years before, we may learn (I think) why it was that Bacon had now begun to doubt how far these observations could be trusted. Believing, as he did, that all the received theories of the heavens were full of error, as soon as he heard that by means of the telescope men could really see so much further into the heavens than before, he was prepared to hear of a great number of new and unexpected phenomena; and his only fear was that the observers, instead of following out their observations patiently and carefully, would begin to form new theories. But now that nine years had passed since the discovery of Jupiter’s satellites, the spots in the sun, etc., and no new discovery of importance had been announced, he wondered how it could be that men seeing so much further should be able to see so little more than they did, and began to suspect that it was owing to some defect either in the instrument or in the methods of observation.’ This note I have borrowed from Mr. Spedding. [TF]

[444] See Mullach, Democriti Fragmenta, p. 391. Amongst other authors he quotes Stobaeus, Eel. Phys. p. 576: Δημόκριτος (τὸ γάλα ἔφη εἶναι) πολλῶν καὶ μικρῶν καὶ συνεχῶν ἀστέρων, συμφωτιζομένων ἀλλήλοις, διὰ τὴν πύκνωσιν, συναυγασμόν. CP. Aristotle, Meteorologica I. 8 (p. 345 a), where the same opinion is also attributed to Anaxagoras and his followers. See also Manilius, I. 725-32; Ovid, Met. I. 168, etc.

Democritus also maintained that the moon is a solid body, and that the marks on its face represent mountains and valleys. [TF]

[445] On these various discoveries, the last of which was also claimed by the monk Scheiner, see Delambre, Histoire de l’Astronomie Moderne, tome I. liv. vi, and Mr. Drinkwater’s Life of Galileo, printed in the Library of Useful Knowledge, above referred to; but specially the Sydereus Nuncius of Galileo himself. [TF]

[446] Galileo’s discoveries were often represented as mere optical delusions. The following amusing story is told of Scheiner (Baden Powell’s History of Natural Philosophy, p. 171): ^Scheiner was a monk; and, on communicating to the superior of his order the account of the spots, received in reply from that learned father a solemn admonition against such heretical notions: I have searched through Aristotle,” he said, “ and can find nothing of the kind mentioned: be assured, therefore, that it is a deception of your senses, or of your glasses,” ‘ One Lodovico delle Colombe maintained that the apparently

hollow parts of the moon were filled with pure transparent crystal, to which Galileo replied that he would gladly admit the theory, provided that, with equal courtesy, he was allowed to raise on the smooth surface crystal mountains ten times higher than those which he had ever seen and measured. [TF]

Tertii generis sunt bacilla illa ad terras mensurandas, astrolabia [447], et similia; quae sensum videndi non ampliant, sed rectificant et dirigunt. Quod si sint aliae instantiae quae reliquos sensus juvent in ipsorum actionibus immediatis et individuis, tamen si ejusmodi sint quae informationi ipsi nihil addant plus quam jam habetur, ad id quod nunc agitur non faciunt. Itaque earum mentionem non fecimus.

[447] These were astronomical instruments, used for the purpose of 'taking' or observing the stars. ' The ancient astrolabe consisted of two or more circles, having a common centre, and so inclined to each other as to enable the astronomer to observe in the planes of different circles of the sphere at the same time. For example, if the circles were at right angles, the instrument would give both longitude and latitude, or the right ascension and declination of a star. The equatorial, the altitude and azimuth instrument, and the theodolite, are instruments which answer the same purpose as the ancient astrolabe.' Brande and Cox's Dictionary of Science, etc. The term astrolabe is also employed to denote a planisphere. [TF]

XL.

Inter *praerogativas instantiarum* ponemus loco decimo septimo Instantias Citantes [448], sumpto vocabulo a foris civilibus, quia citant ea ut compareant quae prius non comparuerunt; quas etiam *Instantias Evocantes* appellare consuevimus. Eae deducunt non-sensibile ad sensibile.

[448] 'The *instantiae citantes* enable us to perceive things which are in themselves insensible, or not at all the objects of perception. They cite or place things, as it were, before the bar of the senses, and from this analogy to judicial proceedings is derived the name of *instantiae citantes*. Such, to employ examples which the progress of science has unfolded since the time of Bacon, are the air-pump and the barometer for manifesting the weight and elasticity of air; the measurement of the velocity of light, by means of the eclipses of the satellites of Jupiter, and the aberration of the fixed stars; the experiments in electricity and galvanism, and in the greater part of pneumatic chemistry. In all these instances things are made known which before had entirely escaped the. senses.' Playfair's Preliminary Dissertation. [TF]

Sensum autem fugiunt res, vel propter distantiam objecti locati [449]; vel propter interceptionem sensus per corpora media; vel quia objectum non est habile ad impressionem in sensu faciendam; vel quia deficit quantum in objecto pro feriendo sensu; vel quia tempus non est proportionatum ad actuandum sensum; vel quia objecti percussio non toleratur a sensu; vel quia objectum ante implevit et possedit sensum, ut novo motui non sit locus. Atque haec praecipue ad visum pertinent, et deinde ad tactum.

Nam hi duo sensus sunt informativi ad largum, atque de communibus objectis [450]; ubi reliqui tres non informent fere, nisi immediate et de propriis objectis.

[449] The first and fourth of these cases are, at first sight, hardly distinguishable from the 'Instantiae Januae.' But, when we come to the examples, we find that Bacon has in mind objects which cannot be known in themselves but can be known only by means of indications, whereas in the 'Instantiae Januae' the objects themselves can be detected, provided we have sufficiently powerful instruments. [TF]

[450] The impressions of sight and touch are so intimately associated, that, in most cases, one is an. index of the other. The student will not fail to recall, in connexion with this subject, Berkeley's New Theory of Vision as applied to the acquired perceptions of Sight and the numerous kindred theories, doubtless suggested by it, which have been applied in recent times to the elucidation of some of the more obscure problems of psychology. 'La vue et le toucher' (says Ribot, La Psychologie Allemande Contemporaine, Ecole Experimentale,p.i 12) 'sont deuxlangues que nous employons simultanement d^s notre naissance et qui se mêlent si bien qu'elles semblent n'en faire qu'une. De plus les donnees de la vue, par leur supériorite et leur richesse d'informiation, ont une tendance à effacer les autres.' [TF]

(1) In primo genere non fit deductio ad sensibile, nisi rei, quae cerni non possit propter distantiam, adjiciatur aut substituatur alia res quae sensum magis e longinquo provocare et ferire possit: veluti in significatione rerum per ignes, campanas, et similia [451].

[451] A 'glaring instance' will, of course, suggest itself in the Electric Telegraph. [TF]

(2) In secundo genere fit deductio, cum ea quae interius propter interpositionem corporum latent, nec commode aperiri possunt, per ea quae sunt in superficie, aut ab interioribus effluunt, perducuntur ad sensum: ut status humanorum corporum per pulsus, et urinas, et similia [452].

[452] Dr. Kitchin instances the Stethoscope.

'An excellent instance of the "deductio non-sensibilis ad sensibile" occurs in the experiments recently made by Messrs. Hopkins and Joule for determining the melting-point of substances subjected to great pressure. The substance acted on is enclosed in a tube out of reach and sight. But a bit of magnetised steel has previously been introduced into it, and is supported by it as long as it remains solid. A magnetic needle is placed beside the apparatus, a certain amount of deviation being, of course, produced by the steel within the tube. The moment the temperature reaches the melting-point, the steel sinks; and its doing so is indicated by the motion of the needle.' Mr. Ellis' note. [TF]

(3, 4) At tertii et quarti generis [453] deductiones ad plurima spectant, atque undique in rerum inquisitione sunt conquirendae. Hujus rei exempla sunt. Patet quod aër, et

spiritus, et hujusmodi res quae sunt toto corpore tenues et subtiles, nec cerni nec tangi possint. Quare in inquisitione circa hujusmodi corpora deductionibus omnino est opus.

[453] Of the third kind Dr. Kitchin gives good instances in the chemical detection of gases, and the discovery of Actinism in rays of the sun by exposure pf a plate of silver to them. The microscope (see note 49 above) is not an appropriate instance of the fourth kind. But we might find a good instance in the thermometer (which Bacon himself gives), or a still better one in the thermo-electric pile, as *indicating* small accessions of temperature, inappreciable to the senses. Tests of all kinds, as Bacon observes, fall under one or other of these heads. [TF]

Sit itaque natura inquisita Actio et Motus Spiritus qui includitur in corporibus tangibilibus [454]. Omne enim tangibile apud nos continet spiritum invisibilem et intactilem, eique obducitur atque eum quasi vestit. Hinc fons triplex potens ille et mirabilis processus spiritus in corpore tangibili. Spiritus enim in re tangibili, emissus, corpora contrahit et desiccat; detentus, corpora intenerat et colliquat; nec prorsus emissus nec prorsus detentus, informat, membrificat, assimilat, egerit, organizat, et similia. Atque haec omnia deducuntur ad sensibile per effectus conspicuos.

[454] CP. I. 50, II. 7, 13 (Inst. 38), 27, 50 (modus tertius). Bacon constantly recurs also in his other works to the idea of 'Spirit,' its various kinds, its operations, its effects, etc. See especially Sylva Sylvarum, Exp. 98 (Ellis and Spedding, Vol. II. pp. 380-82); Historia Vitae et Mortis (Ellis and Spedding, Vol. II. pp. 213-21); Historia Densi et Rari (Ellis and Spedding, Vol. II. pp. 254-6). In a note on I. 50, I have commented at some length on Bacon's conception of Spirit. See also the notes on II. 13 (Inst. 38) and 27. This antiquated piece of Physics or Metaphysics, it would be superfluous to annotate in detail. The reader will easily be able to notice for himself the more curious parts of the disquisition which follows.

It may be remarked that, though Bacon's account of 'Spirit' does not seem to be taken directly, at least without considerable modifications, from Paracelsus, there is much in common between the speculations of the two writers on this subject. I have not, however, thought it worth while to point out this fact in detail. [TF]

Etenim in omni corpore tangibili inanimato, spiritus inclusus primo multiplicat se, et tanquam depascit partes tangibiles eas quae sunt maxime ad hoc faciles et praeparatae, easque digerit et conficit et vertit in spiritum, et deinde una evolant. Atque haec confectio et multiplicatio spiritus deducitur ad sensum per diminutionem ponderis. In omni enim desiccatione, aliquid defluit de quanto; neque id ipsum ex spiritu tantum praeinexistente, sed ex corpore quod prius fuit tangibile et noviter versum est: spiritus enim non ponderat. Egressus autem sive emissio spiritus deducitur ad sensibile in rubigine [455] metallorum, et aliis putrefactionibus ejus generis quae sistunt se antequam pervenerint ad rudimenta vitae; nam illae [456] ad tertium genus processus pertinent. Etenim in corporibus magis compactis spiritus non invenit poros et meatus per quos evolet: itaque cogitur partes ipsas tangibiles protrudere et ante se agere, ita ut

illae simul exeant; atque inde fit rubigo, et similia. At contractio partium tangibilium, postquam aliquid de spiritu fuerit emissum (unde sequitur illa desiccatio), deducitur ad sensibile tum per ipsam duritiem rei auctam, tum multo magis per scissuras, angustiationes, corrugationes, et complicationes corporum, quae inde sequuntur. Etenim partes ligni desiliunt et angustiantur; pelles currugantur; neque id solum, sed (si subita fuerit emissio spiritus per calorem ignis) tantum properant ad contractionem ut se complicent et convolvant.

[455] Rust proper is due to the combination of iron with oxygen. Iron, as well as many other metals, becomes oxidised by exposure to moist air. [TF]

[456] This word, as Mr. Ellis suggests, should be illa. [TF]

At contra, ubi spiritus detinetur, et tamen dilatatur et excitatur per calorem aut ejus analoga (id quod fit in corporibus magis solidis aut tenacibus), tum vero corpora emolliuntur, ut ferrum candens; fluunt, ut metalla; liquefiunt, ut gummi, cera, et similia. Itaque contrariae illae operationes caloris (ut ex eo alia durescant [457], alia liquescant) facile conciliantur; quia in illis spiritus emittitur, in his agitatur et detinetur: quorum posterius est actio propria caloris et spiritus; prius, actio partium tangibilium tantum per occasionem spiritus emissi.

[457] The hardening produced by heat is due to the escape of moisture or to some chemical change in the substance.

Cp. Lucretius, vi. 959, etc.:

> 'Hue accedit uti non omnia, quae jaciuntur
> Corpora cumque ab rebus, eodem praedita sensu
> Atque eodem pacto rebus sint omnibus apta.
> Principio terrain sol excoquit et facit are,
> At glaciem dissolvit et altis montibus altas
> Extructasque nives radiis tabescere cogit.
> Denique cera liquelit in ejus posta vapore.
> Ignis item liquidum facit aes aurumque resolvit,
> At coria et carnem trahit et condiicit in unum.
> Umor aquae porro ferrum condurat ab igni,
> At coria et carnem mollit diirata calore.'

Virgil Eel. VIII. 80:

> 'Limus ut hie durescit, et haec ut cera liquescit
> Uno eodemque igni, sic nostro Daplinis amore.' [TF]

Ast ubi spiritus nec detinetur prorsus nec prorsus emittitur, sed tantum inter claustra sua tentat et experitur, atque nacta est partes tangibiles obedientes et sequaces in promptu, ita ut quo spiritus agit eae simul sequantur; tum vero sequitur efformatio in corpus

organicum, et membrificatio, et reliquae actiones vitales, tam in vegetabilibus quam in animalibus. Atque haec maxime deducuntur ad sensum per notationes diligentes primorum incoeptuum et rudimentorum sive tentamentorum vitae in animalculis ex putrefactione natis: ut in ovis formicarum, vermibus, muscis, ranis post imbrem, etc. Requiritur autem ad vivificationem et lenitas caloris et lentor corporis; ut spiritus nec per festinationem erumpat, nec per contumaciam partium coerceatur, quin potius ad cerae modum illas plicare et effingere possit.

Rursus, differentia illa spiritus, maxime nobilis et ad plurima pertinens (viz. spiritus abscissi, ramosi simpliciter, ramosi simul et cellulati; ex quibus prior est spiritus omnium corporum inanimatorum, secundus vegetabilium, tertius animalium), per plurimas instantias deductorias tanquam sub oculos ponitur.

Similiter patet, quod subtiliores texturae et schematismi rerum (licet toto corpore visibilium aut tangibilium) nec cernantur nec tangantur. Quare in his quoque per deductionem procedit informatio. At differentia schematismorum maxime radicalis et primaria sumitur ex copia vel paucitate materiae quae subit idem spatium sive dimensum. Reliqui enim schematismi (qui referuntur ad dissimilaritates partium, quae in eodem corpore continentur, et collocationes ac posituras earundem) prae illo altero sunt secundarii.

Sit itaque natura inquisita Expansio sive Coitio Materiae in corporibus respective: viz. quantum materiae impleat quantum dimensum in singulis. Etenim nil verius in natura quam propositio illa gemella, *ex nihilo nihil fieri*, neque *quicquam in nihilum redigi*: verum quantum ipsum materiae sive summam totalem constare, nec augeri aut minui [458]. Nec illud minus verum, *ex quanto illo materiae sub iisdem spatiis sive dimensionibus, pro diversitate corporum, plus et minus contineri* [459]: ut in aqua plus, in aëre minus; adeo ut si quis asserat aliquod contentum aquae in par contentum aëris verti posse, idem sit ac si dicat aliquid posse redigi in nihilum; contra, si quis asserat aliquod contentum aëris in par contentum aquae verti posse, idem sit ac si dicat aliquid posse fieri ex nihilo. Atque ex copia ista et paucitate materiae notiones illae densi et rari, quae varie et promiscue accipiuntur, proprie abstrahuntur. Assumenda est et assertio illa tertia, etiam satis certa: quod hoc de quo loquimur plus et minus materiae in corpore hoc vel illo ad calculos (facta collatione) et proportiones exactas aut exactis propinquas reduci possit [460]. Veluti si quis dicat inesse in dato contento auri talem coacervationem materiae, ut opus habeat spiritus vini, ad tale quantum materiae aequandum, spatio vicies et semel majore quam implet aurum, non erraverit [461].

[458] This principle is now known as that of the Indestructibility of Matter. Parallel to it, if not identical with it, is the principle of the Conservation of Energy. These laws are at once amongst the highest generalisations and the most illuminating principles of Science. Mr. Bain gives an excellent summary of the various aspects and consequences of the Principle of Conservation of Energy in his Inductive Logic, 1st Ed., p. 20, etc. (cp. p. 225, etc.); but the student who wishes to see a precise and, at the same time, a concise explanation of the principle in its relation to the recent treatment of Physics (of which,

indeed, it is the very foundation) should consult Professor Balfour Stewart's Elementary Treatise on Heat, 'Remarks on Energy — Historical and Preliminary,' Book III. Chapter i, 5th Ed. pp. 314-328, or the Article on Energy in the last (9th) Edition of the Encyclopaedia Britannica. By Professor Clerk Maxwell the principle has been stated as follows: 'The total energy of any body or system of bodies is a quantity which can neither be increased nor diminished by any mutual action of those bodies, though it may be transformed into any one of the forms of which energy is susceptible.' The work of Sir W. R. Grove (to which I referred in my First Edition) on the 'Correlation of Physical Forces' supplies some most interesting and instructive exemplifications of the transformation of the various forms of energy, one into another.

These maxims in the vaguer and more general forms in which they appear in the Novum Organum are of venerable antiquity. Thus Diogenes Laertius (ix. 44), recounting the opinions of Democritus, says: μηδέν τε ἐκ τοῦ μὴ ὄντος γίνεσθαι, μηδὲ εἰς τὸ μὴ ὂν φθείρεσθαι (cp. Plutarch, Adversus Colotem, Ed. Reiske, Vol. x. p. 569). The same dictum is ascribed to Diogenes of Apollonia (Diog. Laert. IX. 57). Aristotle and others repeat it. εἰ yap Tay μὲν τὸ γινόμενον ἀνάγκη γίνεσθαι ἢ ἐξ ὄντων ἢ ἐκ μὴ ὄντων, τούτων δὲ τὸ μὲν ἐκ μὴ ὄντων γίνεσθαι ἀδίνατον (περὶ γὰρ ταύτης ὁμογνωμονοῦσι τῆς δόξης ἅπαντες οἱ περὶ φύσεως), τὸ λοιπὸν ἤδη, κ.τ.λ. Arist, Phys. I. 4 (p. 1 87 a. 32-35).

'Principium cujus' (sc. naturae) 'bine nobis exordia sumet,
Nullam rem e nilo gigni divinitus unquam.
* * * * * * * * * * *
Quas ob i*es ubi viderimus nil posse creari
De nilo, turn quod sequimur jam rectius inde
Perspiciemus, et unde queat res quaeque creari
Et quo quaeque modo fiant opera sine divom.'

Lucretius, I. 149-158.

'Gigni
De niliilo nihilum, in nihilum nil posse reverti.'

Persius, Sat. III. 83-4.

οὐδὲν yap ἐκ τοῦ μηδενὸς ἔρχεται, ὥσπερ μηδ' εἰς τὸ οὐκ ὂν ἀπέρχεται.

Marcus Antoninus, IV. 4.

Telesius, De Rerum Natura, I. 5 (referred to by Mr. Ellis) says: 'Nihil tamen ejus ' (sc. materiae) ' moles, itaque nec mundi magnitudo imminui augerive apparet unquam.' [TF]

[459] Both on this and the last proposition, CP. Historia Densi et Rari, Aditus (Ellis and Spedding, Vol. II. pp. 243-4). The maxim 'Ex nihiio nihil fieri, neque quicquam in nihilum, redigi' is there stated somewhat differently: ' Non scilicet fieri in aliqiia transmutatione corporum transactionem aut a nihiio, aut ad nihilum; sed opera esse ejusdem omnipotentiae, creare ex nihiio, et redigere in nihilum; ex cursu naturae vero hoc

nunquam fieri, Itaque summa materiae totalis semper constat; nil additur, nil minuitur.' It will be noticed that this statement guards the maxim from any theological objection.

On the relation of Bacon's doctrine of density and rarity to that of Aristotle and the Peripatetics, see Mr, Ellis' Preface to the Historia Densi et Rari, pp. 234-7. [TF]

[460] He makes an attempt to effect this calculation in the Table given in the Historia Densi et Rari (E, and S,, Vol. II. pp. 245-6). [TF]

[461] In the Historia Densi et Rari (Ellis and Spedding, Vol. II. pp. 245-6) he makes the ratio as 20 Den. o Gr.: o Den. 22 Gr. The true ratio of the Specific Gravity of Stamped Gold to Absolute Alcohol is 19.362: 0.803 or about 24.3: I, while that of Cast Gold is 19.258: 0.803 or about 24.07: 1. [TF]

Coacervatio autem materiae et rationes ejus deducuntur ad sensibile per pondus. Pondus enim respondet copiae materiae, quoad partes rei tangibilis; spiritus autem, et ejus quantum ex materia, non venit in computationem per pondus; levat enim pondus potius quam gravat [462]. At nos hujus rei tabulam fecimus [463] satis accuratam; in qua pondera et spatia singulorum metallorum, lapidum praecipuorum, lignorum, liquorum, oleorum, et plurimorum aliorum corporum tam naturalium quam artificialium, excepimus: rem polychrestam, tam ad lucem informationis quam ad normam operationis; et quae multas res revelet omnino praeter expectatum. Neque illud pro minimo habendum est, quod demonstret omnem varietatem quae in corporibus tangibilibus nobis notis versatur (intelligimus autem corpora bene unita, nec plane spongiosa et cava et magna ex parte aëre impleta) non ultra rationes partium 21 excedere [464]: tam finita scilicet est natura, aut saltem illa pars ejus cujus usus ad nos maxime pertinet.

[462] This remark must apply to the 'spiritus vivi' which are peculiar to living creatures, and not to the 'spiritus crudi,' which are present in every tangible substance; for in the Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 256), and elsewhere, he speaks of the 'spiritus crudi' as denser than air, which he regarded as having neither weight nor levity ('diligenter expert! sumus, aerem ad minuendum aut sublevanclum pondus nihil conferre'), whereas the 'spiritus vivi' are 'acre ipso aiiquanto rariores,' and are, therefore, endowed with positive levity. 'Videtur aer pondus non minuere; spiritus autem vivus hoc facere. Atque cum pondus densitates dijudicet, etiam levatio ponderis raritates dijudicare debet.' The whole passage is exceedingly curious. On the notion that air has no weight, CP. Sylva Sylvarum, Exp. 29 (Ellis and Spedding, Vol. II, pp. 350-1). [TF]

[463] The Table referred to above in note 60. [TF]

[464] The bodies arranged after 'spiritus vini' in the Table are probably regarded by him as 'spongiosa et cava,' etc. Platinum is heavier than Gold, and Ether lighter than Alcohol. The ratio of the Specific Gravity of rolled Platinum to that of Ether is 22.069:0.723 or about 30.5: 1. [TF]

Etiam diligentiae nostrae esse putavimus, experiri si forte capi possint rationes corporum non tangibilium sive pneumaticorum, respectu corporum tangibilium. Id quod tali molitione aggressi sumus. Phialam vitream [465] accepimus, quae unciam fortasse unam capere possit; parvitate vasis usi, ut minori cum calore posset fieri evaporatio sequens. Hanc phialam spiritu vini implevimus fere ad collum; eligentes spiritum vini, quod per tabulam priorem eum esse ex corporibus tangibilibus (quae bene unita, nec cava sunt) rarissimum, et minimum continens materiae sub suo dimenso, observavimus. Deinde pondus aquae [466] cum phiala ipsa exacte notavimus. Postea vesicam accepimus, quae circa duas pintas contineret. Ex ea aërem omnem, quoad fieri potuit, expressimus eo usque ut vesicae ambo latera essent contigua: etiam prius vesicam oleo oblevimus cum fricatione leni, quo vesica esset clausior: ejus, si qua erat, porositate oleo obturata. Hanc vesicam circa os phialae, ore phialae intra os vesicae recepto, fortiter ligavimus; filo parum cerato, ut melius adhaeresceret arctius ligaret. Tum demum phialam supra carbones ardentes in foculo collocavimus. At paulo post vapor sive aura spiritus vini, per calorem dilatati et in pneumaticum versi, vesicam paulatim sufflavit, eamque universam veli instar undequaque extendit. Id postquam factum fuit, continuo vitrum ab igne removimus, et super tapetem posuimus ne frigore disrumperetur; statim quoque in summitate vesicae foramen fecimus, ne vapor, cessante calore, in liquorem restitutus resideret, et rationes confunderet. Tum vero vesicam ipsam sustulimus, et rursus pondus excepimus spiritus vini qui remanebat. Inde quantum consumptum fuisset in vaporem seu pneumaticum computavimus: et facta collatione quantum locum sive spatium illud corpus implesset quando esset spiritus vini in phiala, et rursus quantum spatium impleverit postquam factum fuisset pneumaticum in vesica, rationes subduximus: ex quibus manifeste liquebat, corpus istud ita versum et mutatum expansionem centuplo majorem quam antea habuisset acquisivisse.

[465] CP. Historia Densi et Rari, p. 257. The result of the experiment given there is that the vapour occupied more than 320 times as much space as the spirits themselves. The difference between the results of the two experiments is to be accounted for from the different temperatures of the vapours, the tension of a vapour increasing rapidly with the temperature, and, at the higher temperatures, in much larger ratios than the temperature itself.

In the Phaenomena Universi (Ellis and Spedding, Vol. III. pp. 705-7) we have an account of the same experiment tried with water, and a comparison of the result with the result obtained from spirits of wine (p. 710). [TF]

[466] Unless ‘aquae’ be taken here in a very general sense, it must be a mistake for ‘spiritus,’ which word, I find, is substituted in the Oxford Edition of 1813. [TF]

Similiter sit natura inquisita Calor aut Frigus; ejus nempe gradus, ut a sensu non percipiantur ob debilitatem. Haec deducuntur ad sensum per vitrum calendare, quale superius descripsimus [467]. Calor enim et frigus, ipsa non percipiuntur ad tactum; at calor aërem expandit, frigus contrahit. Neque rursus illa expansio et contractio aëris

percipitur ad visum; at aër ille expansus aquam deprimit, contractus attollit; ac tum demum fit deductio ad visum, non ante, aut alias.

[467] II. 13 (38). [TF]

Similiter sit natura inquisita Mistura Corporum: viz. quid habeant ex aqueo, quid ex oleoso, quid ex spiritu, quid ex cinere et salibus, et hujusmodi; vel etiam (in particulari) quid habeat lac butyri, quid coaguli, quid seri, et hujusmodi. Haec deducuntur ad sensum per artificiosas et peritas separationes, quatenus ad tangibilia. At natura spiritus in ipsis, licet immediate non percipiatur, tamen deprehenditur per varios motus et nixus corporum tangibilium in ipso actu et processu separationis suae; atque etiam per acrimonias, corrosiones, et diversos colores, odores, et sapores eorundem corporum post separationem. Atque in hac parte, per distillationes atque artificiosas separationes, strenue sane ab hominibus elaboratum est; sed non multo foelicius quam in caeteris experimentis, quae adhuc in usu sunt: modis nimirum prorsus palpatoriis, et viis caecis, et magis operose quam intelligenter; et (quod pessimum est) nulla cum imitatione aut aut aemulatione naturae, [468] sed cum destructione (per calores vehementes aut virtutes nimis validas) omnis subtilioris schematismi, in quo occultae rerum virtutes et consensus praecipue sitae sunt. Neque illud etiam, quod alias monuimus [469], hominibus in mentem aut observationem venire solet in hujusmodi separationibus: hoc est, plurimas qualitates, in corporum vexationibus tam per ignem quam alios modos, indi ab ipso igne iisque corporibus quae ad separationem adhibentur, quae in composito prius non fuerunt; unde mirae fallaciae. Neque enim scilicet vapor universus, qui ex aqua emittitur per ignem, vapor aut aër antea fuit in corpore aquae; sed factus est maxima ex parte per dilatationem aquae ex calore ignis.

[468] CP. the interesting passage in De Augmentis Scientiarum, V. 2 (Ellis and Spedding, Vol. I. pp. 627-8). The passage concludes with the sentence: 'Debuerant autem homines, si illis utilia inquirere vacaret, naturalia opificia et operationes singulas attente et minutim et ex composito intueid; et secum perpetuo et acriter cogitare, quaenam ex ipsis ad artes transferri possint. Speculum enim artis natura.' [TF]

[469] II. 7. This remark shews that Bacon was fully aware of one of the principal sources of deception in experimentation; namely, that the employment of an abnormal process often itself introduces new conditions in the object under investigation. [TF]

Similiter in genere omnes exquisitae probationes corporum sive naturalium sive artificialium, per quas vera dignoscuntur ab adulterinis, meliora a vilioribus, huc referri debent: deducunt enim non-sensibile ad sensibile. Sunt itaque diligenti cura undique conquirendae.

(5) Quintum vero genus latitantiae quod attinet, manifestum est actionem sensus transigi in motu, motum in tempore. Si igitur motus alicujus corporis sit vel tam tardus, vel tam velox, ut non sit proportionatus ad momenta in quibus transigitur actio sensus, objectum omnino non percipitur; ut in motu indicis horologii, et rursus in motu pilae

sclopeti. Atque motus qui ob tarditatem non percipitur, facile et ordinario deducitur ad sensum per summas motus [470]; qui vero ob velocitatem, adhuc non bene mensurari consuevit; sed tamen postulat inquisitio naturae ut hoc fiat in aliquibus [471].

[470] A good instance of this device is the one given by Bacon, the hands of a clock. Still slower motions, which may be measured with tolerable accuracy, are the elevation or subsidence of continents, the advance or retreat of the sea, the gradual retreat of waterfalls, etc. [TF]

[471] This requirement has now been fulfilled in the case of light, sound, the motion of projectiles, electricity, etc. Perhaps the most magnificent example of the calculation of large velocities is to be found in the case of the velocity of light, which was computed on observations of the eclipses of Jupiter's satellites and confirmed by Bradley's discovery of the aberration of light. In recent times, Fizeau and Foucault have measured it by direct experiments. [TF]

(6) Sextum autem genus, ubi impeditur sensus propter nobilitatem objecti, recipit deductionem, vel per elongationem majorem objecti a sensu; vel per hebetationem objecti per interpositionem medii talis, quod objectum debilitet, non annihilet [472]; vel per admissionem et exceptionem objecti reflexi, ubi percussio directa sit nimis fortis, ut solis in pelvi aquae.

[472] The use of ground or coloured glass would afford an instance of what Bacon means. [TF]

(7) Septimum autem genus latitantiae, ubi sensus ita oneratur objecto ut novae admissioni non sit locus, non habet fere locum nisi in olfactu et odoribus [473]; nec ad id quod agitur multum pertinet. Quare de deductionibus non-sensibilis ad sensibile, haec dicta sint.

[473] Surely this is a defect common to all the senses. See Aphorism 43 ad fin. We often cannot clearly distinguish objects in the glare of the sun; nor hear sounds, while being whirled along in a coach or a railway carriage; nor feel slight sensations of touch, while suffering great pain; nor discriminate delicate flavours, while tasting something very pungent, acrid, or luscious. It is a well-known fact that the nicer and more delicate sensations are over-powered by those which are stronger or coarser in the same class. [TF]

Quandoque tamen deductio fit non ad sensum hominis, sed ad sensum alicujus alterius animalis cujus sensus in aliquibus humanum excellet: ut nonnullorum odorum, ad sensum canis; lucis, quae in aëre non extrinsecus illuminato latenter existit, ad sensum felis, noctuae, et hujusmodi animalium quae cernunt noctu. Recte enim notavit Telesius [474], etiam in aëre ipso inesse lucem quandam originalem, licet exilem et tenuem, et maxima ex parte oculis hominum aut plurimorum animalium non inservientem; qui illa

animalia, ad quorum sensum hujusmodi lux est proportionata, cernant noctu; id quod vel sine luce fieri, vel per lucem internam, minus credibile est.

[474] The passage referred to is the following: 'Nullum porro nec infima nec suprema coeli portio ad nos calorem, nullamque emittere videtur lucem: quod in longe utraque tenuissima perexilis inest calor, et qui nec proprias vires nec propriam speciem valenter manifestare queat. At ab ipsis lucem quandam emanare, et quae, si non nobis, quibusdam certe animalium generibus percipiatur, quae longissima noctu conficiunt itinera declarant.' De Rerum Natura, I. 3. It seems plain to me, though Mr. Ellis thinks it doubtful, that 'infima coeli portio' in this passage includes the air. Moreover, I think that in the exceedingly tedious discussion on Light in Libro iv, and elsewhere, it is implied that air is self-luminous; for air always contains some heat, and light is the concomitant of heat, 'cui inhaeret et cujus facies est.'

In the 'De Principiis atque Originibus,' Bacon gives an elaborate account of the opinions of Telesius, mentioning this doctrine amongst others. See Ellis and Spedding, Vol. III. p. 106.

The curious idea that the air is self-luminous might have seemed to derive support not only from the habits of nocturnal and crepuscular animals, but also from the fact that it is hardly ever so dark in the open air but that some small amount of light is perceptible. [TF]

Atque illud utique notandum est, de destitutionibus sensuum eorumque remediis hic nos tractare. Nam fallaciae sensuum ad proprias inquisitiones de sensu et sensibili [475] remittendae sunt: excepta illa magna fallacia sensuum nimirum quod constituant lineas [476] rerum ex analogia hominis, et non ex analogia universi [477]; quae non corrigitur nisi per rationem et philosophiam universalem.

[475] CP. De Augmentis Scientiarum, IV. 3 (Ellis and Spedding, Vol. I. pp. 610-13). [TF]

[476] CP. I. 59: 'Verba autem plerunque ex captu vulgi induntur, atque per lineas, vulgari intellectui maxime coiispiciias, res secant.' [TF]

[477] CP. I. 41. [TF]

XLI.

Inter *praerogativas instantiarum* ponemus loco decimo octavo *Instantias Viae* [478], quas etiam *Instantias Itinerantes* et *Instantias Articulatas* appellare consuevimus. Eae sunt quae indicant naturae motus gradatim continuatos [479]. Hoc autem genus instantiarum potius fugit observationem quam sensum. Mira enim est hominum circa hanc rem indiligentia. Contemplantur siquidem naturam tantummodo desultorie et per periodos, et postquam corpora fuerint absoluta ac completa, et non in operatione sua [480]. Quod si artificis alicujus ingenia et industriam explorare et contemplari quis

cuperet, is non tantum materias rudes artis atque deinde opera perfecta conspicere desideraret, sed potius praesens esse cum artifex operatur et opus suum promovet. Atque simile quiddam circa naturam faciendum est. Exempli gratia; si quis de vegetatione plantarum [481] inquirat, ei inspiciendum est ab ipsa satione seminis alicujus (id quod per extractionem, quasi singulis diebus, seminum quae per biduum, triduum, quatriduum, et sic deinceps, in terra manserunt, eorumque diligentem intuitum, facile fieri potest), quomodo et quando semen intumescere et turgere incipiat et veluti spiritu impleri; deinde quomodo corticulam rumpere et emittere fibras, cum latione nonnulla sui interim sursum, nisi terra fuerit admodum contumax; quomodo etiam emittat fibras, partim radicales deorsum, partim cauliculares sursum, aliquando serpendo per latera, si ex ea parte inveniat terram apertam et magis facilem; et complura id genus. Similiter facere oportet circa exclusionem ovorum; ubi facile conspici dabitur processus vivificandi et organizandi, et quid et quae partes fiant ex vitello, quid ex albumine ovi, et alia. Similis est ratio circa animalia ex putrefactione [482]. Nam circa animalia perfecta et terrestria, per exectiones foetuum ex utero, minus humanum esset ista inquirere [483]; nisi forte per occasiones abortuum, et venationum, et similium. Omnino igitur vigilia quaedam servanda est circa naturam, ut quae melius se conspiciendam praebeat noctu quam interdiu. Istae enim contemplationes tanquam nocturnae censeri possint, ob lucernae parvitatem et perpetuationem.

[478] It is difficult to distinguish between this class of instances and the 'Instantiae Migran tes' of II. 23. We may, perhaps, say that the 'Instantiaeviae' are propounded with reference to the preliminary process of observation, while the 'Instantiae migrantes' are propounded with reference to the subsequent processes of reasoning. [TF]

[479] It is, perhaps, needless to remind the reader of the Law of Continuity, with the many marvellous exemplifications of it afforded by recent observations and discoveries in Physics, Geology, Biology, etc., as well as in the sciences more immediately relating to the history and condition of man. As bearing on certain aspects of it, the student may read with advantage the Essay on Continuity, appended to Sir W. R. Grove's Correlation of Physical Forces, already referred to. [TF]

[480] CP. the Aphorism on Latent Process, II. 6:1 Cum cnim omnis action naturalis per minima transigatur, aut saltern per ilia quae sunt minora quam ut sensum feriant, nemo se haturam regere aut vertere posse speret nisi ilia debito modo comprehendefit et notaverit.' [TF]

[481] For the interest which Bacon took in Gardens and Gardening, see the Essay 'Of Gardens,' and the numerous 'experiments' in the Sylva Sylvarum bearing on these subjects. [TF]

[482] The epithet perfecta is generally given to those animals which cannot result from putrefaction, Caesalpinus, in the Ouaestiones Peripat. V. i, maintains that all animals may result from putrefaction, and that this was the doctrine of Aristotle, The same opinion had, I believe, been advanced by Averroes. That mice may be produced by equivocal

generation is asserted, as a matter not admitting of dispute, by Cardan, De Rerum Varietate. Caesalpinus refers to the same instance, but less confidently than Cardan. It is worth remarking that Aristotle, though he speaks of the great fecundity of mice, and even of their being impregnated by licking salt, does not mention the possibility of their being produced by putrefaction. (De Hist. Animal, vi. 37, Problem, x. 64.) Paracelsus, De Rerum Generatione, affirms that all animals produced from putrefaction are more or less venomous. Telesius' opinion is that the more perfect animals cannot result from putrefaction, because the conditions of temperature necessary to their production cannot be fulfilled except by means of animal heat.' Mr. Ellis' note.

A brief summary of Aristotle's opinions as to the origin of animal life is given in the Historia Animalium, V. I (p. 539 a. 21-25): οὕτω καὶ τῶν ζῴων τὰ μὲν ἀπὸ ζῴων γίνεται κατὰ συγγένειαν τῆς μορφῆς, τὰ δ' αὐτόματα Kal οὐκ ἀπὸ συγγενῶν, Kat τούτων TA μὲν ἐκ γῆς σηπομένης Kal φυτῶν, ὥσπερ πολλὰ συμβαίνει τῶν ἐντόμων, τὰ δ' ἐν τοῖς ζῴοις αὐτοῖς ἐκ τῶν ἐν τοῖς μυρίοις περιττωμάτων. The subject of spontaneous generation frequently recurs both in the Historia Aninialium and in the De Generatione Animalium (see especially I. 16 and III. 11 of the latter treatise). Amongst the most interesting points of Aristotle's doctrine are the theory that spontaneous generation is due to the moisture which is found in putrefying matter (De Gen. An. III. ii), and the statement that eels are the only animals, possessing blood, which do not arise either from congress or from eggs (Historia Animalium, VI. 16). Mr. Lewes has some good remarks on Aristotle's doctrine in his 'Aristotle,' pp. 364-6.

Bacon does not seem to have entertained any doubt as to the generation of animals from putrefaction. CP. Sylva Sylvarum, Exps. 328, 900; Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 264). Sir Thomas Browne in his Enquiries into Vulgar and Common Errors (first published in 1646) appears to receive the doctrine with as little questioning. See, for instance, Book II. Chapter 6: 'So when the ox corrupteth into bees, or the horse into hornets, they come not forth in the image of their originals. So the corrupt and excrementitious humours in men are animated into lice,' and more to the same effect. He even seems to believe in the equivocal generation of mice (Book III. Chapter 28). These theories were all but finally disposed of by Harvey in his great Treatise, De Generatione Animalium, first published in 1651. There he maintains the thesis 'Ovum esse primordium commune omnibus animalibus.' [TF]

[483] And yet it is plain that Bacon did not object to vivisection. See the passage in the New Atlantis (Ellis and Spedding, Vol. III. p. 159), beginning with the following remarkable sentences: 'We have also parks and inclosures of all sorts of beasts and birds, which we use not only for view or rareness, but likewise for dissections and trials; that thereby we may take light what may be wrought upon the body of man. Wherein we find many strange effects: as continuing life in them, though divers parts, which you account vital, be perished and taken forth; resuscitating of some that seem dead in appearance; and the like. We try also all poisons, and other medicines upon them, as well of chirurgery as physic.' And, in the De Augmentis Scientiarum (IV. 2, Ellis and Spedding, Vol. I. pp. 593-4), there is, perhaps, a still more remarkable passage, in -which,

while accepting the condemnation passed by Celsus on vivisection of the human subject, lie thinks that considerations both of 'utility and humanity' may be reconciled by substituting the vivisection of brutes. 'De illo vero altero defectu circa Anatomiam (nempe quod non fieri consueverit in *corporibus vivis*) quid attinet dicere? Res enim haec odiosa et barbara, et a Celso recte damnata. Neque tanien illud minus verum est (quod annotatum fuit a priscis) poros complures et meatus et pertusiones, quae sunt ex subtilioribus, in anatomicis dissectionibus non comparere; quippe quae in cadaveribus occluduntur et latent; cum in viventibus dilatentur, et possint esse conspicui. Itaque ut et usui consulatur simul et humanitati, non est omnino rejicienda Anatomia Vivorum, neque ad fortuitas chirargicorum inspectiones (quod Celsus fecit) remittenda; cum hoc ipsum bene expediri possit per dissectionem brutorum vivorum quae, non obstante suarum partium dissimilitudine ab humanis, huic inquisitioni adhibito judicio satisfacere possint.' In the light of recent controversies, it is curious to notice that, in writing these passages, it never seems to have crossed Bacon's mind that there might be objections, on moral and 'humanitarian' grounds, to the vivisection even of brute animals. On the moral aspect of this subject, and of the treatment of the lower animals generally, I have spoken briefly in my 'Progressive Morality,' pp. 193-198. [TF]

Quin et in inanimatis idem tentandum est; id quod nos fecimus in inquirendis aperturis liquorum per ignem [484]. Alius enim est modus aperturae in aqua, alius in vino, alius in aceto, alius in omphacio [485]; longe alius in lacte, et oleo, et caeteris [486]. Id quod facile cernere erat per ebullitionem super ignem lenem, et in vase vitreo, ubi omnia cerni perspicue possint. Verum haec brevius perstringimus; fusius et exactius de iis sermones habituri, cum ad inventionem *latentis* rerum *processus* [487] ventum erit. Semper enim memoria tenendum est, nos hoc loco non res ipsas tractare, sed exempla tantum adducere.

[484] See notes on last Aphorism and the passages in the Historia Densi et Rari, etc., there referred to. 'Apertura,' as Mr. Ellis remarks, means the same thing as 'Expansio.' It was a general term, used by the chemists of that period, to signify the modification which a substance undergoes, when it receives another, as it were, into its bosom. [TF]

[485] ὀμφάκιον, 'succus ex olea aut uva expressus, priusquani cibo aut vino maturae sint.' Facciolati. See Pliny, Naturalis Historia xii. 27 (60), sects. 130-31, xxiii. ad init., and other passages. [TF]

[486] See Historia Densi et Rari, Ellis and Spedding, Vol. II. pp. 268-9. [TF]

[487] CP. II. 52 ad fin. This part of the Novum Organum was never written. [TF]

XLII.

Inter *praerogativas instantiarum* ponemus loco decimo nono *Instantias Supplementi*, sive *Substitutionis*; quas etiam *Instantias Perfugii* appellare consuevimus. Eae sunt, quae supplent informationem ubi sensus plane destituitur; atque idcirco ad eas confugimus

cum instantiae propriae haberi non possint. Dupliciter autem fit substitutio; aut per Graduationem [488], aut per Analoga. Exempli gratia: non invenitur medium quod inhibeat prorsus operationem magnetis in movendo ferrum; non aurum interpositum, non argentum, non lapis, non vitrum, lignum, aqua, oleum, pannus aut corpora fibrosa, aër, flamma, et caetera. Attamen per probationem exactam fortasse inveniri possit aliquod medium, quod hebetet virtutem ipsius plus quam aliquod aliud, comparative et in aliquo gradu: veluti quod non trahat magnes ferrum per tantam crassitiem auri quam per par spatium aëris; aut per tantum argentum ignitum quam per frigidum; et sic de similibus. Nam de his nos experimentum non fecimus; sed sufficit tamen ut proponantur loco exempli [489]. Similiter non invenitur hic apud nos corpus quod non suscipiat calidum igni approximatum. Attamen longe citius suscipit calorem aër [490] quam lapis. Atque talis est substitutio quae fit per Gradus.

[488] As Dr. Kitchin remarks, one would have thought this was the office of the Tabula Graduum in Aphorism 13. [TF]

[489] I am informed that the question put by Bacon has not even yet been answered, the experiment being, on account of the various influences at work, of the most delicate description. It is possible, however, that the interposition of bismuth, and the so-called 'diamagnetic' substances generally, might, if we had sufficiently powerful instruments and sufficient means of measurement, be found to produce a perceptible influence in modifying the effect of a magnet on iron at a distance. Gold and silver are both included among the diamagnetic substances. [TF]

[490] The nature of Bacon's error with regard to air as a conductor of heat has already been pointed out See notes on II. 12 (18), (20); 13 (38). It will be noticed how loosely Bacon speaks of 'stone,' without distinguishing the different kinds of 'stones.' [TF]

Substitutio autem per Analoga, utilis sane, sed minus certa est; atque idcirco cum judicio quodam adhibenda. Ea fit, cum deducitur non-sensibile ad sensum, non per operationes sensibiles ipsius corporis insensibilis, sed per contemplationem corporis alicujus cognati sensibilis [491]. Exempli gratia: si inquiratur de Mistura Spirituum, qui sunt corpora non-visibilia, videtur esse cognatio quaedam inter corpora et fomites sive alimenta sua. Fomes autem flammae videtur esse oleum et pinguia; aëris, aqua et aquea: flammae enim multiplicant se super halitus olei, aër super vapores aquae [492]. Videndum itaque de mistura aquae et olei, quae se manifestat ad sensum; quandoquidem mistura aëris et flammei generis fugiat sensum. At oleum et aqua inter se per compositionem aut agitationem imperfecte admodum miscentur: eadem in herbis, et sanguine, et partibus animalium, accurate et delicate miscentur. Itaque simile quiddam fieri possit circa misturam flammei et aërei generis in spiritalibus [493]: quae per confusionem simplicem non bene sustinent misturam, eadem tamen in spiritibus plantarum et animalium misceri videntur; praesertim cum omnis spiritus animatus depascat humida utraque, aquea et pinguia, tanquam fomites suos.

[491] An excellent instance in modem Science would be the analogy of vibrations or wave-motions as applied to the phenomena of Heat, Light, and Sound. Mr. Ellis says: 'Du Bois Raymond's Researches in Animal Electricity give a good example of this substitution. He constructed what may be called an electrical model of a muscle, and succeeded in obtaining an illustration not only of his fundamental result, namely that any transverse section is negative with respect to any longitudinal one, but also of the more complicated relations between two different portions of the same section.'

The former of Bacon's illustrations, it is needless to say, is purely fanciful. The analogy, in the second case, corresponds pretty closely with facts. [TF]

[492] See Aphorism 48 (11), and the note .upon the parallel passage in that place. [TF]

[493] The 'spiritus vitalis,' it will recollected, was regarded by Bacon as composed of air and flame. [TF]

Similiter si non de perfectioribus misturis spiritalium, sed de compositione tantum inquiratur; nempe, utrum facile inter se incorporentur, an potius (exempli gratia) sint aliqui venti et exhalationes, aut alia corpora spiritalia, quae non miscentur cum aëre communi, sed tantum haerent et natant in eo, in globulis et guttis, et potius franguntur ac comminuuntur ab aëre quam in ipsum recipiuntur et incorporantur: hoc in aëre communi et aliis spiritalibus, ob subtilitatem corporum, percipi ad sensum non potest; attamen imago quaedam hujus rei, quatenus fiat, concipi possit in liquoribus argenti vivi, olei, aquae; atque etiam in aëre, et fractione ejus, quando dissipatur et ascendit in parvis portiunculis per aquam; atque etiam in fumis crassioribus; denique in pulvere excitato et haerente in aëre; in quibus omnibus non fit incorporatio. Atque repraesentatio praedicta in hoc subjecto non mala est, si illud primo diligenter inquisitum fuerit, utrum possit esse talis heterogenia inter spiritalia qualis invenitur inter liquida; nam tum demum haec simulacra per Analogiam non incommode substituentur.

Atque de *instantiis* istis *supplementi*, quod diximus informationem ab iis hauriendam esse, quando desint instantiae propriae, loco *perfugii*; nihilominus intelligi volumus, quod illae etiam magni sint usus etiam cum propriae instantiae adsint; ad roborandam scilicet informationem una cum propriis. Verum de his exactius dicemus quando ad *Adminicula Inductionis* tractanda sermo ordine dilabetur.

XLIII.

Inter *praerogativas instantiarum* ponemus loco vicesimo *Instantias Persecantes*; quas etiam *Instantias Vellicantes* appellare consuevimus, sed diversa ratione. *Vellicantes* enim eas appellamus, quia vellicant intellectum, *persecantes*, quia persecant naturam [494]: unde etiam illas quandoque *Instantias Democriti* [495] nominamus. Eae sunt, quae de admirabili et exquisita subtilitate naturae intellectum submonent, ut excitetur et expergiscatur ad attentionem et observationem et inquisitionem debitam. Exempli gratia: quod parum guttulae atramenti ad tot literas vel lineas extendatur; quod

argentum, exterius tantum inauratum, ad tantam longitudinem fili inaurati continuetur [496]; quod pusillus vermiculus [497], qualis in cute invenitur, habeat in se spiritum simul et figuram dissimilarem partium [498]; quod parum croci etiam dolium aquae colore inficiat; quod parum zibethi aut aromatis longe majus contentum aëris odore; quod exiguo suffitu tanta excitetur nubes fumi; quod sonorum tam accuratae differentiae, quales sint voces articulatae, per aërem undequaque vehantur, atque per foramina et poros etiam ligni et aquae (licet admodum extenuatae) penetrent, quin etiam repercutiantur, idque tam distincte et velociter; quod lux et color, etiam tanto ambitu et tam perniciter, per corpora solida vitri, aquae, et cum tanta et tam exquisita varietate imaginum permeent, etiam refringantur et reflectantur; quod magnes per corpora omnigena, etiam maxime compacta, operetur: sed (quod magis mirum est) quod in his omnibus, in medio adiaphoro (quale est aër) unius actio aliam non magnopere impediat; nempe quod eodem tempore per spatia aëris devehantur et visibilium tot imagines [499], et vocis articulatae tot percussiones, et tot odores specificati, ut violae, rosae; etiam calor et frigus et virtutes magneticae; omnia (inquam) simul, uno alterum non impediente, ac si singula haberent vias et meatus suos proprios separatos, neque unum in alterum impingeret aut incurreret.

[494] 'The *instantiae persecanies*, or *vellicantes*,' says Professor Playfair, 'are those which force us to attend to things which, from their subtilty and minuteness, escape common observation.

'Some of Bacon's remarks on this subtilty are such as would do credit to the most advanced state of science, and shew how much his mind was fitted for distinguishing and observing the great and admirable in the works of nature.' [TF]

[495] CP. I. 51. [TF]

[496] 'Dr. Woolaston's [Wollaston's] method for obtaining wires of extreme fineness was perhaps suggested by the circumstance mentioned in the text. He enclosed a gold wire in a cylinder of silver, drew them out together, and then dissolved away the silver by means of warm nitrous acid.' Mr. Ellis' note. [TF]

[497] See note 45 on II. 34. [TF]

[498] 'The form of its parts dissimilar,' i.e. a varied organisation. [TF]

[499] This language bears traces of the old doctrine, according to which ἀπόῤῥοιαι, emanations or images, were thrown off from outward objects and conveyed to the eyes. The student, who is interested in the history of this doctrine, will find it curious to compare the language employed by Bacon in the Sylva Sylvarum, Exps, 255-77 (Ellis and Spedding, Vol. II. pp. 429-33), and to note there the intrusion of the newer optical theories on the old physical doctrine of emanations, as inherited from Empedocles and Democritus. [TF]

Solemus tamen utiliter hujusmodi *instantiis persecantibus* subjungere instantias, quas *Metas Persecationis* appellare consuevimus; veluti quod in iis, quae diximus, una actio in diverso genere aliam non perturbet aut impediat, cum tamen in eodem genere [501] una aliam domet et extinguat: veluti, lux solis, lucem cicindelae; sonitus bombardae, vocem; fortior odor, delicatiorem; intensior calor, remissiorem; lamina ferri interposita inter magnetem et aliud ferrum, operationem magnetis [502]. Verum de his quoque inter Adminicula Inductionis erit proprius dicendi locus.

[501] This phenomenon is, of course, due to the fact that, when a sense is highly stimulated, stimuli of a low power have no effect upon it. See note 73 on Aphorism 40. [TF]

[502] This example is only true with some qualification. A magnet developes magnetism in iron (this is called *magnetic induction*), and hence the piece of iron itself becomes a magnet, often supporting in turn another piece of iron, and so on, according to the power of the magnet, and the minuteness of the pieces. The way in which iron filings become attached to the poles of magnets is a familiar illustration of this principle. But, of course, there are limits to magnetic induction, and the last piece of iron in the series, being itself so feebly magnetised as to be unable to support another, would furnish an example of what Bacon means. What, however, he more probably has in view is the still more common case, where the first piece of iron in contact with the magnet is unable to sustain any weight, either from being itself of some size, or from the feeble power of the magnet, or from a combination of both these circumstances. [TF]

XLIV.

Atque de instantiis quae juvant sensum, jam dictum est; quae praecipui usus sunt ad Partem Informativam. Informatio enim incipit a sensu. At universum negotium desinit in Opera; atque quemadmodum illud principium, ita hoc finis rei est [503]. Sequentur itaque instantiae praecipui usus ad *partem operativam*. Eae genere duae sunt, numero septem; quas universas, generali nomine, *Instantias Practicas* appellare consuevimus. *Operativae* autem *partis*, vitia duo; totidemque dignitates [504] instantiarum in genere. Aut enim fallit operatio, aut onerat nimis. Fallit operatio maxime (praesertim post diligentem naturarum inquisitionem) propter male determinatas et mensuratas corporum vires et actiones. Vires autem et actiones corporum circumscribuntur et mensurantur, aut per spatia loci, aut per momenta temporis, aut per unionem quanti, aut per praedominantiam virtutis [505]; quae quatuor nisi fuerint probe et diligenter pensitata, erunt fortasse scientiae speculatione quidem pulchrae, sed opere inactivae. Instantias vero quatuor itidem, quae huc referuntur, uno nomine *Instantias Mathematicas* vocamus, et *Instantias Mensurae*.

[503] CP. I. 73, 81, II. 3 ad fin., and the numerous other passages in which this idea occurs. [TF]

[504] This word was used in the old Logic both for axioms (properly so called) and for propositions. See Hamilton on Reid, p. 766. But, in this place, there is no doubt that the word 'prerogatives,' adopted in Ellis and Spedding's Translation, is the true equivalent. CP. end of this Aphorism. [TF]

[505] The meaning of this and the last phrase will be clear, when we come to Aphorisms 47, 48. [TF]

Onerosa autem fit praxis, vel propter misturam rerum inutilium, vel propter multiplicationem instrumentorum, vel propter molem materiae et corporum quae ad aliquod opus requiri contigerint. Itaque eae instantiae in pretio esse debent, quae aut dirigunt operativam ad ea quae maxime hominum intersunt; aut quae parcunt instrumentis; aut quae parcunt materiae sive supellectili. Eas autem tres instantias quae huc pertinent, uno nomine *Instantias Propitias* sive *Benevolas* vocamus. Itaque de his septem instantiis jam sigillatim dicemus; atque cum iis partem illam de Praerogativis sive Dignitatibus Instantiarum claudemus.

XLV.

Inter praerogativas instantiarum ponemus loco vicesimo primo *Instantias Virgae*, sive *Radii* [506]; quas etiam *Instantias Perlationis*, vel *de Non Ultra* appellare consuevimus. Virtutes enim rerum et motus operantur et expediuntur per spatia non indefinita aut fortuita, sed finita et certa; quae ut in singulis naturis inquisitis teneantur et notentur plurimum interest practicae, non solum ad hoc, ut non fallat, sed etiam ut magis sit aucta et potens. Etenim interdum datur virtutes producere, et distantias tanquam retrahere in propius; ut in perspecillis.

[506] Examples of these 'instances' are not far to seek. We may notice the thermometer, the barometer, the hygrometer, the goniometer, the micrometer, the quadrant, scales, the photometer, the electrometer, the thermoelectric pile, etc. Besides instruments, we may also include methods of measurement, such as that of double-weighing or that of coincidences or interferences. The student will find many good examples both of instruments and methods amongst those given by Dr. Whewell in the Novum Organum Renovatum, Book III. Chapter 2, or by Professor Jevons in the Principles of Science, Book III. Some interesting remarks on the subject of exact measurement, interspersed with illustrations, are made by Sir John Herschel, Discourse, etc., §§ 115-25, 226-30, 387-9.

These instances, it must be remembered, 'measure nature' 'per gradus spatii,' as the 'instantiae curriculi' 'per momenta temporis.' (See Aphorism 46 ad init.)

In speaking of the defects of Bacon's method, Professor Playfair says: 'Another remark I must make on Bacon's method is, that it does not give sufficient importance to the *instantiae radii*, or those which furnish us with accurate measures of physical quantities. The experiments of this class are introduced as only subservient to practice; they are, however, of infinite value in the theoretical part of induction, or for ascertaining the

causes and essences of the things inquired into. We have an instance of this in the discovery of that important truth in physical astronomy, that the moon is retained in her orbit by the force of gravity, or the same which, at the earth's surface, makes a stone fall to the ground. This proposition, however it might have been suspected to be true, could never have been demonstrated but by such observations and experiments as assigned accurate geometrical measures to the quantities compared. The semidiameter of the earth; the velocity of falling bodies at the earth's surface; the distance of the moon, and her velocity in her orbit: —all these four elements must have been determined with great precision, and afterwards compared together by certain theorems deduced from the laws of motion, before the relation between the force which retains the moon in her orbit, and that which draws a stone to the ground, could possibly be discovered. The discovery also, when made, carried with it the evidence of demonstration; so that here, as in many other cases, the *instantiae radii* are of the utmost importance in the theoretical part of Physics.'

Again, after speaking, in a passage which is well worth the attention of the student, of the generalisations accomplished by the methods of geometry, he adds: 'This can only happen when the experiments afford accurate measures of the quantities concerned, like the *instantiae radii*, *curriculi*, etc.; and this advantage of admitting generalisation with so much certainty is one of their properties, of which it does not appear that even Bacon himself was aware.' [TF]

Atque plurimae virtutes operantur et afficiunt tantum per tactum manifestum; ut fit in percussione corporum, ubi alterum non summovet alterum, nisi impellens impulsum tangat. Etiam medicinae quae exterius applicantur, ut unguenta, emplastra, non exercent vires suas nisi per tactum corporis. Denique objecta sensuum tactus et gustus non feriunt nisi contigua organis.

Sunt et aliae virtutes quae operantur ad distantiam, verum valde exiguam, quarum paucae adhuc notatae sunt, cum tamen plures sint quam homines suspicentur: ut (capiendo exempla ex vulgatis) cum succinum aut gagates [507] trahunt paleas; bullae approximatae solvunt bullas [508]; medicinae nonnullae purgativae eliciunt humores ex alto [509], et hujusmodi. At virtus illa magnetica per quam ferrum et magnes, vel magnetes invicem [510], coeunt, operatur intra orbem virtutis certum, sed parvum; ubi contra, si sit aliqua virtus magnetica emanans ab ipsa terra (paulo nimirum interiore [511) super acum ferream, quatenus ad verticitatem, operatio fiat ad distantiam magnam.

[507] 'Amber or jet.' [TF]

[508] See note 67 on Aphorism 25. [TF]

[509] 'Bacon here speaks in accordance with the medical theory in which the brain is the origin and seat of the rheum, which descends from thence and produces disease in other

organs — a theory preserved in the word catarrh. Certain purgatives were supposed to draw the rheum down.' Mr, Ellis' note. [TF]

[510] On the mutual attraction of magnets for one another, see Gilbert, De Magnete, Libro I. Cap. 5. [TF]

[511] 'A little below the surface.' CP. Gilbert, De Magnete, Libro I. Cap. 17: 'Talis igitur nobis est tellus in interioribus partibus, magneticam homogenicam naturam habens,' etc.

The earth may be compared with an immense magnet, whose poles, though variable, approach more or less nearly to the terrestrial poles, and whose neutral line cuts the equator at very acute angles. [TF]

Rursus, si sit aliqua vis magnetica quae operetur per consensum inter globum terrae et ponderosa [512], aut inter globum lunae et aquas maris [513] (quae maxime credibilis videtur in fluxibus et refluxibus semi-menstruis), aut inter coelum stellatum et planetas, per quam evocentur et attollantur ad sua apogaea [514]; haec omnia operantur ad distantias admodum longinquas. Inveniuntur et quaedam inflammationes sive conceptiones flammae, quae fiunt ad distantias bene magnas, in aliquibus materiis; ut referunt de naphtha Babylonica [515]. Calores etiam insinuant se per distantias amplas, quod etiam faciunt frigora; adeo ut habitantibus circa Canadam moles sive massae glaciales, quae abrumpuntur et natant per oceanum septentrionalem et deferuntur per Atlanticum versus illas oras, percipiantur et incutiant frigora e longinquo. Odores quoque (licet in his videatur semper esse quaedam emissio corporea [516]) operantur ad distantias notabiles; ut evenire solet navigantibus juxta litora Floridae, aut etiam nonnulla Hispaniae, ubi sunt sylvae totae ex arboribus limonum, arantiorum [517], et hujusmodi plantarum odoratarum, aut frutices rorismarini, majoranae, et similium [518]. Postremo radiationes lucis et impressiones sonorum operantur scilicet ad distantias spatiosas.

[512] CP. II. 36 (3) and 37, with notes. [TF]

[513] See II. 35 and 36 (1), with notes. In both these places, he is speaking of the ebb and flow which takes place twice a day. Here, he speaks of the spring and neap tides, each of which occurs twice a month, namely at new and full moon and at the first and last quarters, respectively.

It is curious to note Bacon's change of opinion with regard to the cause of these semi-menstrual phenomena; for in the De Fluxu et Refluxa Maris, written before or not long after 1616, he rejects the hypothesis of the influence of the moon, using, as his main argument, the fact that, when the moon is in opposite conditions, namely new and full moon, the same tidal phenomena take place. 'Et multaalia,' he adds, 'adduci possint quae hujusmodi dominationum phantasias destruant, et eo potius rem deducant, ut ex materiae passionibus catholicis et primis rerum coagmentationibus consensus illi

oriantur, non quasi alterum ab altero regatur, sed quod utrumque ab iisdem originibus et concausis emanet.' Ellis and Spedding, Vol. III. p. 52.

On the semi-diurnal ebb and flow, it will be remembered, Bacon was probably inclined to adopt an entirely different theory. See note 57 on Aphorism 35. [TF]

[514] Note this curious suggestion, that the motions of the planets are due to the magnetic attraction of the coelum stellatum. CP. Thema Coeli (Ellis and Spedding, Vol. III. p. 779): 'Affirmant motum magneticura sive congregativum vigere in astris, ex quo ignis ignem evocat et attollit.' [TF]

[515] See Herodotus, i.,179; Strabo, xvi. i (Ed. Casaubon, p. 743); Pliny, II. 105 (109), sect. 235, XXIV. 17 (101), sect. 158; Plutarch's Life of Alexander, Chapter 35. [TF]

[516] This supposition is, of course, right. CP. Cogitationes De Natura Rerum, Ellis and Spedding, Vol. III. pp. 15, 16; Sylva Sylvarum, Exp. 834. In the latter passage, he says: ^ It is true that some woods of oranges, and heaths of rosemary, will smell a great way into the sea, perhaps twenty miles.' [TF]

[517] This is probably a misprint for aurantiorum, oranges. [TF]

[518] Mr. Ellis refers to Paradise Lost, IV. 99 (it should be 159, etc.):

> 'As when to those who sail
> Beyond the Cape of Hope, and now are past
> Mozambic, off at sea North-East winds blow
> Sabean Odours from the spicy shore
> Of Arable the blest, with such delay
> Well pleas'd they slack their course, and many a League
> Cheer'd with the grateful smell old Ocean smiles.' [TF]

Verum haec omnia, utcunque operentur ad distantias parvas sive magnas, operantur certe ad finitas et naturae notas, ut sit quiddam *Non Ultra*: idque pro rationibus, aut molis seu quanti corporum; aut vigoris et debilitatis virtutum; aut favoribus et impedimentis mediorum; quae omnia in computationem venire et notari debent. Quinetiam mensurae motuum violentorum (quos vocant), ut missilium, tormentorum, rotarum, et similium, cum hae quoque manifesto suos habeant limites certos, notandae sunt.

Inveniuntur etiam quidam motus et virtutes contrariae illis, quae operantur per tactum et non ad distans; quae operantur scilicet ad distans et non ad tactum; et rursus, quae operantur remissius ad distantiam minorem et fortius ad distantiam majorem. Etenim visio non bene transigitur ad tactum, sed indiget medio et distantia [519]. Licet meminerim me audisse ex relatione cujusdam fide digni, quod ipse in curandis oculorum suorum cataractis (erat autem cura talis, ut immitteretur festuca [520] quaedam parva

argentea intra primam oculi tunicam, quae pelliculam illam cataractae removeret et truderet in angulum oculi) clarissime vidisset festucam illam supra ipsam pupillam moventem. Quod utcunque verum esse possit, manifestum est majora corpora non bene aut distincte cerni nisi in cuspide coni, coeuntibus radiis objecti ad nonnullam distantiam [521]. Quin etiam in senibus oculus melius cernit remoto objecto paulo longius, quam propius [522]. In missilibus autem certum est percussionem non fieri tam fortem ad distantiam nimis parvam, quam paulo post [523]. Haec itaque et similia in mensuris motuum quoad distantias notanda sunt.

[519] CP. Sylva Sylvarum, Exp. 272, where the same story about the operation for cataract is told. There is, I am informed, no intrinsic improbability in it.

On the power of accommodation by which the eye adapts itself to variations in the distances of objects, the student, who is not already acquainted with the structure of the eye and the phenomena of the sense of vision, may consult Ganot's Physics, 12th Ed., §§ 601-603, or Carpenter's Human Physiology, 9th Ed., §§ 567-9. It generally requires a great effort to see very near objects, and at a certain distance from the eye, varying with different persons and with the size and colour of the objects, the image on the retina becomes blurred. [TF]

[520] A needle. [TF]

[521] Sc. from the object itself, not from the retina of the eye, which would be absurd. [TF]

[522] This statement is true, as a general rule. 'We commonly meet with myopia (short-sightedness) in young persons, and with presbyopia (long-sightedness) in old: but this is by no means the invariable rule; for even aged persons are sometimes "short-sighted," and "long-sightedness" is occasionally met with amongst the young.' Dr. Carpenter, Human Physiology, 4th Ed., § 879. [I do not find this passage, which was quoted in my First Edition, reprinted in the later editions of Dr. Carpenter's work.] [TF]

[523] While the ball is travelling upwards, the velocity diminishes instead of increasing, and so, contrary to what Bacon supposed, the initial velocity is greater than the velocity at any other point on the upward path. A projectile traces a parabola, and it may easily be shown that the velocity at any point of the parabola is that which would he acquired in falling from the directrix. [TF]

Est et aliud genus mensurae localis motuum, quod non praetermittendum est. Illud vero pertinet ad motus non progressivos, sed sphaericos; hoc est, ad expansionem corporum in majorem sphaeram, aut contractionem in minorem. Inquirendum enim est inter mensuras istas motuum, quantam compressionem aut extensionem corpora (pro natura ipsorum) facile et libenter patiantur, et ad quem terminum reluctari incipiant, adeo ut ad extremum *Non Ultra* ferant; ut cum vesica inflata comprimitur, sustinet illa

compressionem nonnullam aëris, sed si major fuerit, non patitur aër, sed rumpitur vesica.

At nos hoc ipsum subtiliore experimento magis exacte probavimus. Accepimus enim campanulam ex metallo, leviorem scilicet et tenuiorem, quali ad excipiendum salem utimur; eamque in pelvim aquae immisimus, ita ut deportaret secum aërem qui continebatur in concavo usque ad fundum pelvis. Locaveramus autem prius globulum in fundo pelvis, super quem campanula imponenda esset. Quare illud eveniebat, ut si globulus ille esset minusculus (pro ratione concavi), reciperet se aër in locum minorem, et contruderetur solum, non extruderetur. Quod si grandioris esset magnitudinis quam ut aër libenter cederet, tum aër majoris pressurae impatiens campanulam ex aliqua parte elevabat, et in bullis ascendebat.

Etiam ad probandum qualem extensionem [524] (non minus quam compressionem) pateretur aër, tale quippiam practicavimus. Ovum vitreum accepimus, cum parvo foramine in uno extremo ovi. aërem per foramen exuctione forti attraximus, et statim digito foramen illud obturavimus, et ovum in aquam immersimus, et dein digitum removimus. aër vero tensura illa per exuctionem facta tortus et magis quam pro natura sua dilatatus, ideoque se recipere et contrahere nitens (ita ut si ovum illud in aquam non fuisset immersum, aërem ipsum traxisset cum sibilo), aquam traxit ad tale quantum quale sufficere posset ad hoc, ut aër antiquam recuperaret sphaeram sive dimensionem [525].

[524] Thus, Bacon recognised the Elasticity of Air, but, as Dr. Whewell remarks (History of the Inductive Sciences, Book x. Chapter 3. sect, i), the broad facts which exhibit this phenomenon are tolerably evident. It is the reduction of them to law and measurement which has constituted the merit of the researches of Boyle and others. At the same time, Bacon ought to have the credit of the curiosity which he felt on this subject, and of the idea of instituting experiments on it. [TF]

[525] ‘This explanation is wholly unsatisfactory. The principle upon which the true explanation depends, namely the pressure of the atmosphere, was, it seems tolerably certain, first suggested by Torricelli. If the experiment were performed in vacuo, no water would enter the egg, unless the egg were plunged to a considerable depth into the water, or unless the vacuum within it were more perfect than could be produced in the manner described,' Mr. Ellis’ note.

The two preceding experiments, though rough, when compared with more recent proofs, must be admitted as affording evidence of the compressibility and elasticity of air. [TF]

Atque certum est corpora tenuiora (quale est aër) pati contractionem nonnullam notabilem, ut dictum est; at corpora tangibilia (quale est aqua) multo aegrius et ad minus spatium patiuntur compressionem. Qualem autem patiatur, tali experimento inquisivimus.

Fieri fecimus globum ex plumbo cavum, qui duas circiter pintas vinarias contineret; eumque satis per latera crassum, ut majorem vim sustineret. In illum aquam immisimus, per foramen alicubi factum; atque foramen illud, postquam globus aqua impletus fuisset, plumbo liquefacto obturavimus, ut globus deveniret plane consolidatus. Dein globum forti malleo ad duo latera adversa complanavimus; ex quo necesse fuit aquam in minus contrahi, cum sphaera figurarum sit capacissima. Deinde, cum malleatio non amplius sufficeret, aegrius se recipiente aqua, molendino [526] seu torculari usi sumus; ut tandem aqua, impatiens pressurae ulterioris, per solida plumbi (instar roris delicati) exstillaret. Postea, quantum spatii per eam compressionem imminutum foret computavimus; atque tantam compressionem passam esse aquam (sed violentia magna subactam) intelleximus [527].

[526] A Low Latin word for a mill. See Du Cange, and CP. Historia Ventoruni, Ellis and Spedding, Vol. II. pp. 64-5. It is here, as Mr. Ellis observes, used for a press. [TF]

[527] CP. Aphorism 50, Modus Secundus, and Historia Densi et Rari, Ellis and Spedding, Vol. II. pp. 299-300, From a comparison of these passages with that in the text, it is plain that Bacon imagined the experiment to be successful, and that he had thereby proved the compressibility of water. The fact that the water exuded through the pores of the lead ought, however, to have shown him that the experiment was one which could not be relied upon.

'This,' says Mr. Ellis, 'is perhaps the most remarkable of Bacon's experiments; and it is singular that it was so little spoken of by subsequent writers. Nearly fifty years after the publication of the Novum Organum, an account of a similar experiment was published by Megalotti, who was secretary of the Accademia del Cimento at Florence; and it has since been familiarly knovm as the Florentine experiment. I quote his account of it. 'Facemmo lavorar di getto una grande ma sottil palla d' argento, e quella ripiena d' acqua raftreddata col ghiaccio serramo con saldissime vite. Di poi cominciammo a martellaria leggiermente per ogni verso, onde ammaccato V argento (il quale per la sua crudezza non comporta d' assottigliarsi e distendersi come farebbe Foro raffinato, o il piombo, o altro metallo piu dolce) veniva a ristrignersi, e scemare la sua interna capacith, senza che F acqua patisse una minima compressione, poiche ad ogni colpo si videa trasudare per tutti i pori del metallo a guisa d'argento vivo il quale da alcuna pelle premuto minutamente sprizzasse.' — Saggi di natural! Esperienze fatte nelF Accademia del Cimento, p, 204, Firenze, 1667. The writer goes on to remark that the absolute incompressibility of water is not proved by this experiment, but merely that it is not to be compressed in the manner described. But the experiment is on other grounds inconclusive.

'It is to be remarked that Leibnitz, Nouveaux Essais, in mentioning the Florentine experiment, says that the globe was of gold (p. 229, Erdmann), whereas the Florentine academicians expressly say why they preferred silver to either gold or lead.'

Notwithstanding the unsatisfactory character of these experiments, the compressibility of liquids has been fully demonstrated by Canton, Oersted, and others. F or an account of the *piezometer* 'the instrument which is used for measuring the amount of compressibility of various liquids, see Ganot's Physics, 12th Ed., § 97. Ether is much more compressible than water, and fresh water distinctly more so than sea water. In general, the densest liquids are those least capable of compression. [TF]

At solidiora, sicca, aut magis compacta, qualia sunt lapides et ligna, necnon metalla, multo adhuc minorem compressionem aut extensionem, et fere imperceptibilem ferunt [528]; sed vel fractione, vel progressione, vel aliis pertentationibus se liberant: ut in curvationibus ligni aut metalli, horologiis moventibus per complicationem laminae, missilibus, malleationibus, et innumeris aliis motibus apparet. Atque haec omnia cum mensuris suis in indagatione naturae notanda et exploranda sunt, aut in certitudine sua, aut per aestimativas, aut per comparativas, prout dabitur copia.

[528] Compressibility seems to be an universal property of matter, being at once a consequence and a proof of porosity. The compressibility of solids, though much less than that of gases, is greater, often much greater, than that of liquids. 'It is found in all degrees. Cloths, paper, cork, woods are amongst the most compressible of solid substances. Metals are so also to a great extent, as is proved by the process of coining, in which the metal receives the impression from the die. There is, in most cases, a limit beyond which, when the pressure is increased, bodies are fractured or reduced to powder.' Ganot's Physics, 12th Ed., § 16. [TF]

XLVI.

Inter *praerogativas instantiarum* ponemus loco vicesimo secundo *Instantias Curriculi* [529], quas etiam *Instantias ad Aquam* appellare consuevimus; sumpto vocabulo a clepsydris apud antiquos, in quas infundebatur aqua, loco arenae. Eae mensurant naturam per momenta temporis, quemadmodum *Instantiae Virgae* per gradus spatii. Omnis enim motus sive actio naturalis transigitur in tempore; alius velocius, alius tardius, sed utcunque momentis certis et naturae notis. Etiam illae actiones quae subito videntur operari, et in ictu oculi (ut loquimur), deprehenduntur recipere majus et minus quoad tempus [530].

[529] Amongst the instruments which furnish examples of this 'Instance,' we may adduce the dial, the pendulum, the clock, the watch, the chronometer, the electric clock, the transit instrument, etc., and, amongst methods, the various divisions of time, the personal equation as employed in astronomical observatories, the modes of calculating the velocity of sound, light, electricity, etc. Dr. Kitchin remarks very well that the various applications of the Infinitesimal Calculus afford a good illustration both of this and of the last Aphorism.

The works referred to in the first note to the last Aphorism, will also serve for the illustration of this. [TF]

[530] ‘Glaring instances’ of this statement would be light and conducted electricity. [TF]

Primo itaque videmus restitutiones corporum coelestium fieri per tempora numerata; etiam fluxus et refluxus maris. Latio autem gravium versus terram et levium versus ambitum coeli fit per certa momenta, pro ratione corporis quod fertur, et medii [531]. At velificationes navium, motus animalium, perlationes missilium, omnes fiunt itidem per tempora (quantum ad summas) numerabilia. Calorem vero quod attinet, videmus pueros per hyemem manus in flamma lavare, nec tamen uri; et joculatores vasa plena vino vel aqua, per motus agiles et aequales, vertere deorsum et sursum recuperare, non effuso liquore; et multa hujusmodi. Nec minus ipsae compressiones et dilatationes et eruptiones corporum fiunt, aliae velocius, aliae tardius, pro natura corporis et motus, sed per momenta certa. Quinetiam in explosione plurium bombardarum simul, quae exaudiuntur quandoque ad distantiam triginta milliarium, percipitur sonus prius ab iis qui prope absunt a loco ubi fit sonitus, quam ab iis qui longe [532]. At in visu (cujus actio est pernicissima) liquet etiam requiri ad eum actuandum momenta certa temporis: idque probatur ex iis quae propter motus velocitatem non cernuntur; ut ex latione pilae ex sclopeto [533]. Velocior enim est praetervolatio pilae quam impressio speciei ejus quae deferri poterat ad visum.

[531] Φέρεται δέ γε θᾶττον τὸ πλεῖον ἄνω πῦρ Tod ἐλάττονος, καὶ κάτω δὲ πάλιν ὡσαύτως ὁ πλείων χρυσὸς καὶ ὁ μόλιβδος" ὁμοίως δὲ καὶ τῶν ἄλλων ἕκαστον τῶν ἐχόντων βάρος. Aristotle, De Coelo, IV. 2 (p. 309 b. 12-15).

Compare, in addition to the passage towards the end of the next Aphorism, De Augmentis Scientiarum, V. 2 (Ellis and Spedding, Vol. I. p. 625): ‘ Variatio Experimenti fit tertio in Quanto; circa quod diligens admodum est adhibenda cura, cum hoc multi circumstent errores. Credunt enim homines, aucta aut multiplicata quantitate, pro rata augeri aut multiplicari virtutem. Et hoc fere postulant et supponunt, tanquam res sit mathematicae cujusdam certitudinis; quod omnino falsissimum est. *Globus plumibeus tmius librae* a turri demissus (puta) decem pulsuum spatio ad terram descendit: num globus duarum librarum (in quo impetus iste motus, quern vocant, naturalis duplicari debet) spatio quinque pulsuum terram feriet? At ille aequali fere tempore descendet, neque accelerabitur juxta rationem Quanti.’ These passages, though Bacon makes no reference to Galileo, shew plainly enough that he had given up the old Peripatetic and Scholastic doctrine (for which see my Inductive Logic, 4th Ed., p. 258), that heavy bodies fall to the earth in times inversely proportional to their weights, or, in other words, that their velocities are directly proportional to their weights. This doctrine, though for a long time obstinately adhered to by his opponents, had been exploded by Galileo by means of the experiments which he made from the leaning tower of Pisa about 1590. He maintained (and rightly) that all bodies, whatever their ‘weight, would, if we could remove the resistance of the air, fall through equal vertical spaces in equal times. See Dialogo dei Massimi Sistemi, Giornata Seconda, Florentine Ed. of 1842, Vol. I. pp. 245-46; also Sermones de Motu Gravium, Vol. xi. pp. 48-9. The doctrine, which Galileo

combated, pleaded for itself the authority of Aristotle. See the passage above quoted, and, with reference to the proportion, De Coelo, III. 2 (p. 301 b. 1-17).

It is almost superfluous to add that Bacon is right in making the 'ratio medii' an element in the enquiry. The differences in the velocities of bodies falling through the same vertical spaces are, in fact, entirely determined by the various media through which the bodies fall and the different relations subsisting between the two. [TF]

[532] CP. the very interesting passages on the motion and velocity of Sound in Sylva Syl varum, Exps. 207-11, where Bacon proposes an experiment for the purpose of determining the rate at which sound moves. In principle, the experiment, which consists in comparing the time of seeing a light with that of hearing a sound, is the same as that from which the velocity of sound has been actually ascertained. This in dry air and at o° C. is about 1093 ft. in a second.

There are many stories of the distances at which sounds have been heard. The firing at Waterloo is said to have been heard at Dover, and sometimes the reports of cannon or volcanoes are said to have been carried distances of 200, or even 300 miles. [TF]

[533] This incapacity is due partly to the colour of the ball (for we do see a rocket), partly to the fact that the eye cannot adjust itself with sufficient rapidity to its constantly changing positions.

Note again, in the language of the next sentence, the traces of the old theory of 'sensible species.' CP. Aphorism 43 and note 99. [TF]

Atque hoc, cum similibus, nobis quandoque dubitationem peperit plane monstrosam [534]: videlicet, utrum coeli sereni et stellati facies ad idem tempus cernatur quando vere existit, an potius aliquanto post; et utrum non sit (quatenus ad visum coelestium) non minus tempus verum et tempus visum, quam locus verus et locus visus, qui notatur ab astronomis in parallaxibus [535]. Adeo incredibile nobis videbatur, species sive radios corporum coelestium per tam immensa spatia milliarium subito deferri posse ad visum; sed potius debere eas in tempore aliquo notabili delabi. Verum illa dubitatio (quoad majus aliquod intervallum temporis inter tempus verum et visum) postea plane evanuit [536]: reputantibus nobis jacturam illam infinitam et diminutionem quanti, quatenus ad apparentiam, inter corpus stellae verum et speciem visam, quae causatur a distantia; atque simul notantibus ad quantam distantiam (sexaginta scilicet ad minimum milliariorum) corpora, eaque tantum albicantia, subito hic apud nos cernantur; cum dubium non sit lucem coelestium, non tantum albedinis vividum colorem, verum etiam omnis flammae (quae apud nos nota est) lucem, quoad vigorem radiationis, multis partibus excedere. Etiam immensa illa velocitas in ipso corpore, quae cernitur in motu diurno (quae etiam viros graves ita obstupefecit ut mallent credere motum terrae [537]), facit motum illum ejaculationis radiorum ab ipsis (licet celeritate, ut diximus, mirabilem) magis credibilem. Maxime vero omnium nos movit, quod si interponeretur intervallum temporis aliquod notabile inter veritatem et visum, foret ut species per nubes interim

orientes et similes medii perturbationes interciperentur saepenumero, et confunderentur [538]. Atque de mensuris temporum simplicibus haec dicta sint.

[534] It is almost needless to say that this 'dubitatio plane monstrosa' has been amply justified. 'The measurement of the Velocity of light,' says Professor Playfair, 'and the wonderful consequences arising from it, are the best commentaries on this passage, and the highest eulogy on its Author.'

Taking the velocity of light at 190,000 miles a second, it requires 8^m 18^s to traverse a semi-diameter of the earth's orbit. From this datum it is calculated that the light which the very nearest fixed stars send us must take at least 3¼ years to reach us, while the light of some of the stars in the galaxy must have occupied more than 2000 years in travelling over the distance which separates them from our own system. 'See, for more detailed information, Herschel's Astronomy, loth Ed., §§ 801-3. [TF]

[535] On parallax and the corrections for it, see Herschell's Astronomy, 10th Ed., §§ 338-45. [TF]

[536] We hardly know which to admire most, the felicity of Bacon's conjecture or the perverted ingenuity of the arguments by which he attempts to explain it away. The first argument shews what a strangely inadequate notion he had of the distance of the fixed stars from us. [TF]

[537] This 'passage, even if it stood alone, would shew pretty plainly that Bacon did not believe in the diurnal motion of the earth. CP. Aphorism 36 (2), and note 92; also Introduction, pp. 34-7. [TF]

[538] I think that Bacon must here have in mind cosmical clouds, in the interstellar spaces, not ordinary or aerial clouds. The argument is that the light of the stars, if it took a long time for its transmission, would be frequently stopped by various obstacles in the sky, whereas, on a clear night, we invariably see the stars where we expect to find them. At the same time, it must be confessed that, if there were such obstacles as I am supposing Bacon to contemplate, the light might sometimes be intercepted, however instantaneous its transmission. There is, then, an undoubted difficulty in the passage, though it does not appear to me so great as it seems to appear to Mr. Spedding. [TF]

Verum non solum quaerenda est mensura motuum et actionum simpliciter, sed multo magis comparative: id enim eximii est usus, et ad plurima spectat. Atque videmus flammam alicujus tormenti ignei citius cerni, quam sonitus audiatur; licet necesse sit pilam prius aërem percutere, quam flamma quae pone erat exire potuerit; fieri hoc autem propter velociorem transactionem motus lucis, quam soni. Videmus etiam species visibiles a visu citius excipi quam dimitti [539]; unde fit quod nervi fidium, digito impulsi, duplicentur aut triplicentur quoad speciem, quia species nova recipitur, antequam prior demittatur [540]; ex quo etiam fit, ut annuli rotati videantur globosi, et fax ardens, noctu velociter portata, conspiciatur caudata. Etiam ex hoc fundamento

inaequalitatis motuum quoad velocitatem, excogitavit Galilaeus [541] causam fluxus et refluxus maris; rotante terra velocius, aquis tardius; ideoque accumulantibus se aquis in sursum, et deinde per vices se remittentibus in deorsum, ut demonstratur in vase aquae incitatius movente. Sed hoc commentus est concesso non concessibili [542] (quod terra nempe moveatur), ac etiam non bene informatus [543] de oceani motu sexhorario.

[539] The retention of images on the retina of the eye is a familiar phenomenon, of which the reader will easily supply himself with instances. The duration of the persistence varies with the intensity of the light and the sensitiveness of the organ. 'M. Plateau has investigated the duration of the impression by numerous methods, and has found that it is on the average half a second. * * * A great number of pieces of apparatus are founded on the persistence of sensation on the retina. Such are the thaumatrope, the phenakistoscope, Faraday's wheel, the kaleidophone, and the zoetrope.' Ganot's Physics, 12th Ed., § 625. [TF]

[540] Mr. Ellis says that 'in the case of vibrating strings Bacon's explanation is not altogether complete. The distinct or quasi-distinct images to which he refers correspond to limiting positions of the vibrating string.' [TF]

[541] This account of Galileo's theory of the tides is inaccurate. In this theory the tides are caused by the varying velocity of different points of the earth's surface, arising from, the composition of the earth's two motions, namely that about its axis, and that in its orbit. Bacon does not seem to have perceived that both these motions are essential to the explanation. That the earth's being in motion might be the cause of the tides, had been suggested before the time of Galileo by Caesalpinus in the Quaestiones Peripateticae, III. 5. It is odd that Patritius, in giving an account of all the theories which had in his time been devised to explain the cause of the tides (see his Pancosmia, 1 . 28), does not mention Caesalpinus', though it was published some years before his own work. Galileo perhaps alludes to Caesalpinus in his letter to Cardinal Orsino, dated 8th January, 1616. See, for remarks on Caesalpinus' doctrine, the Problemata Marina of Casmann, published in 1596. Casmann's own theory is that of expansion.' Mr. Ellis' note. See also my notes on Aphorism 36 (i). Galileo's Theory of the Tides will be found stated at length in his Dialogo dei Massimi Sistemi, Giomata Quarta. [TF]

[542] See note 37 above on this subject. In the present passage, Bacon may mean nothing more than that Galileo assumed what required to be proved. [TF]

[543] See the passage, on the Tides in Aphorism 36 (1). [TF]

At exemplum hujus rei de qua agitur, videlicet, de comparativis mensuris motuum, neque solum rei ipsius, sed et usus insignis ejus (de quo paulo ante loquuti sumus), eminet in cuniculis subterraneis, in quibus collocatur pulvis pyrius; ubi immensae moles terrae, aedificiorum, et similium, subvertuntur, et in altum jaciuntur, a pusilla quantitate pulveris pyrii [544]. Cujus causa pro certo illa est, quod motus dilatationis pulveris, qui impellit, multis partibus sit pernicior, quam motus gravitatis per quem fieri possit aliqua

resistentia; adeo ut primus motus perfunctus sit, antequam motus adversus inceperit; ut in principiis nullitas quaedam sit resistentiae. Hinc etiam fit, quod in omni missili, ictus, non tam robustus quam acutus et celer, ad perlationem potissimum valeat. Neque etiam fieri potuisset, ut parva quantitas spiritus animalis [545] in animalibus, praesertim in tam vastis corporibus qualia sunt balaenae aut elephanti, tantam molem corpoream flecteret et regeret, nisi propter velocitatem motus spiritus, et hebetudinem corporeae molis, quatenus ad expediendam suam resistentiam.

[544] In describing Blasting, as Dr. Kitchin observes, Bacon confuses the resistance of inertia with the force of gravity. There is in these cases no 'anticipation of motion,' 'anteversio motus,' as Bacon calls it here and in Aphorism 51. [TF]

[545] On Bacon's curious conception of 'Spirit,' CP. Aphorism 40 and the other passages referred to in the notes on that Aphorism. [TF]

Denique, hoc unum ex praecipuis fundamentis est experimentorum magicorum, de quibus mox dicemus [546]; ubi scilicet parva moles materiae longe majorem superat et in ordinem redigit: hoc, inquam, si fieri possit anteversio motuum per velocitatem unius, antequam alter se expediat.

[546] See Aphorism 51. [TF]

Postremo, hoc ipsum *Prius* et *Posterius* in omni actione naturali notari debet; veluti quod in infusione rhabarbari [547] eliciatur purgativa vis prius, astrictiva post; simile quiddam etiam in infusione violarum [548] in acetum experti sumus; ubi primo excipitur suavis et delicatus floris odor; post, pars floris magis terrea, quae odorem confundit. Itaque si infundantur violae per diem integrum, odor multo languidius excipitur: quod si infundantur per partem quartam horae tantum, et extrahantur; et (quia paucus est spiritus odoratus qui subsistit in viola) infundantur post singulas quartas horae violae novae et recentes ad sexies; tum demum nobilitatur infusio, ita ut licet non manserint violae, utcunque renovatae, plus quam ad sesquihoram, tamen permanserit odor gratissimus, et viola ipsa non inferior, ad annum integrum. Notandum tamen est, quod non se colligat odor ad vires suas plenas, nisi post mensem ab infusione. In distillationibus vero aromatum maceratorum in spiritu vini patet quod surgat primo phlegma aqueum et inutile, deinde aqua plus habens ex spiritu vini, deinde post aqua plus habens ex aromate. Atque hujus generis quamplurima inveniuntur in distillationibus notatu digna. Verum haec sufficiant ad exempla.

[547] Rhubarb. CP. Sylva Sylvarum, Exp. 19. [TF]

[548] CP. Sylva Sylvarum; Exp. 17. [TF]

XLVII.

Inter *praerogativas instantiarum* ponemus loco vicesimo tertio *Instantias Quanti*, quas etiam *Doses Naturae* (sumpto vocabulo a Medicinis) vocare consuevimus [549]. Eae sunt quae mensurant virtutes per *Quanta* corporum, et indicant quid *Quantum Corporis* faciat ad Modum Virtutis. Ac primo sunt quaedam virtutes quae non subsistunt nisi in *quanto cosmico*, hoc est, tali *quanto* quod habeat consensum cum configuratione et fabrica universi. Terra enim stat; partes ejus cadunt. Aquae in maribus fluunt et refluunt; in fluviis minime, nisi per ingressum maris. Deinde etiam omnes fere virtutes particulares secundum *multum* aut *parum* [550] corporis operantur. Aquae largae non facile corrumpuntur; exiguae cito. Mustum et cervisia maturescunt longe citius, et fiunt potabilia, in utribus parvis, quam in doliis magnis. Si herba ponatur in majore portione liquoris, fit infusio, magis quam imbibitio [551]; si in minore, fit imbibitio, magis quam infusio. Aliud igitur erga corpus humanum est balneum, aliud levis irroratio. Etiam parvi rores in aëre nunquam cadunt [552], sed dissipantur et cum aëre incorporantur. Et videre est in anhelitu super gemmas, parum illud humoris, quasi nubeculam vento dissipatam, continuo solvi. Etiam frustum ejusdem magnetis non trahit tantum ferri, quantum magnes integer. Sunt etiam virtutes in quibus parvitas quanti magis potest; ut in penetrationibus, stylus acutus citius penetrat, quam obtusus; adamas punctuatus sculpit in vitro; et similia.

[549] These 'instantiae' are peculiarly valuable in medicine. The whole Pharmacopoeia, in fact, is an illustration of them. See some very interesting remarks on the Doses of Medicinal Substances and the circumstances by which their effects are modified in Dr. Paris' Pharmacologia, 9th Ed., pp. 453-67, and CP. pp. 120-3.

The law of definite proportions in chemistry might be brought under this head of instances, without doing much violence to them, though, of course, Bacon had himself no conception of it

In connexion with this Aphorism, the student may again consult Herschel's Discourse, etc., §§ 115-6. [TF]

[550] *Parum* is here used in its later sense of 'little.' [TF]

[551] By this word is meant the absorption of the liquor by the herb. [TF]

[552] Bacon was, of course, ignorant of the true theory of Dew, for which see Dr. Wells' remarkable Memoir on the Theory of Dew, reprinted by Longmans and Co., in 1866. Some account of Dr. Wells' researches is given in Herschel's Discourse on the Study of Natural Philosophy, §§ 163-9, in Mill's Logic, Book III. Chapter 9. § 3. [TF]

The following curious passage in the Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 291) is, perhaps, worth transcribing: 'Rores matutini sunt proculdubio vapores, qui in aerem purum non erant plene dissipati et versi, sed haerebant imperfecte misti, donee

per frigora noctis, praesertim in regione media quam vocant aeris, fuerint repercussi, et in aquam condensati.' For another interesting passage, see Sylva Sylvarum, Exp. 81. [TF]

Verum non hic morandum est in indefinitis, sed etiam de *rationibus quanti* corporis erga modum virtutis inquirendum. Proclive enim foret credere, quod rationes quanti rationes virtutis adaequarent; ut si pila plumbea unius unciae caderet in tali tempore, pila unciarum duarum deberet cadere duplo celerius, quod falsissimum est [553]. Nec eaedem rationes in omni genere virtutum valent, sed longe diversae. Itaque hae mensurae ex rebus ipsis petendae sunt, et non ex verisimilitudine aut conjecturis [554].

[553] This passage, compared with De Augmentis Scientiarum, V. 2 (E, and S., Vol. I. p. 625), shews pretty conclusively that Bacon was acquainted with the experiments on falling bodies made by Galileo from the leaning tower of Pisa, though he nowhere mentions Galileo's name in connexion with them. Indeed, the passage at the beginning of the second paragraph in the last Aphorism seems to shew that he was either imperfectly acquainted with these experiments or that he did not altogether accept the conclusions drawn from them. On the whole subject, see note 31 on the last Aphorism. [TF]

[554] The necessity of bearing in mind Bacon's caution is well illustrated in the case of the expansion of water, as well as of bismuth and the casting-metals generally, which are, at certain temperatures, an exception to the general law that bodies expand with every increase in temperature. In a case like this, mere analogy might easily deceive us. See my Inductive Logic, 4th Ed., pp. 138-9. [TF]

Denique in omni inquisitione naturae *Quantum* corporis requiratur ad aliquod effectum, tanquam dosis, notandum; et cautiones de *Nimis* et *Parum* aspergendae.

XLVIII.

Inter *praerogativas instantiarum* ponemus loco vicesimo quarto *Instantias Luctae*; quas etiam *Instantias Praedominantiae* appellare consuevimus [555]. Eae indicant praedominantiam et cessionem virtutum ad invicem; et quae ex illis sit fortior et vincat, quae infirmior et succumbat. Sunt enim motus et nixus corporum compositi, decompositi, et complicati, non minus quam corpora ipsa. Proponemus igitur primum species praecipuas motuum sive virtutum activarum; ut magis perspicua sit ipsarum comparatio in robore, et exinde demonstratio atque designatio *instantiarum luctae* et *praedominantiae*.

[555] 'By an oversight,' as Dr. Kitchin remarks, 'Bacon gives the same second name to these Instances that he does to the third class (Aphorism 24), namely, "instantiae ostensivae * * * quas etiam eiucescentias, sive instantias liberatas et *praedominanies*, appellare consuevimus."' By comparing the two sets of instance, it will be seen, however, that the word is used in totally different senses.

These 'Instantiae Luctae' or 'wrestling instances' (as they are best called) comprise what Bacon conceived to be the various conflicting kinds of motion. The discussion, as well as his use of the term 'Motion,' will often be found to be vague and unsatisfactory. The indestructibility of matter ('motus antitypiae materiae') and even the property of inertia itself motus decubitus, sive motus exhorrentiae motus [555.1]') are included by him under this generic name. Motion, I need hardly say, ought, strictly speaking, to be used in the sense of 'change of place, 'though it may legitimately be applied to changes in the relative positions of the parts of a body (for instance, of the molecules) as well as to changes of
place of the entire body itself. The vague use of the term 'Motion' dates from Aristotle downwards, Aquinas, in the Summa, repeatedly says that any operation whatever may 'secundum similitudinem' be called motion.

This Aphorism was included in the little volume, entitled Historia Naturalis et Experimentalis, etc., published at Leyden in 1638. See Introduction, p. 146, note 76. [TF]

[555.1] The second "motus" is probably redundant. [HJ]

(1) Motus Primus sit Motus *Antitypiae* [556] materiae, quae inest in singulis portionibus ejus; per quem plane annihilari non vult: ita ut nullum incendium, nullum pondus aut depressio, nulla violentia, nulla denique aetas aut diuturnitas temporis possit redigere aliquam vel minimam portionem materiae in nihilum; quin illa et sit aliquid, et loci aliquid occupet, et se (in qualicunque necessitate ponatur), vel formam mutando vel locum, liberet, vel (si non detur copia) ut est subsistat; neque unquam res eo deveniat, ut aut nihil sit, aut nullibi [557]. Quem motum Schola (quae semper fere et denominat et definit res potius per effectus et incommoda quam per causas interiores) vel denotat per illud axioma, quod *Duo corpora non possint esse in uno loco*; vel vocat motum *Ne fiat penetratio dimensionum* [558]. Neque hujus motus exempla proponi consentaneum est: inest enim omni corpori.

[556] Motion of reaction, resistance, or impenetrability. CP. the use of the verb ἀντιτυπεῖν in Aristotle, Meteorologica, II. 8 (p, 368 a. 3), III. i (p. 370 b. 18, and 371 a. 35). In Sextus Empiricus, Pyrrh. Hypot. Book III. Chapter 5, the incomprehensibility of body is founded on the incomprehensibility of ἀντιτυπία, and that on the incomprehensibility of touch. [TF]

[557] The 'Motus Antitypiae' or Indestructibility of matter is expressed in the adage 'in nihilum nil posse reverti.' See II. 40, pp. 500-1, with notes 58,59. [TF]

[558] CP. II. 36 (6). If there could be two bodies in one place, one of them would be annihilated, which is a contradiction in terms. Hence, both the axioms here referred to imply the indestructibility of matter. [TF]

(2) Sit Motus Secundus, Motus (quem appellamus) *Nexus*; per quem corpora non patiuntur se ulla ex parte sui dirimi a contactu alterius corporis, ut quae mutuo nexu et

contactu gaudeant. Quem motum Schola vocat Motum *Ne detur vacuum* [559]: veluti cum aqua attrahitur sursum exuctione, aut per fistulas; caro per ventosas [560]; aut cum aqua sistitur nec effluit in hydriis perforatis, nisi os hydriae ad immittendum aërem aperiatur; et innumera id genus.

[559] In the Phaenomena Universi (Ellis and Spedding, Vol. III. p. 704) this is called 'Motus successionis, quern motum ne detur vacuum appellant.'

On Bacon's rejection of a vacuum, and his notion of 'Nature's abhorrence of a vacuum,' CP. I. 66 ad fin., II. 8 ad init., with the notes on those passages. Mr. Ellis, in his Preface to the Historia Densi et Rari (Ellis and Spedding, Vol. II. p, 238), remarks on the change which Bacon's opinions seem to have undergone on this subject between writing the Cogitationes de Rerum Natura and the essay on the fable of Cupid on the one hand, and the Historia Densi et Rari and the Novum Organuni on the other. In the 'Canones' appended to the former of these two last works (Ellis and Spedding, Vol. II. p. 303) he says: 'Non est vacuum in natnra, nec congregatum nec intermistum.' But curiously enough, notwithstanding other passages in the Novum Organum to the contrary, he speaks doubtfully towards the end of this present Aphorism: 'Utrum vero motus nexus sit invincibilis, adhuc haeremus. Neque enim pro certo affirmaverimus, utrum detur vacuum, sive coacervatum, sive permistum.' See my notes on this passage. [TF]

[560] Cupping-glasses. The process of cupping has been explained in note 52 on Aphorism 35. It may be remarked of all the phenomena referred to in this section that their explanation depends on a knowledge of the laws of atmospheric pressure. Of these laws, Bacon was ignorant. [TF]

(3) Sit Motus Tertius, Motus (quem appellamus) *Libertatis* [561]; per quem corpora se liberare nituntur a pressura aut tensura praeter-naturali, et restituere se in dimensum corpori suo conveniens. Cujus motus etiam innumera sunt exempla: veluti (quatenus ad liberationem a pressura) aquae in natando, aëris in volando; aquae in remigando, aëris in undulationibus ventorum; laminae in horologiis. Nec ineleganter se ostendit motus aëris compressi in sclopettis ludicris puerorum, cum alnum aut simile quiddam excavant, et infarciunt frusto alicujus radicis succulentae, vel similium, ad utrosque fines; deinde per embolum [562] trudunt radicem vel hujusmodi farcimentum in foramen alterum; unde emittitur et ejicitur radix cum sonitu ad foramen alterum, idque antequam tangatur a radice aut farcimento citimo, aut embolo [563]. Quatenus vero ad liberationem a tensura, ostendit se hic motus in aëre post exuctionem in ovis vitreis remanente [564], in chordis, in corio, et panno, resilientibus post tensuras suas, nisi tensurae illae per moram invaluerint, etc. Atque hunc motum Schola sub nomine Motus ex *Forma Elementi* [565] innuit: satis quidem inscite, cum hic motus non tantum ad aërem, aquam, aut flammam pertineat, sed ad omnem diversitatem consistentiae; ut ligni, ferri, plumbi, panni, membranae, etc., in quibus singula corpora suae habent dimensionis modulum, et ab eo aegre ad spatium aliquod notabile abripiuntur. Verum quia motus iste libertatis omnium est maxime obvius, et ad infinita spectans, consultum fuerit eum bene et perspicue distinguere. Quidam enim valde negligenter confundunt

hunc motum cum gemino illo motu *antitypiae* et *nexus*; liberationem scilicet a pressura, cum motu *antitypiae*; a tensura, cum motu *nexus*; ac si ideo cederent aut se dilatarent corpora compressa, ne sequeretur *penetratio dimensionum*; ideo resilirent et contraherent se corpora tensa, ne sequeretur vacuum. Atqui si aër compressus se vellet recipere in densitatem aquae, aut lignum in densitatem lapidis, nil opus foret *penetratione dimensionum*; et nihilominus longe major posset esse compressio illorum, quam illa ullo modo patiuntur. Eodem modo si aqua se dilatare vellet in raritatem aëris, aut lapis in raritatem ligni, non opus foret vacuo; et tamen longe major posset fieri extensio eorum, quam illa ullo modo patiuntur. Itaque non reducitur res ad *penetrationem dimensionum* et *vacuum*, nisi in ultimitatibus condensationis et rarefactionis; cum tamen isti motus longe citra eas sistant et versentur, neque aliud sint quam desideria corporum conservandi se in consistentiis suis (sive, si malint, in formis suis), nec ab iis recedendi subito, nisi per modos suaves ac per consensum alterentur. At longe magis necessarium est (quia multa secum trahit), ut intimetur hominibus, motum violentum (quem nos *mechanicum*, Democritus, qui in motibus suis primis expediendis etiam infra mediocres philosophos ponendus est, motum *plagae* [566] vocavit) nil aliud esse quam Motum Libertatis, scilicet a compressione ad relaxationem. Etenim in omni sive simplici protrusione sive volatu per aërem, non fit summotio aut latio localis, antequam partes corporis praeter-naturaliter patiantur et comprimantur ab impellente. Tum vero partibus aliis alias per successionem trudentibus, fertur totum [567]; nec solum progrediendo, sed etiam rotando simul; ut etiam hoc modo partes se liberare, aut magis ex aequo tolerare possint. Atque de hoc motu hactenus.

[561] By the 'Motus Libertatis' Bacon means what in modern Physics is called Elasticity, a property common to all matter. It is the property in virtue of which bodies resume their original form or volume, when the force which altered that form or volume ceases to act. It may be developed in bodies by pressure, by traction or pulling ('tensura') by flexion or bending, and by torsion or twisting. [TF]

[562] ἔμβολος, here used for a ramrod. [TF]

[563] This example also illustrates the amount of pressure which may be produced by the compression of air. Champagne bottles, soda-water bottles, etc., are familiar illustrations of the same fact. [TF]

[564] He alludes here to the unsatisfactory experiment made with the glass eggs, mentioned in Aphorism 45. As I have said before, he was not aware that the phenomena there described are due to the pressure of the atmosphere. [TF]

[565] By this expression is meant the tendency of each of the Elements to preserve or recover the consistency which is proper to it. [TF]

[566] See note 59 on Aphorism 35. It is curious to find Bacon in the present passage depreciating Democritus, whom he usually rates so highly. [TF]

[567] CP. Aphorism 36 (6), where he adopts the same explanation of the motion of projectiles, 'motus missilium.' [TF]

(4) Sit Motus Quartus, motus cui nomen dedimus Motus *Hyles* [568]: qui motus antistrophus est quodammodo Motui, de quo diximus, Libertatis. Etenim in Motu Libertatis, corpora novum dimensum sive novam sphaeram sive novam dilatationem aut contractionem (haec enim verborum varietas idem innuit) exhorrent, respuunt, fugiunt, et resilire ac veterem consistentiam recuperare totis viribus contendunt. At contra in hoc Motu Hyles, corpora novam sphaeram sive dimensum appetunt; atque ad illud libenter et propere, et quandoque valentissimo nixu (ut in pulvere pyrio) aspirant. Instrumenta autem hujus motus, non sola certe, sed potentissima, aut saltem frequentissima, sunt calor et frigus. Exempli gratia: aër, si per tensuram (velut per exuctionem in ovis vitreis [569]) dilatetur, magno laboret desiderio seipsum restituendi. At admoto calore, e contra appetit dilatari, et concupiscet [570] novam sphaeram, et transit et migrat in illam libenter, tanquam in novam formam (ut loquuntur); nec post dilatationem nonnullam de reditu curat, nisi per admotionem frigidi ad eam invitetur; quae non reditus est, sed transmutatio repetita. Eodem modo et aqua, si per compressionem arctetur, recalcitrat [571]; et vult fieri qualis fuit, scilicet latior. At si interveniat frigus intensum et continuatum, mutat se sponte sua et libenter in condensationem glaciei; atque si plane continuetur frigus, nec a teporibus interrumpatur (ut fit in speluncis et cavernis paulo profundioribus), vertitur in crystallum [572] aut materiam similem, nec unquam restituitur.

[568] By this 'motus' is meant the tendency of matter to assume and retain a new form, by means of expansion or contraction, in contrast to its tendency, as noticed in last section, to revert, after any temporary change, to its original form. [TF]

[569] On this example, CP. last section and see note 25 on Aphorism 45. The pressure of the atmosphere (with which Bacon was unacquainted) would cause the air to rise within the egg, till the enclosed air assumed the same density as that without it. [TF]

[570] This, which is the reading of the First Edition, is altered in the Second to concupiscit, obviously the right word. [TF]

[571] CP. Bacon's abortive experiment on the leaden globe, as described in Aphorism 45. [TF]

[572] See Pliny, Naturalis Historia, xxxvii. 2 (9), sect. 23 (where he says 'glaciem esse certum est, unde nomen Graeci dedere'), and Seneca, Naturales Quaestiones III. 25 ad fin. Solinus (Polyhistor, Cap. 15 ad fin.) combats this opinion. Mr. Ellis says: 'Though this account of the origin of crystals is of course erroneous, yet there is a class of crystals which have been shown to occupy the same volume which their water of crystallisation would occupy in the state of ice; so that their other constituents may in some sort be said to take up no space. This curious analogy with ice was proved by Playfair and Joule in a very considerable number of cases. See Phil. Mag. Dec. 1845.'

Bacon seems to be speaking of stalactites and stalagmites as well as of what are more commonly called crystals. [TF]

(5) Sit Motus Quintus, Motus *Continuationis* [573]. Intelligimus autem non continuationis simplicis et primariae, cum corpore aliquo altero (nam ille est Motus Nexus); sed continuationis sui, in corpore certo. Certissimum enim est, quod corpora omnia solutionem continuitatis exhorreant; alia magis, alia minus, sed omnia aliquatenus. Nam ut in corporibus duris (veluti chalybis, vitri) reluctatio contra discontinuationem est maxime robusta et valida, ita etiam in liquoribus, ubi cessare aut languere saltem videtur motus ejusmodi, tamen non prorsus reperitur privatio ejus [574]; sed plane inest ipsis in gradu tanquam infimo, et prodit se in experimentis plurimis; sicut in bullis, in rotunditate guttarum [575], in filis tenuioribus stillicidiorum [576], et in sequacitate corporum glutinosorum, et ejusmodi. Sed maxime omnium se ostendit appetitus iste, si discontinuatio tentetur usque ad fractiones minores. Nam in mortariis, post contusionem ad certum gradum, non amplius operatur pistillum; aqua non subintrat rimas minores; quin et ipse aër, non obstante subtilitate corporis ipsius, poros vasorum paulo solidiorum non pertransit subito, nec nisi per diuturnam insinuationem.

[573] This is Cohesion, or the force which unites molecules of the same nature. 'The modern experiments on the strength of different substances, by finding what weights are necessary in order to tear them asunder, are founded on this property. These experiments have been made with bars of wood, metals, glass, etc., of given dimensions, and it has been found that the cohesive strength of a body is in the joint proportion of its elasticity, and toughness, and the area of its section.' Dr. Hippus in the Account of the Novum Organum in the Library of Useful Knowledge. [TF]

[574] The force of cohesion is much stronger in solids than in liquids, while in gases it is overcome by that of repulsion. [TF]

[575] In large masses of liquids, the force of gravity overcomes that of cohesion, and the liquid takes no special shape, but assumes that of the vessel in which it is contained. But in smaller masses cohesion gets the upper hand, and the liquid then presents the spheroidal form. In the imaginary case of the particles being acted upon by the force of cohesion alone, the form assumed would be that of a perfect sphere. [TF]

[576] On the constitution of a jet of liquid issuing through a circular orifice, see Enc. Brit., last (9th) Ed., Vol. V. p. 68, and, for a much more precise and detailed account, Daguin, Traité de Physique, 2nd Ed., tome I. pp. 243-51. [TF]

(6) Sit Motus Sextus, motus quem nominamus Motum *ad Lucrum*, sive Motum *Indigentiae* [577]. Is est, per quem corpora, quando versantur inter plane heterogenea et quasi inimica, si forte nanciscantur copiam aut commoditatem evitandi illa heterogenea et se applicandi ad magis cognata, (licet illa ipsa cognata talia fuerint quae

non habeant arctum consensum cum ipsis) tamen statim ea amplectuntur, et tanquam potiora malunt: et lucri loco (unde vocabulum sumpsimus) hoc ponere videntur, tanquam talium corporum indiga. Exempli gratia: aurum, aut aliud metallum foliatum non delectatur aëre circumfuso. Itaque si corpus aliquod tangibile et crassum nanciscatur (ut digitum, papyrum, quidvis aliud), adhaeret statim, nec facile divellitur [578]. Etiam papyrus, aut pannus, et hujusmodi, non bene se habent cum aëre qui inseritur et commistus est in ipsorum poris. Itaque aquam aut liquorem libenter imbibunt, et aërem exterminant. Etiam saccharum, aut spongia infusa in aquam aut vinum, licet pars ipsorum emineat et longe attollatur supra vinum aut aquam, tamen aquam aut vinum paulatim et per gradus attrahunt in sursum [579].

[577] Under this head Bacon seems to include cases of Adhesion, of Capillary Attraction, and of Chemical Affinity. Dr. Hippus gives a good instance of this 'motion of preference' in the case of mercury, 'the surface of which in a glass bottle appears convex, while, in a metallic vessel, it appears concave, in consequence of its tendency to adhere to the sides of the vessel, as it has a greater attraction for metal than glass. The mercury, in fact, moistens the metallic surface, but does not moisten the glass surface. This example falls under the head of capillary phenomena. [TF]

[578] This is an ordinary case of adhesion. [TF]

[579] These are capillary phenomena. The hostility to air, in ail these examples, is, of course, a mere fancy. [TF]

Unde optimus canon sumitur aperturae et solutionum corporum. Missis enim corrosivis et aquis fortibus, quae viam sibi aperiunt, si possit inveniri corpus proportionatum et magis consentiens et amicum corpori alicui solido quam illud cum quo tanquam per necessitatem commiscetur, statim se aperit et relaxat corpus, et illud alterum intro recipit, priore excluso aut summoto [580]. Neque operatur aut potest iste *motus ad lucrum* solummodo ad tactum. Nam electrica operatio (de qua Gilbertus et alii post eum tantas excitarunt fabulas) non alia est quam corporis per fricationem levem excitati appetitus; qui aërem non bene tolerat, sed aliud tangibile mavult, si reperiatur in propinquo [581].

[580] These are cases of what we should call Chemical Affinity. Any manual of chemistry will furnish abundant examples of what Bacon means.

Thus, Chlorine decomposes bromide of silver, forming Chloride of silver, and eliminating bromine. [TF]

[581] This attack on Gilbert (whom, as we have seen before, Bacon treats in so varying a manner) and the superficial attempt at explaining the action of electricity are both worth noting. With regard to the cause of the production of electricity by friction, nothing is known. Electricity may also be produced by other means, as by chemical action, heat, etc. [TF]

(7) Sit motus Septimus, Motus (quem appellamus) *Congregationis Majoris*; per quem corpora feruntur ad massas connaturalium suorum: gravia, ad globum terrae; levia, ad ambitum coeli [582]. Hunc Schola nomine *Motus Naturalis* [583] insignivit: levi contemplatione, quia scilicet nil spectabile erat ab extra quod eum motum cieret (itaque rebus ipsis innatum atque insitum putavit); aut forte quia non cessat. Nec mirum: semper enim praesto sunt coelum et terra; cum e contra causae et origines plurimorum ex reliquis motibus interdum absint, interdum adsint. Itaque hunc, quia non intermittit sed caeteris intermittentibus statim occurrit, perpetuum et proprium; reliquos ascititios posuit. Est autem iste motus revera satis infirmus et hebes, tanquam is qui (nisi sit moles corporis major) caeteris motibus, quamdiu operantur, cedat et succumbat. Atque cum hic motus hominum cogitationes ita impleverit ut fere reliquos motus occultaverit, tamen parum est quod homines de eo sciunt, sed in multis circa illum erroribus versantur.

[582] CP. I. 66: II. 35; 36 (3); 45; 46, with the notes on the various passages. The concluding observations of this section are very remarkable, when viewed in the light of the discoveries to be made towards the end of the century by Newton. [TF]

[583] On the distinction between Natural and Violent Motion, see I. 66; II. 36 (6), with note 53 on the former Aphorism. [TF]

(8) Sit Motus Octavus, Motus *Congregationis Minoris*; per quem partes homogeneae in corpore aliquo separant se ab heterogeneis, et coeunt inter sese [584]; per quem etiam corpora integra ex similitudine substantiae se amplectuntur et fovent, et quandoque ad distantiam aliquam congregantur, attrahuntur, et conveniunt [585]: veluti cum in lacte flos lactis post moram aliquam supernatat; in vino faeces et tartarum subsidunt [586]. Neque enim haec fiunt per motum gravitatis et levitatis tantum, ut aliae partes summitatem petant, aliae ad imum vergant; sed multo magis per desiderium homogeneorum inter se coeundi et se uniendi [587]. Differt autem iste motus a motu indigentiae, in duobus. Uno, quod in motu *indigentiae* sit stimulus major naturae malignae et contrariae; at in hoc motu (si modo impedimenta et vincula absint) uniuntur partes per amicitiam, licet absit natura aliena quae litem moveat: altero, quod arctior sit unio, et tanquam majore cum delectu. In illo enim, modo evitetur corpus inimicum [588], corpora etiam non admodum cognata concurrunt; at in hoc coeunt substantiae, germana plane similitudine devinctae, et conflantur tanquam in unum. Atque hic motus omnibus corporibus compositis inest; et se facile conspiciendum in singulis daret, nisi ligaretur et fraenaretur per alios corporum appetitus et necessitates, quae istam coitionem disturbant.

[584] These phenomena may all be referred to chemical affinity, to capillary attraction, or to the processes of mechanical distribution dependent on variations in size, form, weight, or specific gravity. Sometimes it may be a question to which of these causes a phenomenon may be due. [TF]

[585] A good instance would be that of two corks, both wet or both dry, floating near each other on water. For an explanation of this phenomenon, see Everett's Translation of Deschanel's Natural Phil. Pt. I. p. 136, or Daguin, Traitd de Physique, Tome I. pp. 209-10, 2ème Ed.). [TF]

[586] In both cases, the phenomenon is due to differences of specific gravity, the lighter particles rising to the top, and the heavier falling to the bottom. [TF]

[587] An excellent illustration of Bacon's meaning may be found in the commonly received opinion with regard to the formation of flint nodules. See Phillips' Manual of Geology, pp. 358-9, or Page's Advanced Text Book of Geology, 6th Ed., pp. 350-4. The latter author discusses the question at some length, and concludes: 'From these facts it would seem that flints are aggregations of silex round some organic nucleus, just like the ironstone septaria of the coal-shales, the grains of the oolite, the ironstone nodules of the gault— all of which are aggregations round some organic centre, be it a fragment of plant, a shell, a tooth, coprolite, or other organism. This is now the generally received opinion; and, when it is remembered that the organisms must have been deposited when the chalk was in a flocculent and pulpy state, there can be little difficulty in conceiving how the silex, held in solution by the waters of deposit, would, by chemical affinity, attach itself to the decaying organism,' Dr. Bowerbank applies a similar theory even to beds of tabular flint, supposing that the sponges originating the deposit had developed themselves laterally, and that, approaching and touching each other, they united and thus formed extensive and continuous beds. On the formation of nodules generally, see also Lyell's Student's Elements of Geology, 2nd Ed., p. 40.

Since the appearance of the 1st Edition, this subject has been treated, at considerable length, by Professor Prestwich in his admirable treatise on Geology, Part II. Chapter 20. [TF]

[588] As we have seen under 'Motus Sextus,' this idea of the 'corpus inimicum' is, in many cases, fanciful. [TF]

Ligatur autem motus iste plerumque tribus modis: torpore corporum; fraeno corporis dominantis; et motu externo. Ad torporem corporum quod attinet; certum est inesse corporibus tangibilibus pigritiam quandam [589] secundum magis et minus, et exhorrentiam motus localis; ut, nisi excitentur, malint statu suo (prout sunt) esse contenta quam in melius se expedire. Discutitur autem iste torpor triplici auxilio: aut per calorem, aut per virtutem alicujus cognati corporis eminentem [590], aut per motum vividum et potentem. Atque primo quoad auxilium caloris; hinc fit, quod calor pronuntietur esse illud quod *separet heterogenea, congreget homogenea*. Quam definitionem Peripateticorum merito derisit Gilbertus; dicens eam esse perinde ac si quis diceret ac definiret hominem illud esse quod serat triticum et plantet vineas: esse enim definitionem tantum per effectus, eosque particulares [591]. Sed adhuc magis culpanda est illa definitio; quia etiam effectus illi (quales quales sunt) non sunt ex proprietate caloris, sed tantum per accidens [592] (idem enim facit frigus, ut postea dicemus [593]),

nempe ex desiderio partium homogenearum coeundi, adjuvante tantum calore ad discutiendum torporem, qui torpor desiderium illud antea ligaverat. Quoad vero auxilium virtutis inditae a corpore cognato; illud mirabiliter elucescit in magnete armato, qui excitat in ferro virtutem detinendi ferrum per similitudinem substantiae, discusso torpore ferri per virtutem magnetis. Quoad vero auxilium motus; conspicitur illud in sagittis ligneis, cuspide etiam lignea, quae altius penetrant in alia ligna quam si fuissent armatae ferro, per similitudinem substantiae, discusso torpore ligni per motum celerem: de quibus duobus experimentis etiam in aphorismo de *instantiis clandestinis* diximus [594].

[589] This is the property of *inertia*, and it is worth noting that Bacon refers to it; but it must be remembered that this property, as we conceive it, applies equally to moving bodies, which would go on moving for ever, if there were nothing external to stop them. [TF]

[590] Taking this phrase as intended to include magnetism and, so far as Bacon had any conception of it, Gravity, we ought to add Light, Electricity, and Chemical Action. [TF]

[591] 'For the definition we may refer to the Margarita Philosophiae, xi. 3.' [It should be IX. 3, The passage runs thus: 'Calidum est quod homogenia id est eiitia ejusdem naturae congregat et heterogenia id est diversarum naturarum entia segregat.' The true title of the book is Margarita Philosophica, to which, in later Editions, 'Nova' is added,] 'It is founded on a passage in the De Gen. et Corr. II. 2' [p, 329 b. 26-30]. 'Gilbert's censure on it is to be found in his posthumous work De Mundo nostro sublunari Philosophia nova, which was published by Gruter in 1651, long after the death of Bacon. It seems however, as Gruter remarks, that the work, which he suggests may have been written before the treatise De Magnete, published in 1600, had been read in tnanuscript by "viri magni et famae celeberrimae.'' "Illi perspicace in Physicis praesertim ingenio baud poenitendae in evolvendo operae testimonium dederunt, quod integrum excussisse censeantur, et aliqua a vulgaribus opinionibus abhorrentia calculo suo comprobata liinc sparsim citent;" in which I do not doubt that Gruter refers to Bacon. Bacon's quotation seems to have been made from imperfect memory, as the words of the original are: — "ciuid illud ostendit aut quae ilia differentia ab effectu tantum in quibusdam corporibus, congregans *homogenea et disgregans heterogenea*? ac si cliceres liominem animal esse carduos et sentes evellens, et friiges serens, cum istud sit agricolae studium.''— De Mundo, etc., I. c. 26.' Mr. Ellis' note. [TF]

[592] That is to say 'are not peculiar to heat, but result only accidentally, through the instrumentality of that agent; the true cause being the desire in the homogeneous parts of coming together.' To understand the reason given by Bacon, 'idem enim facit frigus,' we must recollect that the definition of 'proprium,' in the Text-books of his time, was 'quod convenit omni, soli, et semper.' [TF]

[593] See the next paragraph. It need hardly be repeated that Bacon had no idea of the true relation of heat and cold, as different degrees of the same phenomenon. The phrase

'change of temperature' would include both, and it might have supplied him with a key to his difficulties. [TF]

[594] See II. 25 ad fin., with notes. [TF]

Ligatio vero motus *congregationis minoris*, quae fit per fraenum corporis dominantis, conspicitur in solutione sanguinis et urinarum [595] per frigus. Quamdiu enim repleta fuerint corpora illa spiritu agili [596], qui singulas eorum partes cujuscunque generis ipse ut dominus totius ordinat et cohibet, tamdiu non coeunt heterogenea [597] propter fraenum; sed postquam ille spiritus evaporaverit, aut suffocatus fuerit per frigus, tum solutae partes a fraeno coeunt secundum desiderium suum naturale. Atque ideo fit, ut omnia corpora quae continent spiritum acrem (ut sales, et hujusmodi) durent et non solvantur, ob fraenum permanens et durabile spiritus dominantis et imperiosi.

[595] With regard to urine, as affected by cold, see Dr. Watson's Lectures on the Principles and Practice of Physic, 5th Ed., Lect. 70, Vol. II. p. 702.

As to blood, Bacon is in error. 'So far from coagulation being promoted by cold,' says Dr. Carpenter (Principles of Human Physiology, 9th Ed., § 187), Mt can be shown to be accelerated by moderate warmth, the natural heat of the body from which the blood is taken appearing to be most favourable to it; but the coagulating power appears to be destroyed by a temperature of about 150° F., blood heated to that point remaining permanently fluid.' Bacon was, of course, deceived by seeing the blood gradually coagulate after being taken from the body, the decreasing temperature, which was only a concomitant of coagulation, occurring to him as the cause. [TF]

[596] It is needless to add anything to what I have already said on Bacon's conception of 'spirit' in the notes on I. 50, II. 40, and elsewhere. [TF]

[597] This word should, perhaps, be 'homogenea,' as Mr. Ellis suggests. But 'heterogenea' seems intelligible enough, in the sense of 'different parts.' CP. the expression 'omnia solvuntur et redeunt in heterogeneas suas, sive (si placet) elementa sua in the passage referred to just below. [TF]

Ligatio vero motus *congregationis minoris*, quae fit per motum externum, maxime conspicitur in agitationibus corporum per quas arcetur putrefactio. Omnis enim putrefactio fundatur in congregatione homogeneorum [598]; unde paulatim fit corruptio prioris (quam vocant) formae, et generatio novae [599]. Nam putrefactionem, quae sternit viam ad generationem novae formae, praecedit solutio veteris; quae est ipsa coitio ad homogeniam. Ea vero, si non impedita fuerit, fit solutio simplex: sin occurrant varia quae obstant, sequuntur putrefactiones quae sunt rudimenta generationis novae. Quod si (id quod nunc agitur) fiat agitatio frequens per motum externum, tum vero motus iste coitionis (qui est delicatus et mollis et indiget quiete ab externis) disturbatur et cessat; ut fieri videmus in innumeris: veluti cum quotidiana agitatio aut profluentia

aquae arceat putrefactionem; venti arceant pestilentiam aëris; grana in granariis versa et agitata maneant pura; omnia denique agitata exterius non facile putrefiant interius.

[598] CP. Historia Vitae et Mortis, Ellis and Spedding, Vol. II. p. 214. This remark shows how little Bacon was acquainted with organic chemistry. 'Putrefaction' (I quote from Dr. Ure's Dictionary of Arts, Manufactures, etc.) 'is the spontaneous decomposition of albuminoid or protein and gelatine compounds, when exposed to a limited amount of air. It is the decomposition of bodies containing nitrogen, called by some persons azotised bodies; although such bodies are produced only by life, are the principa means of producing life, and are more fitly called zoogens.'

'Thus bodies decompose at any temperature between 32° and 140° Fahrenheit (0° — 60° C.). Their decomposition begins by the action of the oxygen of the air, so that a partial oxidation and a gradual disruption are simultaneous. The result of this is a number of liquid and gaseous compounds: carbonic acid, hydrogen, nitrogen, ammonia, sulphuretted hydrogen, phosphuretted hydrogen, carburetted hydrogen, acetic acid, lactic acid,' etc.

On 'Experiments touching the inducing and accelerating, the prohibiting and preventing putrefaction,'' see Sylva Sylvarum, Exps. 328-51. [TF]

[599] On the theory of 'Spontaneous Generation,' see II. 41 and note 82. [TF]

Superest ut non omittatur coitio illa partium corporum, unde fit praecipue induratio et desiccatio. Postquam enim spiritus, aut humidum in spiritum versum, evolaverit in aliquo corpore porosiore (ut in ligno, osse, membrana, et hujusmodi), tum partes crassiores majore nixu contrahuntur et coeunt, unde sequitur induratio aut desiccatio [601]: quod existimamus fieri, non tam ob motum *nexus*, ne detur vacuum, quam per motum istum amicitiae et unionis.

[601] CP. II. 40: 'Spiritus in re tangibili, emissus, corpora contrahit et desiccat.' This position is expanded in the following paragraph, beginning 'Etenim in Omni corpore,' etc. [TF]

Ad coitionem vero ad distans quod attinet, ea infrequens est et rara; et tamen in pluribus inest quam quibus observatur. Hujus simulacra sunt, cum bulla solvat bullam [602]; medicamenta ex similitudine substantiae trahant humores [603]; chorda in diversis fidibus ad unisonum moveat chordam [604]; et hujusmodi. Etiam in spiritibus animalium hunc motum vigere existimamus [605], sed plane incognitum. At eminet certe in magnete, et ferro excito. Cum autem de motibus magnetis loquimur, distinguendi plane sunt. Quatuor enim virtutes sive operationes sunt in magnete, quae non confundi, sed separari debent; licet admiratio hominum et stupor eas commiscuerit. Una, coitionis magnetis ad magnetem, vel ferri ad magnetem, vel ferri exciti ad ferrum. Secunda, verticitatis ejus ad septentriones et austrum, atque simul declinationis ejus [606]. Tertia, penetrationis ejus per aurum, vitrum, lapidem, omnia [607]. Quarta, communicationis

virtutis ejus de lapide in ferrum, et de ferro in ferrum, absque communicatione substantiae. Verum hoc loco de prima virtute ejus tantum loquimur, videlicet coitionis. Insignis etiam est motus coitionis argenti vivi et auri [608]: adeo ut aurum alliciat argentum vivum, licet confectum in unguenta; atque operarii inter vapores argenti vivi soleant tenere in ore frustum auri, ad colligendas emissiones argenti vivi, alias crania et ossa eorum invasuras; unde etiam frustum illud paulo post albescit. Atque de motu *congregationis minoris* haec dicta sint.

[602] This is the case when two bubbles come into contact, and is due, amongst other causes, to Capillary Attraction. See p. 427, note 67. [TF]

[603] This is an example of the False Analogies of which ancient medicine was so full, and is a special application of the maxim 'Similia similibus curantur.' We find the opposite sentiment in Aristotle, Eth. II. 2 (p. 1104 b. 17, 18): αί δὲ ἰατρεῖαι διὰ τῶν ἐναντίων πεφύκασι γίνεσθαι. [TF]

[604] The sympathetic vibrations of strings, tuning-forks, etc., in unison, are well-known phenomena. See Tyndall's Lectures on Sound, Lect. 8 ad fin. (Chapter 9 in later editions), or, for a more detailed account, Helmholtz on the Sensations of Tone, Translation by Mr. Ellis, Pt. I. Chapter 3. [TF]

[605] See Sylva Sylvarum, Exp. 1000; De Augmentis Scientiarum, Libro IV. Cap. 3 (Ellis and Spedding, Vol. I. pp. 608-9). Both these passages are well worth consulting. [TF]

[606] These and the other phenomena which Bacon notices are fully described by Gilbert, De Magnete. [TF]

[607] See Aphorism 42 ad init. [TF]

[608] The phenomena which Bacon noticed are due to the facts that, even at ordinary temperatures, Mercury is slightly volatile, and that the smallest quantity of mercurial vapour coming in contact with gold is sufficient to turn it white. It is, however, true that mercury combines very readily with gold, and hence it is used for the purpose of extracting that metal from the ore. [TF]

(9) Sit Motus Nonus, Motus Magneticus; qui licet sit ex genere motus *congregationis minoris* [609], tamen si operetur ad distantias magnas et super massas rerum magnas, inquisitionem meretur separatam; praesertim si nec incipiat a tactu, quemadmodum plurimi, nec perducat actionem ad tactum, quemadmodum omnes motus congregativi; sed corpora tantum elevet, aut ea intumescere faciat, nec quicquam ultra. Nam si luna attollat aquas [610], aut turgescere aut intumescere faciat humida [611]; aut coelum stellatum attrahat planetas versus sua apogaea; aut sol alliget astra Veneris et Mercurii [612], ne longius absint a corpore ejus quam ad distantiam certam; videntur hi motus nec sub *congregatione majore* nec sub *congregatione minore* bene collocari, sed esse

tanquam congregativa media et imperfecta, ideoque speciem debere constituere propriam.

[609] It is curious to observe that it never occurred to Bacon, as it did afterwards to Newton, that the phenomena here described belong to the same class as those included under the 'Motus Congregationis Majoris.' [TF]

[610] See II.45 and notes 13, 14, both for this passage and for the one below on the attraction of the planets by the coelum stellatum. [TF]

[611] CP. Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 266): 'Recepta est opinio, humores et siiccos, non in animalibus tantum sed et in plantis, sub pleniluniis magis turgescere, et cava implere.' CP. Cicero, De Divinatione, II. 14; Pliny, Nat History II. 99, loi {102, 104), sects. 201, etc.; Horace Sat II. 4, l. 30:

'Lubrica nascentes implent concliylia Lunae.' [TF]

[612] The two inferior planets, or those whose orbits are nearer to the sun than that of the earth. Whether referred to the heliocentric or geocentric system, the peculiarities of these planets early attracted attention. On the geocentric hypothesis, it was doubted whether their orbits were superior or inferior to that of the sun. Bacon starts various questions with regard to them in the Descriptio Globi Intellectualis (Ellis and Spedding, Vol. III. pp. 746-7).

As to the words 'ne longius absint' etc., the best commentary on them will be found in Herschel's Outlines of Astronomy, 10th Ed., § 467, etc. Herschel begins his account of the motions of these planets almost in the very words of Bacon: 'Two of the planets— Mercury and Venus— perform their circuit evidently as attendants upon the sun, from whose vicinity they never depart beyond a certain limit.' [TF]

(10) Sit Motus Decimus, *Motus Fugae* [613]; motus scilicet motui *congregationis minoris* contrarius; per quem corpora ex antipathia fugiunt et fugant inimica, seque ab illis separant, aut cum illis miscere se recusant. Quamvis enim videri possit in aliquibus hic motus esse motus tantum per accidens aut per consequens, respectu motus congregationis minoris, quia nequeunt coire homogenea, nisi heterogeneis exclusis et remotis; tamen ponendus est motus iste per se, et in speciem constituendus, quia in multis appetitus *fugae* cernitur magis principalis quam appetitus coitionis.

[613] The following excellent remarks on this section are made by Dr. Hippus in his Account of the Novum Organum in the Library of Useful Knowledge: '*Motus fugae*, or the *motion of avoidance*, though very crudely and almost ludicrously illustrated by Bacon, has its foundation in fact, and is that property of matter which is now called *repulsion*. Newton found that a convex lens' when put upon a flat glass, remained at the distance of the of an inch; and that a very considerable force was requisite to diminish this distance. Again, though steel is so much heavier than its bulk of water, yet if a dry *needle* be placed carefully upon the surface of a basin of water, it will float; the repulsion

of the water preventing its sinking. Also the particles of all *gases* seem to repel each other, as appears from their elasticity. According to Boscovich, the atoms of which bodies are composed are capable of acting on each other with a force, which differs in intensity, and in kind, according to the distance. At sensible distances the force is *attractive*, and diminishes inversely as the squares of the distance. At the smallest distances the force is *repulsive*; it increases as the distance diminishes; and at last becomes infinite or insuperable. Hence, if Boscovich's theory be correct, absolute contact, however paradoxical this may appear, is impossible. Facts, at all events, prove, in many cases, a repulsive power, whatever be its precise laws; and to these facts may be added, though somewhat differing from the former examples, the repulsion of electrified pith balls; also of the similar poles of two magnets. In the latter case, all the force of a strong man has proved insufficient to make the two north poles touch each other.' Other instances might be found in the fact that some chemical elements, so far as we know at present, will not combine with other elements (as, for instance, oxygen with fluorine), while others only combine with great difficulty; or, again, in certain phenomena of repulsion partly due to capillarity, as, for example, in the fact, analogous to that of the needle, that insects can often move on the surface of water without sinking, or that a dry ball and a moistened ball, if placed on a liquid in such a manner that the curved surfaces of the liquid in their respective neighbourhoods intersect, will repel each other. [TF]

Eminet autem hic motus insigniter in excretionibus animalium; nec minus etiam in sensuum nonnullorum odiosis objectis, praecipue in olfactu et gustu. Odor enim foetidus ita rejicitur ab olfactu, ut etiam inducat in os stomachi motum expulsionis per consensum; sapor amarus et horridus ita rejicitur a palato aut gutture, ut inducat per consensum capitis conquassationem et horrorem. Veruntamen etiam in aliis locum habet iste motus. Conspicitur enim in antiperistasibus [614] nonnullis; ut in aëris media regione, cujus frigora videntur esse rejectiones naturae frigidae ex confiniis coelestium; quemadmodum etiam videntur magni illi fervores et inflammationes, quae inveniuntur in locis subterraneis, esse rejectiones naturae calidae ab interioribus terrae [615]. Calor enim et frigus, si fuerint in quanto minore, se invicem perimunt; sin fuerint in massis majoribus et tanquam justis exercitibus, tum vero per conflictum se locis invicem summovent et ejiciunt. Etiam tradunt cinamomum et odorifera, sita juxta latrinas et loca foetida, diutius odorem retinere; quia recusant exire et commisceri cum foetidis. Certe argentum vivum, quod alias se reuniret in corpus integrum, prohibetur per salivam hominis, aut axungiam [616] porci, aut terebinthinam, et hujusmodi, ne partes ejus coeant; propter malum consensum quem habent cum hujusmodi corporibus; a quibus undique circumfusis se retrahunt; adeo ut fortior sit earum *fuga* ab istis interjacentibus quam desiderium uniendi se cum partibus sui similibus; id quod vocant *mortificationem* [617] argenti vivi. Etiam quod oleum cum aqua non misceatur, non tantum in causa est differentia levitatis, sed malus ipsorum consensus: ut videre est in spiritu vini, qui cum levior sit oleo, tamen se bene miscet cum aqua. At maxime omnium insignis est motus *fugae* in nitro, et hujusmodi corporibus crudis, quae flammam exhorrent [618]; ut in pulvere pyrio, argento vivo, necnon in auro [619]. *Fuga* vero ferri [620] ab altero polo magnetis a Gilberto [621] bene notatur non esse fuga propria, sed conformitas, et coitio ad situm magis accommodatum.

[614] See II. 12 (Inst. 24), and 27, with note 96 on the latter Aphorism. [TF]

[615] It is curious to find all this nonsense adopted by Bacon, It is borrowed from Telesius (see De Principiis atque Originibus, Ellis and Spedding, Vol. III. pp. 109-10). Cp., for similar notions, Aristotle, Meteorologica, I. 12 (p. 348 b, 2, κ.τ.λ.). [TF]

One of the Peripatetic doctrines (for which see Aristotle, De Gen, et Corr. II. 3) was that fire is hot and dry, air hot and moist, water cold and moist, earth cold and dry. It required, therefore, to be explained why 'the middle region of the air' is cold and why 'subterraneous places' are warm, both phenomena being contrary to what might have been expected. Telesius (whom Bacon so frequently follows) adopted so much of the Peripatetic theory, as to make the heavens the principal seat of heat and the earth of cold. See the account of Telesius' philosophy in the De Principiis atque Originibus (p, 94, etc.), and CP. Telesius, De Rerum Natura, Libro I. capp. 1-3. [TF]

[616] Axle-tree grease, hog's lard. See Pliny, Naturalis Historia xxviii. 9 (37), sects, 135, etc. [TF]

[617] CP. Historia Densi et Rari, Ellis and Spedding, Vol. II. pp. 286-7. [TF]

[618] CP. II. 36 (7). [TF]

[619] CP. Historia Ventorum, Ellis and Spedding, Vol. II. p. 74, and see Beckmann's History of Inventions, Vol. III. p. 128 (as quoted in Ellis and Spedding) for an account of the discovery of fulminating gold. In the two-volume Edition, the reference is Vol. II. p. 301, etc. The effects of detonating silver are much more violent than those of detonating gold. [TF]

[620] That is, magnetised iron; for the law that 'Poles of the same name repel, and poles of contrary name attract one another' applies only to substances both of which are magnets. [TF]

[621] 'Ita coitio niagnetica actus est magnetis et ferri, non actio unius, utriusque ἐντελέχεια non ἔργον, συντελέχεια et conactus potius quam sympathia; antipathia nulla est proprie magnetica. Nam fiiga et declination terminorum, sive conversio totius, utriusque actus est ad unitatem, a conactu et συνεντελέχεια [sic] amborum.' Gilbert, De Magnete, Libro II, Cap. 4. But surely this is as much a case of repulsion as any of the others which have been noticed. Faraday (Experimental Researches in Electricity) has shewn that there are many substances (called by him diamagnetic substances) which are repelled by both poles of a magnet. [TF]

(11) Sit Motus Undecimus, *Motus Assimilationis*, sive *Multiplicationis sui*, sive etiam *Generationis Simplicis*. *Generationem* autem *simplicem* dicimus non corporum integralium, ut in plantis, aut animalibus; sed corporum similarium [622]. Nempe per

hunc motum corpora similaria vertunt corpora alia affinia, aut saltem bene disposita et praeparata, in substantiam et naturam suam: ut flamma, quae super halitus et oleosa multiplicat se, et generat novam flammam [623]; aër, qui super aquam et aquea multiplicat se, et generat novum aërem [624]; spiritus vegetabilis et animalis, qui super tenuiores partes tam aquei quam oleosi in alimentis suis multiplicat se, et generat novum spiritum [625]; partes solidae plantarum et animalium, veluti folium, flos, caro, os, et sic de caeteris, quae singulae ex succis alimentorum assimilant et generant substantiam successivam et epiusiam [626]. Neque enim quenquam cum Paracelso delirare juvet, qui (distillationibus suis scilicet occaecatus) nutritionem per separationem tantum fieri voluit; quodque in pane vel cibo lateat oculus, nasus cerebrum, jecur [627]; in succo terrae radix, folium, flos. Etenim sicut faber ex rudi massa lapidis vel ligni, per separationem et rejectionem superflui, educit folium, florem, oculum, nasum, manum, pedem, et similia; ita *Archaeum* illum Fabrum [628] internum ex alimento per separationem et rejectionem educere singula membra et partes asserit ille. Verum missis nugis, certissimum est partes singulas, tam similares quam organicas, in vegetabilibus et animalibus, succos alimentorum suorum fere communes, aut non multum diversos, primo attrahere cum nonnullo delectu, deinde assimilare, et vertere in naturam suam. Neque *assimilatio* ista, aut *generatio simplex*, fit solum in corporibus animatis, verum et inanimata ex hac re participant; veluti de flamma et aëre dictum est. Quinetiam spiritus emortuus [629], qui in omni tangibili animato continetur, id perpetuo agit, ut partes crassiores digerat et vertat in spiritum, qui deinde exeat; unde fit diminutio ponderis et exsiccatio, ut alibi diximus [630]. Neque etiam respuenda est in *assimilatione* accretio illa, quam vulgo ab alimentatione distinguunt; veluti cum lutum [631] inter lapillos concrescit, et vertitur in materiam lapideam; squammae circa dentes vertuntur in substantiam non minus duram quam sunt dentes ipsi, etc. Sumus enim in ea opinione, inesse corporibus omnibus desiderium assimilandi, non minus quam coeundi ad homogenea; verum ligatur ista virtus, sicut et illa, licet non iisdem modis. Sed modos illos, necnon solutionem ab iisdem, omni diligentia inquirere oportet, quia pertinent ad senectutis refocillationem [632]. Postremo videtur notatu dignum, quod in novem [633] illis motibus, de quibus diximus, corpora tantum naturae suae conservationem appetere videntur; in hoc decimo autem propagationem.

[622] This is a curious limitation. The subject proposed for enquiry is not the process by which the life of the whole animal or plant is sustained, but the process by which and the materials out of which the separate parts (as the bone, muscles, flesh, etc.) are repaired or augmented. Bacon's ignorance of organic chemistry renders the discussion almost worthless. [TF]

[623] On the physical constitution of flame, and the means by which it is sustained or augmented (on which points Bacon was, of course, ignorant), see Tyndall's Heat a Mode of Motion, 3rd Ed., § 49, etc., or Watts' Dictionary of Chemistry, article 'Combustion,' already referred to in one of the notes on II. 36 (8). CP. also the whole of the passage on Flame in II. 36 (8), with the notes upon it. [TF]

[624] The transmutability of the Elements was one of the leading doctrines of the Peripatetic school. The student will find a clear and succinct statement of the theory in Aristotle, De Gen. et Corr. II. 4 (p. 331). The conversion of water into air requires only the change of one quality, namely of 'cold' into 'warm,' the 'moist' being already common to the two. The intimate relation between air and water is spoken of in a variety of ways. Thus in Phys. IV. 5 (p. 213 a. 1-4), Aristotle says (in a passage already quoted): οὕτω δὲ καὶ ἀὴρ ἔχει πρὸς ὕδωρ᾽ οἷον ὕλη γάρ, τὸ δὲ εἶδος, τὸ μὲν ὕδωρ ὕλη ἀέρος, ὁ δὲ ἀὴρ οἷον ἐνέργειά τις ἐκείνου: τὸ γὰρ ὕδωρ δυνάμει ἀήρ ἐστιν, ὁ δ᾽ ἀὴρ δυνάμει ὕδωρ ἄλλον τρόπον. See also a curious discussion in Meteorologica, I. 3 (339 a-341 a). Seneca (Nat. Quaest. III. 10) has a striking passage on the constant interchange of the elements.

Patricius, who attacks the doctrine of the transmutability of the elements (Discuss. Peripatet. Tome IV. Libro 3. pp. 395-6), asks very pertinently, who ever saw air converted into water, or water into air. 'Dicat mihi de numero istorum philosophorum aliquis, an unquam viderint, observarint, aerem in aquam converti? Scio ego, vidi, concedam, ex aqua et terra in aërem vapores ascendere, aerem eos fieri nemo unquam vidit ****** At dixit [Aristoteles] aërem in aquam transmutari. Scio eum dixisse, sed experimentum cur non attulit? Adferant sui pro eo.'

Bacon's idea seems to have been that air renews itself, and feeds, as it were, on water, as flame renews itself and feeds on 'vapours and oily matter.'

Air itself, on the other hand, while in the lower regions, he appears to have regarded as a fixed body, which does not admit of resolution. 'Aer autem corpus fixum est, nec solvitur: licet enim aer ex humido aqueo novum aerem gignat, tamen vetus aer nihilominus manet; unde fit superoneratio ilia aeris, de quo dixiinus in titulo de Vends.' Plist. Vitae et Mortis, as quoted in the next note. CP. Historia Ventorum, Ellis and Spedding, Vol. II. pp. 42-3; 75. But, in the upper regions, it is resolved again into water, this 'reciprocation' being a necessary conclusion 'ex conservatione rerum.' See Historia Densi et Rari, Ellis and Spedding, Vol. II. P- 293. [TF]

[625] On this absurd notion, CP. Historia Vitae et Mortis, Canon 32, Ellis and Spedding, Vol. II, pp. 225-6. [TF]

[626] ἐπιούσιον, sufficient for the day, or proper for their sustenance. The word is, of course, adopted from the Lord's Prayer (Matt. vi. n; Luke xi. 3). On the various opinions as to the meaning and derivation of this word, the two translations in the Vulgate (supersubstantialem - quotidianum), and the celebrated dispute thence arising between St, Bernard and Abelard (see Morison's St. Bernard, 1st Ed., p. 313, etc.), it would be travelling beyond my present province to speak. [TF]

[627] I borrow, with slight additions, the following note from Mr. Ellis: 'I have not been able to find any passage in Paracelsus which altogether corresponds to this remark; and in his Modus Pharmacandi the process of digestion is described without reference to the Archeus; nor is it said that each member "latet in pane vel cibo." "Hoc scimus, quod

cujusque membri nutrimentum latitet in pane, carne, et in aliis similiter.' Quot vero modis et quibus, necnon qua ratione membris corporis nutrimentum dividatur, nos ignoramus; hoc tantum scimus, rem ita se habere ut diximus." — De Mod. Pharm. [Operum medico-chimicorum sive paradoxorum tomi undecim genuini, tom.] V. p. 233. (I use the edition of 1603.) [TF]

'Bacon has, however, correctly stated the general doctrine that alimentation is by separation; and again Paracelsus affirms that officium vero Archei est in microcosmo purum ab impure separare" [rather sequesirare]. — De Morbis Tartareis, [tom.] III. 195. The truth is that Paracelsus's views are so often repeated and varied in the course of his writings, that it is difficult to know how far his opinions are represented by any particular passage.

'It is well to remark that, to a certain extent, the theory here so decidedly condemned has, by the recent progress of organic chemistry, been shown to be true. Nothing seems better established than that the nitrogenised components of animal bodies are derived from the corresponding elements of their food. With respect to fat, it is, I believe, a prevailing opinion at present, that animals have the power of converting into it the starch or sugar of their food [see Miller's Organic Chemistry, Elements of Chemistry, 4th Ed., Vol. III. § 1718]; and the production of butyric acid by fermentation has been regarded as at least an illustration of the transformation. One of the highest authorities on such a subject, however, I mean M. Boussingault, was, at least a few years ago, of a different opinion. He regarded animal fat as the representative of the fatty matters contained in the food.' [TF]

[628] Paracelsus is very fond of this analogy. Thus, in the De Morbis Tartareis, Cap. 3, he says: 'Ac insuper Archaeum loco et vice fabri praesto esse debeat.' Hallam (History of Literature, part, I. Chapter 7. §§ 17-20) gives a short account of the whimsical theories of Paracelsus. For a longer account, see Sprengei, Geschichte der Arzneykunde, Th. III. Kap. 10. [TF]

[629] On the distinction between the 'spiritus mortualis' and the 'spiritus vitalis,' see Historia Vitae et Mortis., Ellis and Spedding, Vol. II, pp. 214-7. In Canons vii, viii, he makes the same remarks as in the present passage. [TF]

[630] See II. 40. [TF]

[631] He means clay mixed up with pebbles or gravel, as in conglomerate strata. The induration would take place just as readily, if it were detached, provided it were subjected to the same influences in other respects. [TF]

[632] To attain this end is the practical object of the 'Historia Vitae et Mortis.' See also De Augmentis Scientiarum, Libro IV. Cap. 2.

The word ‘refocillatio,’ which is not to be found in classical Latin, though the verb refocillo is occasionally found in post-Augustan writers, occurs in some of the old College graces, as, for instance, in that of Lincoln College, Oxford: ‘Agimus Tibi gratias pro *** praesentique refocillatione.’ [TF]

[633] Nine, that is to say, excluding the first so-called ‘motus,’ which is common to all matter, and of which no examples are proposed; ‘inest enim omni corpori.' [TF]

(12) Sit Motus Duodecimus, *Motus Excitationis* [634]; qui motus videtur esse ex genere assimilationis, atque eo nomine quandoque a nobis promiscue vocatur. Est enim motus diffusivus, et communicativus, et transitivus, et multiplicativus, sicut et ille; atque effectu (ut plurimum) consentiunt, licet efficiendi modo et subjecto differant. Motus enim assimilationis procedit tanquam cum imperio et potestate; jubet enim et cogit assimilatum in assimilantem verti et mutari. At motus *excitationis* procedit tanquam arte et insinuatione et furtim; et invitat tantum, et disponit excitatum ad naturam excitantis. Etiam motus *assimilationis* multiplicat et transformat corpora et substantias; veluti, plus fit flammae, plus aëris, plus spiritus, plus carnis. At in motu *excitationis*, multiplicantur et transeunt virtutes tantum; et plus fit calidi, plus magnetici, plus putridi [635]. Eminet autem iste motus praecipue in calido et frigido. Neque enim calor diffundit se in calefaciendo per communicationem primi caloris; sed tantum per *excitationem* partium corporis [636] ad motum illum qui est Forma Calidi; de quo in *vindemiatione prima de natura calidi* diximus. Itaque longe tardius et difficilius excitatur calor in lapide aut metallo quam in aëre [637], ob inhabilitatem et impromptitudinem corporum illorum ad motum illum; ita ut verisimile sit posse esse interius versus viscera terrae materias quae calefieri prorsus respuant; quia ob condensationem majorem spiritu illo destituuntur a quo motus iste *excitationis* plerunque incipit [638]. Similiter magnes induit ferrum nova partium dispositione et motu conformi; ipse autem nihil ex virtute perdit. Similiter fermentum panis, et flos cervisiae [639], et coagulum lactis, et nonnulla ex venenis, excitant et invitant motum in massa farinaria, aut cervisia, aut caseo, aut corpore humano, successivum et continuatum; non tam ex vi excitantis quam ex praedispositione et facili cessione excitati.

[634] The last ‘motus’ is conceived of as multiplying substances by assimilation, this as exciting or communicating qualities by means of diffusion. The growth of the body and its various parts would be the typical instance of the one, heat of the other. [TF]

[635] On the doubtful character of this last example, see note 39 below. [TF]

[636] This view is, of course, the true one. [TF]

[637] This mistake, as already pointed out, arises from confusing the radiation with the conduction of heat. [TF]

[638] This curious passage seems to imply the notions that heat is communicated by means of a 'spiritus' and that, in very dense bodies, this 'spiritus' vanishes or is crushed out.

It is worth noting that Bacon regards the interior of the earth as much denser than the surface. CP. Historia Densi et Rari, E, and S., Vol. II. pp. 248-9. 'De interioribus autem terrae nihil decernimus; cum nec sensui nec experimento subjidantur. Ilia, cum a calore coelestium primo longius, deinde penitus, semota sint, possint esse corporibus nobis notis densiom.' 'Cum fons densitatis videatur esse in profundo terrae, adeout versus superficiem ejus corpora eximie extenuentur; illud notatu dignuin est, quod aurum,' etc. He then proceeds to ask why gold, which is so heavy, should be found on the surface of the earth. [TF]

[639] Yeast 'The flower of beer.' For cervisia, see Pliny, Libro xxii. ad fin. In consequence of the researches of Pasteur and others, the generally received opinion as to the working of yeast and leaven is that it is due to a chemical action set up by the life processes of minute organisms which have an indefinite power of self-multiplication. (See Watts' Dictionary of Chemistry, art. ^Fermentation,' both in Vol. II. and in the Supplement.) The opposed view, held by Liebig and others, attributing these changes entirely to chemical and physical forces, seems to have been set aside by recent experiments. Hence, these phenomena must be regarded as illustrating the last section rather than the present one. Putrefaction (see note 98 above) is a particular case of fermentation.

The coagulation of milk, when spontaneous, is also probably due to chemical action set up by minute living organisms. But, when produced by artificial means, as by an acid, the phenomenon is purely chemical, and may, therefore, be regarded as an example of the 'motus excitationis.'

As to poisons, we must distinguish three cases. Some poisons, like vaccine virus, are due to the indefinite self-multiplication of low organisms within the body. Others, like arsenic, act purely chemically. Lastly, a third class, like chloroform or prussic acid, act, as it were, physiologically, by destroying the dynamical activity of some tissue or organ. I am indebted for this division to the late Dr. Rolleston. The student will find some interesting remarks on the action of poisons in Dr. Carpenters Human Physiology, 8th Ed., §§ 220-9 (Chapter 7). [Omitted in the 9th Edition.] [TF]

(13) Sit Motus Decimus Tertius, *Motus Impressionis* [640]; qui motus est etiam ex genere motus *assimilationis*, estque ex diffusivis motibus subtilissimus. Nobis autem visum est eum in speciem propriam constituere, propter differentiam insignem quam habet erga priores duos. Motus enim *assimilationis* simplex corpora ipsa transformat; ita ut si tollas primum movens nihil intersit ad ea quae sequuntur. Neque enim prima accensio in flammam, aut prima versio in aërem, aliquid facit ad flammam aut aërem in generatione succedentem. Similiter, motus *excitationis* omnino manet, remoto primo movente, ad tempora bene diuturna; ut in corpore calefacto, remoto primo calore; in ferro excito, remoto magnete; in massa farinaria, remoto fermento. At Motus Impressionis, licet sit

diffusivus, et transitivus, tamen perpetuo pendere videtur ex primo movente; adeo ut, sublato aut cessante illo, statim deficiat et pereat; itaque etiam momento, aut saltem exiguo tempore [641], transigitur. Quare motus illos *assimilationis* et *excitationis*, motus *generationis Jovis*, quia generatio manet; hunc autem motum *Motum Generationis Saturni* [642], quia natus statim devoratur et absorbetur, appellare consuevimus. Manifestat se vero hic motus in tribus; in lucis radiis; sonorum percussionibus; et magneticis, quatenus ad communicationem [643]. Etenim amota luce, statim pereunt colores et reliquae imagines ejus; amota percussione prima et quassatione corporis inde facta, paulo post perit sonus. Licet enim soni etiam in medio per ventos tanquam per undas [644] agitentur; tamen diligentius notandum est, quod sonus non tam diu durat quam fit resonatio [645]. Etenim impulsa campana, sonus ad bene magnum tempus continuari videtur; unde quis facile in errorem labatur, si existimet toto illo tempore sonum tanquam natare et haerere in aëre; quod falsissimum est. Etenim illa resonatio non est idem sonus numero, sed renovatur. Hoc autem manifestatur ex sedatione sive cohibitione corporis percussi. Si enim sistatur et detineatur campana fortiter et fiat immobilis, statim perit sonus nec resonat amplius; ut in chordis, si post primam percussionem tangatur chorda, vel digito ut in lyra, vel calamo ut in espinetis, statim desinit resonatio. Magnete autem remoto, statim ferrum decidit. Luna autem a mari non potest removeri; nec terra a ponderoso dum cadit [646]. Itaque de illis nullum fieri potest experimentum; sed ratio eadem est.

[640] This 'motus' is distinguished from the two last by the continuance of the original impressions being necessary to the continuance of the effects. Thus light or sound ceases, when the source of the impression is withdrawn. [TF]

[641] This qualification allows for the time required for the propagation of light or sound, CP. Aphorism 46, with notes upon it. [TF]

[642] The Latin Satunius was confounded with the Greek god Κρόνος. For the story, see Hesiod, Theogonia, 1. 453, etc. [TF]

[643] That is, mere communication of motion, as distinguished from the magnetic induction spoken of above and in the last section. The latter is permanent; the former disappears with the attracting body. [TF]

[644] It would seem from this passage as if Bacon had a vague notion of the undulatory motion of sound. [TF]

[645] He is speaking of the reinforcement of sound caused by the continued vibration of the object struck, even after the first effect of the percussion has ceased. The case of stringed instruments, which have sounding boards, is different from that of a bell. On the phenomena of Overtones and Resonance, see Tyndall on Sound or Helmholtz on Sensations of Tone. [TF]

[646] Note that here, as in II. 45 and elsewhere, Bacon connects the fall of heavy bodies to the earth and the phenomena of the spring and neap tides with magnetic attraction. [TF]

(14) Sit Motus Decimus Quartus, *Motus Configurationis*, aut Situs [647]; per quem corpora appetere videntur, non coitionem aut separationem aliquam, sed situm, et collocationem, et *configurationem* cum aliis. Est autem iste motus valde abstrusus, nec bene inquisitus. Atque in quibusdam videtur quasi incausabilis; licet revera (ut existimamus) non ita sit. Etenim si quaeratur cur potius coelum volvatur ab oriente in occidentem quam ab occidente in orientem [648]; aut cur vertatur circa polos positos juxta Ursas potius quam circa Orionem, aut ex alia aliqua parte coeli [649]: videtur ista quaestio tanquam quaedam extasis [650], cum ista potius ab experientia, et ut positiva [651] recipi debeant. At in natura profecto sunt quaedam ultima et incausabilia; verum hoc [652] ex illis non esse videtur. Etenim hoc fieri existimamus ex quadam harmonia et consensu mundi, qui adhuc non venit in observationem. Quod si recipiatur motus terrae ab occidente in orientem, eaedem manent quaestiones. Nam et ipsa super aliquos polos movetur. Atque cur tandem debeant isti poli collocari magis ubi sunt quam alibi? Item verticitas, et directio, et declinatio magnetis ad hunc motum referuntur. Etiam inveniuntur in corporibus tam naturalibus quam artificialibus, praesertim consistentibus et non fluidis, collatio quaedam et positura partium, et tanquam villi et fibrae, quae diligenter investigandae sunt; utpote sine quarum inventione corpora illa commode tractari aut regi non possunt. At circulationes illas in liquidis, per quas illa dum pressa sint, antequam se liberare possunt, se invicem relevant, ut compressionem illam ex aequo tolerent, motui libertatis verius assignamus.

[647] This ‘motus’ may be illustrated by the form of crystals, or the cellular structure of animals and plants, or the tendency of each particular species to assume a definite shape. I cannot agree with Dr. Hippus that there is anything strange in referring to this head the directions of the celestial motions or the polarity of the magnetic needle. [TF]

[648] Or, as we should put it, why the earth rotates from west to east. This direction of motion, whether orbital or axial, as we have already seen (see II. 36 (2) with note 98), is common to all the planets and their satellites, with the sole known exception of the satellites of Uranus. Moreover, the sun itself rotates on its axis in the same direction. For Laplace’s calculations, by which he showed the enormously preponderating probability of some common cause for this uniformity of direction, see Jevons’ Principles of Science, Vol. I. pp. 287-9, and the works, on both sides of the question, there referred to. This cause is, in all probability, connected with the circumstances of the detachment of the planets or satellites from the central mass of which they are supposed, according to the nebular hypothesis, to have originally formed a part. F or this ingenious theory and for the earlier one of Buffon, which had for its object the explanation of the same phenomena, see Laplace, Exposition du Système du Monde, note VII. (Œuvres, Vol. vi. p. 470, etc.). [TF]

[649] Mr. Ellis, commenting on the corresponding passage below, says: 'This passage shows that Bacon was not aware that the poles are not fixed (collocati) anywhere; in other words, that he was not acquainted with the precession of the equinoxes — an additional proof how little of his attention had been given to mathematical physics.' In the Historia Ventorum (Ellis and Spedding, Vol. II. p. 28), as Mr. Spedding (employing Mr. Ellis's notes) has pointed out, he speaks of the north pole as being above, and the south pole below us. See Mr. Spedding's Preface to the De Interpretatione Naturae Prooemium, Vol. III. p. 512. [TF]

[650] ἔκστασις, a displacement, or a standing aside. We may construe 'out of place.' The word is common in Aristotle. [TF]

[651] 'As ultimate facts.' CP. I. 48, with note 73. However far we may carry our speculations, there is always something beyond which is left unexplained. And this difficulty the human mind, with its restless activity, attempts, and cannot but attempt, to resolve. There must always, it is true, be some barrier to these efforts, but, unless they were constantly being made, the mind would become atrophied, and human knowledge would soon be at a standstill. [TF]

[652] This remark does credit to Bacon's sagacity. See note 48 above, on Laplace's nebular hypothesis. Though, of course, Bacon had not the slightest suspicion of such explanations as. would now be given, still he had the penetration to suspect that there must be some explanation forthcoming. [TF]

(15) Sit Motus Decimus Quintus, *Motus Pertransitionis*, sive *Motus secundum Meatus*; per quem virtutes corporum magis aut minus impediuntur aut provehuntur a mediis ipsorum, pro natura corporum et virtutum operantium, atque etiam medii. Aliud enim medium [653] luci convenit, aliud sono, aliud calori et frigori, aliud virtutibus magneticis, necnon aliis nonnullis respective.

[653] On the medium of Light, CP. Topica Inquisitionis De Luce et Lumine, x, xi (Ellis and Spedding, Vol. II, p. 320), and Sylva Sylvarum, Exps. 761-2, where he notices the phenomenon of Refraction; on the medium of Sound, the numerous 'Experiments' on Sound in Sylva Sylvarum, Centuries II, iii; on the medium of Heat, the numerous remarks scattered throughout this Book of the Novum Organum; and on the medium through which the Magnet acts, the Inquisitio De Magnete (Ellis and Spedding, Vol. II. pp. 311-2), and Novum Organum II. 42. His remarks on the transmission of Heat are vitiated throughout by his not distinguishing between radiation and conduction.

One of the most important differences with respect to transmission through media is that, while heat and light can be transmitted in vacuo, sound cannot. Moreover, the denser the air in which a sound is generated, the more intense is it. A magnet will act in vacuo, but Faraday has shown that a substance, which is paramagnetic in vacuo, may become diamagnetic in air. As respects electricity, I may quote the following passage from Ganot's Physics (12th Ed. of Translation, § 927): 'The electrical discharge does not

pass through a vacuum, as is shown by the following experiment. A small tube containing caustic potash is fused to a Geissler's tube connected with a Sprengel pump. By continual exhaustion while the caustic potash is being heated, as complete a vacuum as possible is made of the tube sealed. The last minute trace of aqueous vapour is absorbed by the caustic potash as it cools. In this complete vacuum the discharge, however strong, no longer passes; the vacuum acts as a complete non-conductor.' [TF]

(16) Sit Motus Decimus Sextus, *Motus Regius* (ita enim eum appellamus) sive *Politicus* [654]; per quem partes in corpore aliquo praedominantes et imperantes reliquas partes fraenant, domant, subigunt, ordinant, et cogunt eas adunari, separari, consistere, moveri, collocari, non ex desideriis suis, sed prout in ordine sit et conducat ad bene esse partis illius imperantis; adeo ut sit quasi *Regimen* et *Politia* quaedam, quam exercet pars regens in partes subditas. Eminet autem hic motus praecipue in spiritibus animalium, qui motus omnes partium reliquarum, quamdiu ipse in vigore est, contemperat. Invenitur autem in aliis corporibus in gradu quodam inferiore; quemadmodum dictum est de sanguine et urinis, quae non solvuntur donec spiritus, qui partes earum commiscebat et cohibebat, emissus fuerit aut suffocatus. Neque iste motus omnino spiritibus proprius est, licet in plerisque corporibus spiritus dominentur ob motum celerem et penetrationem. Veruntamen in corporibus magis condensatis, nec spiritu vivido et vigente (qualis inest argento vivo et vitriolo) repletis, dominantur potius partes crassiores; adeo ut nisi fraenum et jugum hoc arte aliqua excutiatur, de nova aliqua hujusmodi corporum transformatione minime sperandum sit. Neque vero quispiam nos oblitos esse existimet ejus quod nunc agitur; quia cum ista series et distributio motuum ad nil aliud spectet, quam ut illorum *praedominantia* per *instantias luctae* melius inquiratur, jam inter motus ipsos praedominantiae mentionem faciamus. Non enim in descriptione *motus* istius *regii*, de *praedominantia* motuum aut virtutum tractamus, sed *praedominantia* partium in corporibus. Haec enim ea est *praedominantia*, quae speciem istam motus peculiarem constituit.

[654] This somewhat fanciful notion, still more fancifully illustrated, requires no comment. Better illustrations would have been, in respect of determining functions, the place of the heart and brain in the animal economy, or, in respect of relative importance, that of the seed-vessels in plants. For the metaphor, CP. Aristotle, Pol. I. 5 (6): ἡ μὲν yap ψυχὴ τοῦ σώματος ἄρχει δεσποτικὴν ἀρχήν, ὁ δὲ νοῦς τῆς ὀρέξεως πολιτικὴν καὶ βασιλικήν, κ.τ.λ. [TF]

(17) Sit Motus Decimus Septimus, *Motus Rotationis Spontaneus* [655]; per quem corpora motu gaudentia, et bene collocata, natura sua fruuntur, atque seipsa sequuntur, non aliud, et tanquam proprios petunt amplexus. Etenim videntur corpora aut movere sine termino; aut plane quiescere; aut ferri ad terminum, ubi pro natura sua aut rotent aut quiescant. Atque quae bene collocata sunt, si motu gaudeant, movent per circulum: motu scilicet aeterno et infinito. Quae bene collocata sunt, et motum exhorrent, prorsus quiescunt. Quae non bene collocata sunt, movent in linea recta (tanquam tramite brevissimo) ad consortia suorum connaturalium [656]. Recipit autem motus iste *rotationis* differentias novem [657]. Primam, centri sui, circa quod corpora movent:

secundam, polorum suorum, supra quos movent: tertiam, circumferentiae sive ambitus sui, prout distant a centro: quartam, incitationis suae, prout celerius aut tardius rotant: quintam, consequutionis motus sui, veluti ab oriente in occidentem, aut ab occidente in orientem: sextam, declinationis a circulo perfecto per spiras longius aut propius distantes a centro suo: septimam, declinationis a circulo perfecto per spiras longius aut propius distantes a polis suis: octavam, distantiae proprioris aut longioris spirarum suarum ad invicem: nonam et ultimam, variationis ipsorum polorum [658], si sint mobiles: quae ipsa ad rotationem non pertinet, nisi fiat circulariter [659]. Atque iste motus communi et inveterata opinione habetur pro proprio coelestium. Attamen gravis de illo motu lis est inter nonnullos tam ex antiquis quam modernis, qui *rotationem* terrae attribuerunt. At multo fortasse justior [660] movetur controversia (si modo res non sit omnino extra controversiam), an motus videlicet iste (concesso quod terra stet) coeli finibus contineatur, an potius descendat, et communicetur aëri et aquis [661]. Motum autem rotationis in missilibus, ut in spiculis, sagittis, pilis sclopetorum, et similibus, omnino ad motum libertatis rejicimus [662].

[655] CP. II. 5 ad fin., II. 35, II, 36 (2), and notes. There is little on this subject to add to what has already been said on the above passages. The reader will not fail to contrast Bacon's curious conceptions about motion (derived from the Peripatetics) with the Laws of Motion, as known to us. [TF]

[656] This passage is wholly in accordance with the Peripatetic system of physics. But the modifications which Bacon goes on to enumerate, to which, as he conceives, the eternal circular motions of the heavenly bodies may be subject, are sufficient to destroy the whole 'priori argument in favour of such a system of astronomy as that which we find in the twelfth book of the Metaphysics. It has not been sufficiently observed that the Ptolemaic system is no less at variance with the Peripatetic philosophy than the heliocentrical. The attempts of Turrianus and Fracastorius to construct what may be called an orthodox system of astronomy — that is one in which all the motions should take place in circles of which the earth is the centre — was suggested chiefly, as we learn from the Plomocentrica of the latter, by the wish to reconcile astronomy and philosophy. It had no scientific value, since it left all the phenomena of variations of parallax and apparent diameter unexplained, or, at any rate, gave an explanation of them which no astronomer would accept. It was nevertheless favourably received by the systematic Peripaticians. See, for instance, Flaminius, De prima Philosoph. Paraph, p. 119. (I quote the Basle edition of 1557.) Mr. Ellis' note. [TF]

[657] That is, nine respects in which the motions may differ. [TF]

[658] That is, libration.

The reader need hardly be again reminded that he will find a detailed account of Bacon's astronomical views (written, however, about eight years before the publication of the Novum Organum), in the Descriptio Globi Intellectualis and the appended tract Thema Coeli (Ellis and Spedding, Vol. III. pp. 713-80). [TF]

[659] Mr. Ellis says: 'I believe the sense is that unless we restrict ourselves to circular motion, that is, unless we reject the sixth and seventh species of variation, it will not be necessary for us to suppose the poles themselves to be movable: in other words, that the phenomena of which we could by this hypothesis give an account may be adequately represented without it by means of spirals.' [TF]

[660] This language, the reader will perceive, exactly accords with what we have so often elsewhere found to be Bacon's opinion not only as to the annual, but also as to the diurnal motion of the earth. [TF]

[661] CP. Aphorism 36 (2), and notes. [TF]

[662] See 'Motus tertius' above, and Aphorism 36 (6). [TF]

(18) Sit Motus Decimus Octavus, *Motus Trepidationis*, cui (ut ab astronomis intelligitur) non multum fidei adhibemus [663]. Nobis autem corporum naturalium appetitus ubique serio perscrutantibus occurrit iste motus; et constitui debere videtur in speciem. Est autem hic motus veluti aeternae cujusdam captivitatis. Videlicet ubi corpora non omnino pro natura sua bene locata, et tamen non prorsus male se habentia, perpetuo trepidant, et irrequiete se agant [664], nec statu suo contenta, nec ulterius ausa progredi. Talis invenitur motus in corde et pulsibus animalium; et necesse est ut sit in omnibus corporibus, quae statu ancipiti ita degunt inter commoda et incommoda, ut distracta liberare se tentent, et denuo repulsam patiantur, et tamen perpetuo experiantur [665].

[663] 'The name of trepidation was given by the Alphonsine astronomers to a motion by which they imagined the starry heaven to be affected, and in virtue of which its equinoxes described small circles of nine degrees radius about those of the ninth or next superior orb. To account for this motion they introduced a tenth orb. The phenomenon, however, thus accounted for was altogether imaginary, although it is true that the length of the tropical year, by supposed variations of which the idea of trepition was suggested, is not rigorously constant. It may be questioned whether Bacon's hesitation to accept the astronomical motion of trepidation had any better foundation than his doubts whether the proper motions of, the planetary orbs were anything more than "res confictae et supposititae." [See Aphorism 36 (2).] The question of the existence or non-existence of trepidation could only be decided by a person conversant with the details of the received system of astronomy.' Mr. Ellis' note. [TF]

[664] The word 'agant,' which occurs in the First Edition, should be replaced by 'agunt,' as is done in the Second and Third Editions. [TF]

[665] CP. Historia Densi et Rari, Ellis and Spedding, Vol. II. p. 263: 'Pulsus cordis et arteriarum in animalibus fit per irrequietam dilatationem spirituum, et receptum ipsorum, per vices.' In reading vague and fanciful passages like these, we must recollect that Harvey did not begin to teach his theory of the circulation of the blood till 1619, and

that it was not till 1628 that his great treatise, the 'Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus,' was published. Bacon might, it is true, have derived more precise views than those which he expresses from earlier writers, but there was nothing specially to direct bis attention to this subject.

The Tides and the astronomical phenomena of Nutation and Libration might furnish appropriate instances of the 'Motus Trepidationis.' [TF]

(19) Sit Motus Decimus Nonus et postremus, motus ille cui vix nomen motus competit, et tamen est plane motus. Quem motum, *Motum Decubitus* [666], sive *Motum Exhorrentiae Motus*, vocare licet. Per hunc motum terra stat mole sua [667], moventibus se extremis suis in medium; non ad centrum imaginativum, sed ad unionem. Per hunc etiam appetitum omnia majorem in modum condensata motum exhorrent, atque illis pro omni appetitu est non moveri; et licet infinitis modis vellicentur et provocentur ad motum, tamen naturam suam (quoad possunt) tuentur. Quod si ad motum compellantur, tamen hoc agere semper videntur ut quietem et statum suum recuperent, neque amplius moveant. Atque circa hoc certe se agilia praebent, et satis perniciter et rapide (ut pertaesa et impatientia omnis morae) contendunt. Hujus autem appetitus imago ex parte tantum cerni potest; quia hic apud nos, ex subactione et concoctione coelestium [668], omne tangibile non tantum non condensatum est ad ultimitatem, sed etiam cum spiritu nonnullo miscetur.

[666] Decubitus = lying away from, sc. motion. See Facciolati on decubo. He quotes Fabius Pictor apud Aul. Cell. Libro x. Cap. 15: 'Pedes lecti, in quo cubat [sc. Flamen Dialis], luto tenui circumlitos esse oportet: et de .eo lecto trinoctium continuum non decubat: neque in eo lecto cubare alium fas est.' Decubitus might, however, simply mean 'lying down,' 'reclining,' 'repose.' (Cp. decumbo.)

On Bacon's vague and improper use of the word 'motion,' see the first note on this Aphorism. Here it cannot be rendered even by 'process' or 'operation,' but we must resort to some word of very wide meaning, such as 'tendency ' or 'affection ' of matter.

'Inertia,' the property of which Bacon here speaks, is simply the incapacity of matter to change its own state of rest or motion. The obscure notions of Bacon and his contemporaries about motion prevented them from seeing that this property applies as much to the tendency of a body in motion to go on moving as to that of a body at rest to remain at rest. For a brief account of the establishment of the First Law of Motion (which seems to have been first enunciated by Galileo in 1638), see Whewell's History of the Inductive Sciences, Vol. II. Book vi. Chapter 2. [TF]

[667] Bacon seems never weary of parading his belief in the immobility of the earth. [TF]

[668] CP. what he says above under 'Motus Duodecimus: 'ita ut verisimile sit posse esse,' etc. It was one of the leading doctrines of Telesius that the sun, and the heavenly bodies generally, modify the surface of the earth and the parts adjacent to the surface,

rendering them rarer and warmer than they are by their own nature; while the interior parts of the earth exhibit its peculiar characteristics of coldness, crassness, darkness, and immobility. See Telesius, De Rerum Natura, Libro I. (especially Chapters 5, 10-14); Bacon, De Principiis atque Originibus, Ellis and Spedding, Vol. III. PP. 98-9.

Towards the end of Aphorism 20, Bacon uses the expression 'imbutum a coelestibus,' on which see note. [TF]

Proposuimus itaque jam species sive elementa simplicia motuum, appetituum, et virtutum activarum, quae sunt in natura maxime catholica. Neque parum scientiae naturalis sub illis adumbratum est. Non negamus tamen et alias species fortasse addi posse [669], atque istas ipsas divisiones secundum veriores rerum venas transferri, denique in minorem numerum posse redigi. Neque tamen hoc de divisionibus aliquibus abstractis intelligimus: veluti si quis dicat corpora appetere vel conservationem, vel exaltationem, vel propagationem, vel fruitionem naturae suae; aut si quis dicat motus rerum tendere ad conservationem et bonum, vel universi, ut *antitypiam* et *nexum*; vel universitatum magnarum, ut motus *congregationis majoris*, *rotationis*, et *exhorrentiae* motus; vel formarum specialium, ut reliquos. Licet enim haec vera sint, tamen nisi terminentur [670] in materia et fabrica secundum veras lineas, speculativa sunt, et minus utilia. Interim sufficient et boni erunt usus ad pensitandas *praedominantias* virtutum et exquirendas *instantias luctae*; id quod nunc agitur.

[669] Dr. Hippus remarks very well that this class of facts or rather tendencies might have been further illustrated by *torsion* or the effort made by a thread, wire, or the like, when twisted, to untwist itself.

To attempt to classify, reduce, or complete this list of so-called 'motions,' would be of no service to the student. I have already said enough to enable him to estimate the value of Bacon's enumeration, as well as its various errors and defects. [TF]

[670] Be 'defined,' or 'limited.' [TF]

Etenim ex his quos proposuimus motibus alii prorsus sunt invincibiles; alii aliis sunt fortiores, et illos ligant, fraenant, disponunt; alii aliis longius jaculantur; alii alios tempore et celeritate praevertunt; alii alios fovent, roborant, ampliant, accelerant.

Motus *antitypiae* omnino est adamantinus et invincibilis. Utrum vero Motus nexus sit invincibilis adhuc haeremus. Neque enim pro certo affirmaverimus [671] utrum detur Vacuum, sive coacervatum sive permistum [672]. At de illo nobis constat, rationem illam [673], propter quam introductum est Vacuum a *Leucippo et Democrito* (videlicet quod absque eo non possent eadem corpora complecti et implere majora et minora spatia), falsam esse. Est enim plane *plica materiae* [674] complicantis et replicantis se per spatia, inter certos fines, absque interpositione vacui; neque est in aëre ex vacuo bis millies (tantum enim esse oportet) plus quam in auro [675]. Id quod ex potentissimis corporum pneumaticorum virtutibus (quae aliter tanquam pulveris minuti natarent in vacuo), et

multis aliis demonstrationibus, nobis satis liquet. Reliqui vero Motus regunt et reguntur invicem, pro rationibus vigoris, quanti, incitationis, ejaculationis, necnon tum auxiliorum tum impedimentorum quae occurrunt.

[671] In II, 8, Bacon absolutely denies the existence of a vacuum. See note on that passage and also note 59 on the 'Motus Secundus.' In the latter note, I have referred to Bacon's change of opinion on the subject of a vacuum, and have quoted a 'Canon' from the Historia Densi et Rari (which work, or, at least, the latter part of it, was written during his last 'quinquennium where he says: 'Non est vacuum in natura, nec congregatum nec intermistum.' See Ellis and Spedding, Vol. II. p. 303. Taking that as his last utterance on the subject, and bearing in mind the positive manner in which he speaks in II. 8, as also the apparent bias of I. 66 and II. 48 (2), we must, I think, notwithstanding the expressions of doubt in the present passage, regard him as having deliberately rejected the doctrine of a vacuum. [TF]

[672] I borrow the following note from Ellis and Spedding's Edition: '"Vacuum permistum," κενὸν ἀχώριστον, is vacuum diffused through the interstices of any portion of matter. By "vacuum coacervatum," κενὸν κεχωρισμένον, is meant clear empty space. See, for this distinction, Aristotle, Phys. IV. 7 [p. 214]. Hero of Alexandria, whom Bacon mentions more than once, approves of those who admit the former kind of vacuum and reject the latter. See the Introduction to his Spiritalia.

'[It is perhaps worth observing that in the fable entitled "Cupido sive Atomus" (De Sap. Vet. xvii), where the theory of a vacuum is mentioned, this distinction was not introduced till Bacon revised the work in his later years. The passage which stands thus in the original edition (1609) — "Quisquis autem atomum ponit et vacuum, necessario virtutem atomi ad distans introducit is altered, in the edition published by Rawley after Bacon's death, to Quisquis autem atomum asserit atque vacuum (licet istud vacuum intermistum ponat, non segregatum) necessario," etc. — J.S.]'

Cp. the similar distinction of -^aer permistus' and 'aer coacervatus' in Aphorism 50 ad init. [TF]

[673] For this and other reasons, see Arist Phys. IV. 6 (p. 213 b). [TF]

[674] CP. Historia Densi et Rari, Ellis and Spedding, Vol. II. p. 303: 'Inter terminos densi et rari est plica materiae, per quam se compiicat et replicat absque vacuo.'

Bacon's own theory, therefore, was that the atoms, instead of being separated by a vacuum, have the power of expanding and contracting themselves, so as exactly to adjust themselves, one to another, without leaving any intervening space.

Plica (from plico) is explained by Du Cange as ' plicatura vel involutio.' [TF]

[675] 'Nor is there in air two thousand times more of vacuity than in gold.' Bacon appears to regard this supposition as a *reductio ad absurdum* of the theory of a vacuum. In II. 40, he states the density of gold at 21 times that of spirits of wine, and that of spirits of wine at 100 times that of its own vapour; while, in the Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 255), he says that all fumes are denser than air. This calculation would make the density of gold more than 2100 times greater than that of air, or, speaking roughly, 2000 times greater. Bacon, who was not much of a mathematician, probably took for granted that the ratio of the amounts of vacuity, supposing a vacuum possible, contained in equal weights of the two bodies, would be inversely that of the densities. But this is plainly not the case.

Proceeding on a calculation based on passages in the Historia Densi et Rari only, Mr. Ellis makes the supposed density of gold 1900-fold that of air. Supposing that nineteen-twentieths of the gold consisted of vacuity (perhaps not an extravagant calculation, when we consider the supposed density of the bodies in the interior of the earth), the ratio of the supposed vacuity in the same weights of air and gold would = $1899 + \frac{19}{20} : \frac{19}{20}$ (approximately) = $\frac{1900 \cdot 20}{20} : \frac{19}{20} = 2000 : 1$, the ratio given in the text. [TF]

Exempli gratia: magnes armatus nonnullus detinet et suspendit ferrum, ad sexagecuplum [675.5] pondus ipsius; eo usque dominatur motus *congregationis minoris* super motum *congregationis majoris*; quod si majus fuerit pondus, succumbit. Vectis tanti roboris sublevabit tantum pondus; eo usque dominatur motus *libertatis* super motum *congregationis majoris*; sin majus fuerit pondus, succumbit. Corium tensum ad tensuram talem non rumpitur; eo usque dominatur motus continuationis super motum *tensurae*; quod si ulterior fuerit tensura, rumpitur corium, et succumbit motus *continuationis*. Aqua per rimam perforationis talis effluit; eo usque dominatur motus *congregationis majoris* super motum *continuationis*; quod si minor fuerit rima, succumbit, et vincit motus *continuationis*. In pulvere sulphuris solius immissi [676] in sclopetum cum pila, et admoto igne, non emittitur pila; in eo motus *congregationis majoris* vincit motum *hyles* [576.5]. At in pulvere pyrio immisso vincit motus *hyles* in sulphure, adjutus motibus *hyles* et *fugae* in nitro. Et sic de caeteris. Etenim instantiae luctae (quae indicant *praedominantiam* virtutum, et secundum quas rationes et calculos praedominentur et succumbant) acri et sedula diligentia undique sunt conquirendae.

[675.5] The right spelling of "sexagecuplum" probably is "sexasgecuplum". [HJ]

[676] Mr. Ellis proposes to read 'immisso.' [TF]

[676.5] I need to check this word. At two places we have "Hyles" and at three places "hyles". [HJ]

Etiam modi et rationes ipsius succumbentiae motuum diligenter sunt introspiciendae. Nempe, an omnino cessent, vel potius usque nitantur, sed ligentur. Etenim in corporibus hic apud nos, nulla vera est quies, nec in integris nec in partibus; sed tantum secundum apparentiam [677]. Quies autem ista apparens causatur aut per *aequilibrium*, aut per

absolutam *praedominantiam* motuum. Per *aequilibrium*, ut in bilancibus, quae stant si aequa sint pondera. Per *praedominantiam*, ut in hydriis perforatis, ubi quiescit aqua et detinetur a decasu [678], per *praedominantiam* motus nexus. Notandum tamen est (ut diximus) quatenus nitantur motus illi succumbentes. Etenim si quis per luctam detineatur extensus in terra, brachiis et tibiis vinctis, aut aliter detentis; atque ille tamen totis viribus resurgere nitatur; non est minor nixus, licet non proficiat [679]. Hujus autem rei conditio (scilicet utrum per *praedominantiam* motus succumbens quasi annihiletur, an potius continuetur nixus, licet non conspiciatur), quae latet in conflictibus, apparebit fortasse in concurrentiis. Exempli gratia; fiat experimentum in sclopetis, utrum sclopetus, pro tanto spatio quo emittat pilam in linea directa, sive (ut vulgo loquuntur) in puncto blanco, debiliorem edat percussionem ejaculando in supra, ubi Motus Ictus est simplex [679.5], quam desuper, ubi Motus Gravitatis concurrit cum Ictu [680].

[677] See note 68 above. The 'hic apud nos' is opposed to the interior parts of the earth. The equilibrium of entire bodies, he supposes, is only apparent, while, amongst the minute particles of bodies, there is a motion constantly going on, — a 'latens processus,' a 'latio per minima.'

This idea, I need hardly say, is in accordance with the views of the most recent physicists, who regard the minute molecules of which matter is or may be supposed to be composed as being in a constant state of motion. See, for instance, Tyndall's Heat a Mode of Motion, 3rd ed., Chapter 3 with the Appendix. M. Bouillet points out the coincidence between Bacon's opinion and that of Leibnitz, as shewn, amongst other places, in the following passage: 'Et hanc agendi virtutem otnni substantiae inesse aio, semperque aliquam ex eo actionem nasci; adeoque nec ipsam substantiam corpoream (non magis quam spiritualem) ab agendo cessare unquam; quod illi non satis percepisse videntur, qui essentiam ejus in sola extensione, vel etiam impenetrabilitate collocaverunt, et corpus omnimode quiescens concipere sibi sunt visi.' De Primae Philosophiae Emendatione, Acta Eruditorum, 1694. Ed. Erdmann, p. 122. [TF]

[678] In 'Motus Secundus,' he adds the important words 'nisi os hydriae ad immittendum aerem aperiatur.' These phenomena, when once observed, ought to have led to the discovery of the pressure of the atmosphere. [TF]

[679] This statement is, of course, true. A cause always operates to the full extent of its efficiency, though its effects may not be apparent, owing to the action of other causes, whether concurring or counteracting. Though a truism, when once stated, this consideration is often lost sight of. [TF]

[679.5] "motus ictus est simplex" should be changed to "motus ictus simplex est". [HJ]

[680] This passage is very curious, as shewing that Bacon had no suspicion that, in both cases alike, the force of gravity is acting at every moment of the projectile's path; nor was he aware, of course, that the path of the projectile, if we leave out of account the resistance of the atmosphere, is in all cases a parabola. The experiment proposed is to

ascertain how far a gun will carry point-blank, and then, firing that distance, first upwards, then downwards, to compare the force of the two shots. As the velocity at any point of the parabola is that which would be acquired in falling from the directrix, there can be no doubt that the downward shot would make much the greater impression of the two. But, as it is almost needless to add, Bacon entirely mistook the conditions of the problem.

The true theory of the motion of projectiles was first distinctly enunciated by Galileo in the fourth of his Dialogues on Motion, which were published at Leyden in 1638 (Dialoghi delle Nuove Scienze, Giornata iv, Florence Ed., Vol. xiii. p. 222, etc.). On the previous speculations of Tartaglia, Digges, etc., see WhewelPs History of the Inductive Sciences, Vol. II. Book vi. Chapter 2. sect. 3, and Drinkwatefs Life of Galileo (lib. Soc. U. K.), Chapter 16. It is curious that one of the books (the Pantometria, published in 1591), in which Thomas Digges alludes to the compounded motion of a projectile, was dedicated to Sir Nicholas Bacon, Bacon's father. A series of very interesting remarks on this subject will be found at the end of the Stratioticos, published by Digges in 1579. [TF]

Etiam canones *praedominantiarum* qui occurrunt colligendi sunt. Veluti, quod quo communius est bonum quod appetitur, eo motus est fortior [681] ut motus nexus, qui respicit communionem universi, fortior est motu gravitatis, qui respicit communionem densorum. Etiam quod appetitus qui sunt boni privati, non praevalent plerunque contra appetitus boni magis publici, nisi in parvis quantis. Quae utinam obtinerent in civilibus.

[681] Note this strange application of the doctrine of Final Causes, and the very doubtful example by which it is supported.

On Public and Private Good, CP. the interesting passages in De Augmentis Scientiarum VII. I (E, and S., Vol. I. p. 717, etc.), or Advancement of Learning, Book II. (Ellis and Spedding, Vol. III. p. 420, etc.). The application of this distinction to 'judge and determine the controversies wherein Moral Philosophy is conversant' has a peculiar interest in reference to subsequent ethical speculation. [TF]

XLIX.

Inter *praerogativas instantiarum* ponemus loco vicesimo quinto *Instantias Innuentes* [682]; eas scilicet, quae commoda hominum innuunt aut designant. Etenim ipsum *Posse* et ipsum *Scire* naturam humanam amplificant, non beant [683]. Itaque decerpenda sunt ex universitate rerum ea quae ad usus vitae maxime faciunt. Verum de iis erit magis proprius dicendi locus, cum *Deductiones ad Praxim* [684] tractabimus. Quinetiam in ipso opere Interpretationis circa singula subjecta, locum semper *Chartae Humanae*, sive *Chartae Optativae* [685], assignamus. Etenim et quaerere et optare non inepte, pars scientiae est [686].

[682] These are the first of the three 'Instantiae propitiae sive benevolae' (see Aphorism 44). Their office is 'dirigere operatiVam ad ea quae maxime hominum intersunt.' Hence,

they are called 'Intimating Instances;' for they suggest to us what are profitable, and what are unprofitable directions for our experiments, energies, or speculations. [TF]

[683] On the necessity of the union of Knowledge and Practice, Science and Art, see i. Si, II. 4, and the various other passages on the same subject which abound in this treatise. In I. 3, the lesson is conveyed in a somewhat different form: 'Scientia et potentia humana in idem coincidunt.' [TF]

[684] See II. 21, [TF]

[685] CP. the Tables, bearing these names, at the end of the Historia Ventoruin and Historia Densi et Rari. [TF]

[686] As Dr. Kitchin observes, this maxim is but another form of the famous dictum, 'Prudens quaestio est dimidium scientiae.' [TF]

L.

Inter *praerogativas instantiarum* ponemus loco vicesimo sexto *Instantias Polychrestas* [687]. Eae sunt, quae pertinent ad varia et saepius occurrunt; ideoque operae et novis probationibus haud parum parcunt. Atque de instrumentis ipsis atque ingeniationibus [688] proprius erit dicendi locus, cum Deductiones ad Praxim et Experimentandi Modos tractabimus. Quinetiam quae adhuc cognita sunt et in usum venerunt, in Historiis Particularibus singularum artium describentur [689]. In praesenti autem subjungemus quaedam catholica circa ea pro exemplis tantum *polychresti*.

[687] CP. De Gen. Anim. V. 8 ad fin. (p. 789 b. 9-12): οἷον γὰρ ἔνια πολύχρηστά ἐστι τῶν περὶ τὰς τέχνας, ὥσπερ ἐν ΤΗ χαλκευτικῇ ἡ σφύρα καὶ ὁ ἄκμων, οὕτως καὶ τὸ πνεῦμα ἐν τοῖς φύσει συνεστῶσιν. Galen (Ed. Kühn, Tome xiii. pp. 501, 763) speaks of φάρμακα πολύχρηστα. This is the class of instances 'quae parcunt instrumentis' (see Aphorism 44), and includes all rules, processes, or instruments, which, being applicable to a great variety of cases, shorten or facilitate our observations and experiments. They cannot be accurately discriminated from the Instantiae Radii and the Instantiae Curriculi. [TF]

[688] 'Ingenious contrivances.' Perhaps = 'engines.' The word does not occur in classical Latin, though ingeniatus is found in Plautus and other writers. Ducange has the verb ingeniare. [TF]

[689] See the Catalogus Historiarum Particularium, which was published at the end of the First Edition of the Novum Organum. Bacon tells us, at the end of the Parasceve, that it was his design, as soon as he was at leisure, 'in singulis veluti interrogando docere, qualia sint circa unamquamque historiarum illarum pdtissimum inquirenda et conscribenda.' [TF]

Operatur igitur homo super corpora naturalia (praeter ipsam admotionem et

amotionem [690] corporum simplicem) septem praecipue modis: nempe, vel per exclusionem eorum quae impediunt et disturbant; vel per compressiones, extensiones, agitationes, et hujusmodi; vel per calorem et frigus; vel per moram in loco convenienti; vel per fraenum et regimen motus; vel per consensus speciales; vel per alternationem tempestivam et debitam, atque seriem et successionem horum omnium; aut saltem nonnullorum ex illis.

[690] CP. I. 4. [TF]

(1) Ad primum igitur quod attinet; aër communis qui undique praesto est et se ingerit, atque radii coelestium, multum turbant. Quae itaque ad illorum exclusionem [691] faciunt, merito haberi possint pro *polychrestis*. Huc igitur pertinent materies et crassities vasorum, in quibus corpora ad operationem praeparata reponuntur. Similiter, modi accurati obturationis vasorum, per consolidationem et lutum sapientiae [692], ut loquuntur chymici. Etiam clausura per liquores in extimis, utilissima res est; ut cum infundunt oleum super vinum aut succos herbarum, quod expandendo se in summitate instar operculi, optime ea conservat illaesa ab aëre. Neque pulveres res malae sunt; qui, licet contineant aërem permistum [693], tamen vim aëris coacervati et circumfusi arcent: ut fit in conservatione uvarum et fructuum intra arenam, et farinam. Etiam cera, mel, pix, et hujusmodi tenacia, recte obducuntur ad clausuram perfectiorem, et ad summovendum aërem et coelestia. Etiam nos experimentum quandoque fecimus, ponendo vas, necnon aliqua alia corpora, intra argentum vivum, quod omnium longe densissimum est ex iis quae circumfundi possunt. Quinetiam specus et cavernae subterraneae magni usus sunt ad prohibendum insolationem [694] et aërem istum apertum praedatorium; qualibus utuntur Germani Septentrionales pro granariis. Necnon repositio corporum in fundo aquarum ad hoc spectat: ut memini me quippiam audisse de utribus vini demissis in profundum puteum, ad infrigidationem scilicet, sed casu et per neglectum ac oblivionem ibidem remanentibus per multos annos, et deinde extractis; unde vinum factum est non solum non vapidum aut emortuum, sed multo magis nobile ad gustum, per commixtionem partium suarum (ut videtur) magis exquisitam. Quod si postulet res ut corpora demittantur ad fundum aquarum, veluti intra fluvios aut mare, neque tamen aquas tangant, nec in vasibus obturatis concludantur, sed aëre tantum circumdentur; bonus est usus vasis illius quod adhibitum est nonnunquam ad operandum subter aquis super navigia demersa, ut urinatores diutius manere possint sub aquis, et per vices ad tempus respirare. Illud hujusmodi erat. Conficiebatur dolium ex metallo concavum, quod demittebatur aequabiliter ad superficiem aquae, atque sic deportabat totum aërem qui continebatur in dolio secum in fundum maris. Stabat autem super pedes tres (instar tripodis), qui longitudinis erant aliquanto minoris statura hominis; ita ut urinator posset cum anhelitus deficeret, immittere caput in cavum dolii, et respirare, et deinde opus continuare [695]. Atque audivimus inventam esse jam machinam aliquam naviculae aut scaphae, quae homines subter aquis vehere possit ad spatia nonnnulla [696]. Verum sub tali vase, quale modo diximus, corpora quaevis facile suspendi possint; cujus causa hoc experimentum adduximus.

[691] The Air-Pump, invented about 1654 by Otto von Guericke of Magdeburg and subsequently so much improved by Boyle, would have exactly met Bacon's requirements, so far as air is concerned. Light is excluded with comparative ease. [TF]

[692] Lutum sapientiae or philosophorum was a composition, employed for the purpose of sealing hermetically the orifices of vessels. Pliny (Naturalis Historia XXIX. 3 (ii), sect. 51) gives a short recipe for piecing together broken fragments of glass: 'Et, ne quid desit ovorum gratiae, candidum ex his admixtum calci vivae glutinat vitri hragmenta.' Albertus Magnus (referred to by Hoefer, Histoire de la Chimie, tome I, p. 388) enumerates different kinds of 'lutes,' varying their composition according to the difference of temperature. [TF]

[693] Here we have the same distinction as that between the 'vacuum permistum' and the 'vacuum coacervatum' in the concluding remarks of II. 48. In the present passage, the meaning is obvious. [TF]

[694] Drying in the sun, or exposure to the sun. The word is used by Pliny, Naturalis Historia XXI. 14 (49), Section 84. [TF]

[695] CP. Historia Densi et Rari, Ellis and Spedding, Vol. II. p. 299. Beckmann (History of Inventions) has a long article on the history of Diving and Diving-Bells. 'The oldest information,' he says, 'that we have respecting the use of the diving-bell in Europe is that of John Taisnier, quoted by Schott. The former, who was born at Hainault in 1509, had a place at court under Charles V, whom he attended on his voyage to Africa. He relates in what manner he saw at Toledo [in 1538], in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water, in a large inverted kettle, with a burning light, and rise up again without being wet.' The diving-bell was employed for the purpose of trying to recover part of the spoil, after the wreck of the Spanish Armada. [TF]

[696] CP. New Atlantis, Ellis and Spedding, Vol. III. p. 163: 'We have ships and boats for going under water, and brooking of seas.' Mr. Ellis, in a note on that passage, says that a boat for going under water was one of Drebbel's inventions exhibited in 1620. See also his note on De Augmentis Scientiarum, Libro V. Cap. 2 (Ellis and Spedding, Vol. I. p. 628). [TF]

Est et alius usus diligentis et perfectae clausurae corporum: nempe, non solum ut prohibeatur aditus aëris per exterius (de quo jam dictum est), verum etiam ut cohibeatur exitus spiritus corporis, super quod fit operatio per interius. Necesse est enim ut operanti circa corpora naturalia constet de summis suis: viz. quod nihil expirarit aut effluxerit. Fiunt enim profundae alterationes in corporibus, quando, natura prohibente annihilationem, ars prohibeat etiam deperditionem aut evolationem alicujus partis [697]. Atque hac de re invaluit opinio falsa (quae si vera esset, de ista conservatione summae certae absque diminutione esset fere desperandum): viz. spiritus corporum, et aërem majori gradu caloris attenuatum, nullis vasorum claustris posse contineri, quin

per poros vasorum subtiliores evolent [698]. Atque in hanc opinionem adducti sunt homines per vulgata illa experimenta, poculi inversi super aquam cum candela aut charta inflammata, ex quo fit ut aqua sursum attrahatur; atque similiter ventosarum, quae super flammam calefactae trahunt carnes. Existimant enim in utroque experimento aërem attenuatum emitti [699], et inde *quantum* ipsius minui, ideoque aquam aut carnes per *nexum* succedere. Quod falsissimum est. aër enim non *quanto* diminuitur, sed spatio contrahitur; neque incipit motus iste successionis aquae, antequam fiat extinctio flammae aut refrigeratio aëris: adeo ut medici, quo fortius attrahant ventosae, ponant spongias frigidas [701] aqua madefactas super ventosas [702]. Itaque non est cur homines multum sibi metuant de facili exitu aëris aut spirituum. Licet enim verum sit etiam solidissima corpora habere suos poros, tamen aegre patitur aër aut spiritus comminutionem sui ad tantam subtilitatem; quemadmodum et aqua exire recusat per rimam minusculam.

[697] CP. the remarks on 'Spiritus' in II. 40. [TF]

[698] The porosity of even the harder metals has been demonstrated by the Florentine and similar experiments. [TF]

[699] The air does not escape through the pores of the vessel; but, owing to its rarefaction, a portion of it has already escaped, before its application to the winter or flesh. [TF]

[701] 'Mr. Ellis proposes to read frigida, which is undoubtedly the right word. See the corresponding passage in the Historia Densi et Rari. [TF]

[702] 'These experiments are also described in the Historia Densi et Rari, Ellis and Spedding, Vol. II. p. 267; in the Cogitationes De Natura Rerum, Vol. III. pp. 24-5; and in the Phaenomena Univer.si, Vol. III. p. 71 1. Notwithstanding what Dr. Kitchin says, I cannot see that Bacon's explanation in the text, so far as it goes, is wrong; though he certainly was not aware of the pressure of the atmosphere, and in the Historia Densi et Rari he himself refers the rising of the flesh within the cupping-glass to attraction 'per motum nexus.' Still, he is right in maintaining that the 'quantum' of the rarefied air within the cup is not diminished, but only the space which it previously filled contracted by cooling. The water or flesh which is covered by the vessel rises, as the heated air cools and contracts, this rising being, as we now know, due to the pressure of the atmosphere on the parts of the surface external to the vessel. [TF]

(2) De secundo vero modo ex septem praedictis illud imprimis notandum est, valere certe compressiones et hujusmodi violentias ad motum localem, atque alia id genus, potentissime; ut in machinis et missilibus: etiam ad destructionem corporis organici, atque earum virtutum quae consistunt plane in motu. Omnis enim vita, immo etiam omnis flamma et ignitio [703] destruitur per compressiones; ut et omnis machina corrumpitur et confunditur per easdem. Etiam ad destructionem virtutum quae consistunt in posituris, et dissimilaritate partium paulo crassiore; ut in coloribus (neque

enim idem color floris integri et contusi, neque succini integri et pulverizati); etiam in saporibus (neque enim idem sapor pyri immaturi, et ejusdem compressi ac subacti; nam manifesto dulcedinem majorem concipit). Verum ad transformationes et alterationes nobiliores corporum similarium non multum valent istae violentiae; quia corpora per eas non acquirunt consistentiam aliquam novam constantem et quiescentem, sed transitoriam, et nitentem semper ad restitutionem et liberationem sui. Attamen non abs re foret hujus rei facere experimenta aliqua diligentiora; ad hoc scilicet, utrum condensatio corporis bene similaris (qualia sunt aër, aqua, oleum, et hujusmodi), aut rarefactio similiter per violentiam indita, possint fieri constantes et fixae et quasi mutatae in naturam [704]. Id quod primo experiendum per moram simplicem; deinde per auxilia et consensus. Atque illud nobis in promptu fuisset (si modo in mentem venisset), cum aquam (de qua alibi [705]) per malleationes et pressoria condensavimus, antequam erumperet. Debueramus enim sphaeram complanatam per aliquot dies sibi permisisse, et tum demum aquam extraxisse; ut fieret experimentum, utrum statim impletura fuisset talem dimensionem, qualem habebat ante condensationem. Quod si non fecisset aut statim, aut certe paulo post, constans videlicet facta videri potuisset ista condensatio; sin minus, apparuisset factam fuisse restitutionem, et compressionem fuisse transitoriam. Etiam simile quiddam faciendum erat circa extensionem aëris in ovis vitreis [706]. Etenim debuerat fieri, post exuctionem fortem, subita et firma obturatio; deinde debuerant ova illa manere ita obturata per nonnullos dies; et tum demum experiendum fuisset, utrum aperto foramine attractus fuisset aër cum sibilo, aut etiam attracta fuisset tanta quantitas aquae post immersionem, quanta fuisset ab initio, si nulla adhibita fuisset mora. Probabile enim, aut saltem dignum probatione est, haec fieri potuisse et posse; propterea quod in corporibus paulo magis dissimilaribus similia efficiat mora temporis. Etenim baculum per compressionem curvatum post aliquod tempus non resilit; neque id imputandum est alicui deperditioni ex quanto ligni per moram; nam idem fiet in lamina ferri (si augeatur mora), quae non est expirabilis. Quod si non succedat experimentum per moram simplicem, tamen non deserendum est negotium, sed auxilia alia adhibenda. Non enim parum lucri fit, si per violentias indi possint corporibus naturae fixae et constantes. Hac enim ratione aër possit verti in aquam per condensationes [707], et complura alia id genus. Dominus enim est homo motuum violentorum, magis quam caeterorum.

[703] ‘Compression acts, in this case, by stopping the supply of oxygen which maintains the combustion. [TF]

[704] Both gases and liquids are perfectly elastic; that is to say, after undergoing a change in volume, they regain exactly their original volume, when the original pressure is restored. This fact has been established by numerous experiments. [TF]

[705] II. 45 ad fin. [TF]

[706] II. 45. [TF]

[707] This remark has, no doubt, reference to Bacon's theory of the Transmutability of the Elements. See Aphorism 48 (ii), with notes. But there is a certain sense in which his anticipation has been verified. For we now know that water might be produced, by means of cold and compression alone, from its constituent gases, hydrogen and oxygen. In fact, as already pointed out, all aeriform fluids are merely liquids kept in the state of vapour by heat, and a sufficient amount of cold and pressure will reduce them into the liquid state. See note 37 on Aphorism 33. [TF]

(3) At tertius ex septem modis refertur ad magnum illud organum, tam naturae quam artis, quoad operandum; videlicet calidum et frigidum. Atque in hac parte claudicat plane potentia humana, tanquam ex uno pede. Habemus enim calorem ignis, qui caloribus solis (prout ad nos deferuntur) et caloribus animalium quasi infinitis partibus potentior est et intensior. At deest frigus [708], nisi quale per tempestates hyemales, aut per cavernas, aut per circundationes nivis et glaciei, haberi potest: quod in comparatione aequari potest cum calore fortasse solis meridiano in regione aliqua ex torridis, aucto insuper per reverberationes montium et parietum; nam hujusmodi utique tam calores quam frigora ab animalibus ad tempus exiguum tolerari possunt. Nihili autem sunt fere prae calore fornacis ardentis, aut alicujus frigoris quod huic gradui respondeat. Itaque omnia hic apud nos [709] vergunt ad rarefactionem, et desiccationem, et consumptionem: nihil fere ad condensationem et intenerationem [710], nisi per misturas et modos quasi spurios. Quare Instantiae Frigoris omni diligentia sunt conquirendae: quales videntur inveniri in expositione corporum super turres quando gelat acriter; in cavernis subterraneis; circundationibus nivis et glaciei in locis profundioribus, et ad hoc excavatis; demissione corporum in puteos; sepulturis corporum in argento vivo et metallis; immersione corporum in aquis, quae vertunt ligna in lapides; defossione corporum in terra (qualis fertur apud Chinenses esse confectio porcellanae [711], ubi massae ad hoc factae dicuntur manere intra terram per quadraginta aut quinquaginta annos, et transmitti ad haeredes, tanquam minerae quaedam artificiales); et hujusmodi. Quinetiam quae interveniunt in natura condensationes, factae per frigora, similiter sunt investigandae; ut, causis eorum cognitis, transferri possint in artes. Quales cernuntur in exudatione marmoris et lapidum [712]; in rorationibus super vitra per interius fenestrarum, sub auroram, post gelu noctis; in originibus et collectionibus vaporum in aquas sub terra, unde saepe scaturiunt fontes [713]; et quaecunque sunt hujus generis.

[708] Bacon, it need hardly be repeated, regarded cold as a distinct quality from heat, not merely as a lower degree of it. The expression 'variations of temperature,' had it existed in his time, might, as I have already pointed out, have preserved him from this error.

The greatest cold known is produced by the evaporation of liquefied gases. 'By surrounding the gas under experiment by concentric tubes containing liquid oxygen, which in turn is surrounded by liquid ethylene, Olszewski obtained temperatures low enough to solidify nitrogen, carbonic oxide, marsh gas, and nitric oxide. The evaporation of solid nitrogen under a pressure of 4^{mm} produces a temperature of —225° (C. = - 373° F.), Ganot's Physics, Translation, 12th: Ed., § 382. [TF]

[709] Here again (CP. Aphorism 48 (12), (19)) he alludes to his theory of the rapidly increasing density of bodies, as we approach the centre of the earth. [TF]

[710] This word is opposed to desiccationem. It is another of the numerous words employed by Bacon, which are not found in classical Latin. Nor is it recognised by Du Cange. [TF]

[711] CP. Historia Densi et Rari, Ellis and Spedding, Vol. II. p. 295; New Atlantis, Ellis and Spedding, Vol. III. p. 157. Mr. Ellis refers to Marco Polo, II. 77. In Marsden's Translation of Marco Polo (London, 1818), the passage runs as follows: ' They collect a certain kind of earth, as it were from a mine, and, laying it in a great heap, suffer it to be exposed to the wind, the rain, and the sun, for thirty or forty years, during which time it is never disturbed. By this it becomes refined and fit for being wrought into the vessels above mentioned. Such colours as may be thought proper are then laid on, and the ware is afterwards baked in ovens or furnaces. Those persons therefore who cause the earth to be dug, collect it for their children or grandchildren.' For the original, see Ramusio's Collection: 'Navigationi et Viaggi,' Vol. II. p. 49, The chapter is there numbered as 79.

From the general resemblance between what Bacon says and the passage in Marco Polo, I can entertain little doubt that he had read it, or some account taken from it. But, on the main point, it will be seen, the passages are discordant.

One of the numerous derivations of porcelain is the odd one 'pour cent années;' 'because it was believed by Europeans, that the materials of porcelain were matured under ground one hundred years.' Dr. Johnson's Dictionary. CP. Sir Thomas Browne's Vulgar Errors, Book II. Chapter 5 (Pickering's Ed., Vol. II. pp. 352-4). Several authorities are there cited both for and against this 'common belief.'

In Col, Yule's Edition of Marco Polo, the passage given above is rejected as an inteqpolation of Ramusio. Commenting on it, Col. Yule says: 'This story of the life-long period during which the porcelain clay was exposed to temper long held its ground, and probably was only dispelled by the publication of the details of the King-te-ching manufacture by Père d'Entrecolles in the Lettres Édifiantes.' [TF]

[712] This and the next phenomenon both fall under the general head of the Deposition of Dew, For references on this subject, see notes on Aphorism 47, CP. also Sylva Sylvarum, Exp. 81. [TF]

[713] Bacon's meaning will be made plain by the following marvellous passage in the Historia Densi et Rari (Ellis and Spedding, Vol. II. p. 293): 'Existimatur origo fontium et aquarum dulcium, quae ex terra scaturiunt, fieri ex aere concluso in cavis terrae (praesertim montium) coagulate et condensate.' CP. Aristotle, Meteorologica, I. 13 (p. 349 b. 19, etc.); Seneca, Natural Quaest. III. 9, 10. Granted the doctrine of the transmutability of the elements; this absurd theory seems natural enough. [TF]

Inveniuntur autem, praeter illa quae sunt frigida ad tactum, quaedam alia potestate frigida, quae etiam condensant; veruntamen operari videntur super corpora animalium tantum, et vix ultra. Hujus generis se ostendunt multa in medicinis et emplastris. Alia autem condensant carnes et partes tangibiles; qualia sunt medicamenta astringentia, atque etiam inspissantiae: alia condensant spiritus; id quod maxime cernitur in soporiferis [714]. Duplex autem est modus condensationis spirituum, per medicamenta soporifera, sive provocantia somnum: alter per sedationem motus; alter per fugam spirituum. Etenim viola, rosa sicca, lactuca, et hujusmodi benedicta sive benigna, per vapores suos amicos et moderate refrigerantes, invitant spiritus ut se uniant, et ipsorum acrem et inquietum motum compescunt. Etiam aqua rosacea, apposita ad nares in deliquiis animae, spiritus resolutos et nimium relaxatos se recipere facit, et tanquam alit. At opiata et eorum affinia spiritus plane fugant, ex qualitate sua maligna et inimica. Itaque si applicentur parti exteriori, statim aufugiunt spiritus ab illa parte, nec amplius libenter influunt: sin sumantur interius, vapores eorum, ascendentes ad caput, spiritus in ventriculis cerebri contentos undequaque fugant; cumque se retrahant spiritus neque in aliam partem effugere possint, per consequens coeunt et condensantur; et quandoque plane extinguuntur et suffocantur; licet rursus eadem opiata moderate sumpta, per accidens secundarium (videlicet condensationem illam quae a coitione succedit), confortent spiritus, eosque reddant magis robustos, et retundant eorum inutiles et incensivos [715] motus, ex quo ad curas morborum, et vitae prolongationem haud parum conferant.

[714] The reader will find some very curious remarks on these subjects in the Historia Vitae et Mortis, Ellis and Spedding, Vol. II. pp, 161-71. [TF]

[715] This word may mean ‘inflammatory,’ or it may simply be written for ‘incentivos.’ [TF]

Etiam praeparationes corporum ad excipiendum frigus non sunt omittendae; veluti quod aqua parum tepida [716] facilius conglacietur quam omnino frigida, et hujusmodi.

[716] This result occurs because the freezing is assisted by the evaporation. It is also the case with water which has been previously boiled. The reason of this latter phenomenon is that the air combined with the water has been already discharged by the act of boiling, and hence the process of congelation is facilitated.

For notices of these phenomena amongst classical authors, see Aristotle, Meteorologica, I. 12 (p. 348 b. 30, κ.τ.λ.); Galen’s Commentary on the Ἐπιδήμια of Hippocrates, Libro vi. comm. IV. (Kühn’s Ed., Vol. xvii. pt. II. P. 155); Juvenal, Sat. V. 49-50 (‘Frigidior Geticis petitur decocta pruinis’); Pliny, xxxi. 3 (23), sect. 40 (cp. with the last passage, Suetonius, Nero, Cap. 48). [TF]

Praeterea, quia natura frigus tam parce suppeditat, faciendum est quemadmodum pharmacopolae solent; qui, quando simplex aliquod haberi non possit, capiunt

succedaneum [717] ejus, et *quid* pro *quo*, ut vocant: veluti lignum aloes pro xylobalsamo [718], cassiam pro cinamomo. Simili modo diligenter circumspiciendum est, si quae sint succedanea frigoris; videlicet quibus modis fieri possint condensationes in corporibus, aliter quam per frigus, quod illas efficit ut opus suum proprium. Illae autem condensationes videntur intra quaternum numerum (quantum adhuc liquet) contineri. Quarum prima videtur fieri per contrusionem simplicem; quae parum potest ad densitatem constantem (resiliunt enim corpora) sed nihilominus forte res auxiliaris esse queat. Secunda fit per contractionem partium crassiorum in corpore aliquo, post evolationem aut exitum partium tenuiorum, ut fit in indurationibus per ignem, et repetitis extinctionibus metallorum, et similibus. Tertia fit per coitionem partium homogenearum, quae sunt maxime solidae in corpore aliquo, atque antea fuerant distractae, et cum minus solidis commistae: veluti in restitutione mercurii sublimati, qui in pulvere longe majus occupat spatium quam mercurius simplex, et similiter in omni repurgatione metallorum a scoriis suis. Quarta fit per consensus [719], admovendo quae ex vi corporum occulta condensant; qui consensus adhuc raro se ostendunt; quod mirum minime est, quoniam antequam inventio succedat formarum et schematismorum, de inquisitione consensuum non multum sperandum est. Certe quoad corpora animalium, dubium non est quin sint complures medicinae, tam interius quam exterius sumptae, quae condensant tanquam per consensum, ut paulo ante diximus. Sed inanimatis rara est hujusmodi operatio. Percrebuit sane, tam scriptis quam fama, narratio de arbore in una ex insulis sive Terceris [720] sive Canariis (neque enim bene memini), quae perpetuo stillat; adeo ut inhabitantibus nonnullam commoditatem aquae praebeat [721]. Paracelsus autem ait, herbam vocatam *Rorem Solis* [722] meridie et fervente sole rore impleri, cum aliae herbae undique sint siccae. At nos utramque narrationem fabulosam esse existimamus. Omnino autem illae instantiae nobilissimi forent usus, et introspectione dignissimae, si essent verae. Etiam rores illos mellitos, et instar mannae, qui super foliis quercus inveniuntur mense Maio, non existimamus fieri et densari a consensu aliquo, sive a proprietate folii quercus; sed cum super aliis foliis pariter cadant, contineri scilicet et durare in foliis quercus, quia sunt bene unita, nec spongiosa, ut plurima ex aliis [723].

[717] Or succidaneum. The meaning of this word, in medical science, is obvious. It is an epithet for medicines that may be substituted for others possessing similar properties. There is a spurious work attributed to Galen, entitled Περὶ ᾽Αντεμβαλλομένων. [TF]

[718] These are twigs of the tree called Balsomodendron Gileadense, The celebrated Balsam of Gilead is an exudation from this tree. [TF]

[719] That is, sympathies. [TF]

[720] Now called the Azores. [TF]

[721] ‘This wonderful tree is described in Jonston’s Dendrographia, published at Frankfort in 1669. See book the tenth, c. 4. One of the authorities he refers to is Cardan (De variet. rerum), from whom not improbably Bacon derived the story. The tree is said

to be found in the island of Ferro. Cardan, with more than usual caution, remarks, at the close of the account he gives of it; Sed postquam hoc tot scriptores affirmant, fieri potest ut tale aliquid contingat, sed modus nondum perspectus est." — De rerum variet. vi, c, 22.' Mr. Ellis' note. Mr. Ellis proceeds to refer to Ramusio. His reference, however, is altogether misleading. The true one is to 'Della Historia Delle Indie, libro II,' in Ramusio, Vol. III. p. 86 A.

Bacon's account of this tree is remarkably modest, as compared with that which Cardan reports. He says: 'Circa arborem singulo mane densa nebula colligitur, quae in aquam versa non solum hominibus, sed et jumentis et pecoribus satisfacit.'

The story may have originated in the observation of some plant which exudes moisture. Such plants are not uncommon, as, for instance, the Pitcher Plant, some of the Musas, the Drosera, next mentioned, etc. Or the plant may have been one on which dew is easily deposited and retained. Or, lastly, the cause might be the constant exudations of small insects. Mr. Andrew Johnson, who adopts this view, quotes Livingstone's Travels in South Africa, p. 415: 'I had an opportunity of observing a curious insect which inhabits trees of the fig family (ficus). Seven or eight of them cluster round a spot on one of the smaller branches, and there keep up a constant distillation of a clear fluid, which dropping to the ground forms a little puddle below. If a vessel is placed under them in the evening, it contains four or five pints of fluid in the morning.' Mr. Johnson adds: 'A careless observer might easily suppose this fluid to be the production of the tree itself.'

Lasalle has a long note on this passage. He quotes, in support of the story of the cloud hanging over the tree, an English navigator, one Robert Lade, and supplements the evidence by an observation of his own, in which he saw detached masses of fog clinging to the tops of trees. But Cardan's story' seems to imply more than this rationalistic explanation of it. [TF]

[722] The Drosera (δροσερά) or Sun-Dew. The glands of the leaves exude drops of a clear glutinous fluid, glittering like dew-drops, whence the name.

Mr. Ellis says: 'I have not been able to find this in Paracelsus. It seems, however, to accord with his theory of dew, — namely, that it is an exudation from the sun and stars; the suppression of which would lead to the formation of additional suns.' [TF]

[723] The honey-dew on the oak, lime, rose-tree, plum-tree, etc., is in all probability due to a sugary exudation from the Aphis. For a description of this insect, its devastations, and its exudations, see the Rev, J. G. Wood's Insects at Home, p. 542, etc.

None of the three examples adduced by Bacon, it will be noticed, are really instances of 'condensation.' The phenomena all arise from exudation, either of the plant itself or of an insect settling on the plant. [TF]

Calorem vero quod attinet, copia et potestas nimirum homini abunde adest; observatio

autem et inquisitio deficit in nonnullis, iisque maxime necessariis, utcunque spagyrici [724] se venditent. Etenim caloris intensioris opificia exquiruntur et conspiciuntur; remissioris vero, quae maxime in vias naturae incidunt, non tentantur, ideoque latent. Itaque videmus per vulcanos [725] istos qui in pretio sunt, spiritus corporum magnopere exaltari, ut in aquis fortibus, et nonnullis aliis oleis chymicis; partes tangibiles indurari, et, emisso volatili, aliquando figi; partes homogeneas separari; etiam corpora heterogenea grosso modo incorporari et commisceri; maxime autem compages corporum compositorum et subtiliores schematismos destrui et confundi. Debuerant autem opificia caloris lenioris tentari et exquiri; unde subtiliores misturae et schematismi ordinati gigni possint et educi, ad exemplum naturae et imitationem operum solis; quemadmodum in aphorismo de instantiis *foederis* [726] quaedam adumbravimus. Opificia enim naturae transiguntur per longe minores portiones, et posituras magis exquisitas et varias, quam opificia ignis, prout nunc adhibetur. Tum vero videatur homo revera auctus potestate [727], si per calores et potentias artificiales opera naturae possint specie repraesentari, virtute perfici, copia variari; quibus addere oportet accelerationem temporis. Nam rubigo ferri longo tempore procedit, at versio in crocum Martis [728] subito; et similiter de aerugine et cerussa [729]. Christallum [730] longo tempore conficitur, vitrum subito conflatur. Lapides longo tempore concrescunt, lateres subito coquuntur, etc. Interim (quod nunc agitur) omnes diversitates caloris cum effectibus suis respective diligenter et industrie undique sunt colligendae et exquirendae: coelestium, per radios suos directos, reflexos, refractos, et unitos in speculis comburentibus; fulguris, flammae, ignis carbonum; ignis ex diversis materiis; ignis aperti, conclusi, angustiati, et inundantis, denique per diversas fabricas fornacium qualificati; ignis flatu exciti, quieti et non exciti; ignis ad majorem aut minorem distantiam remoti; ignis per varia media permeantis; calorum humidorum, ut balnei Mariae [731], fimi, caloris animalium per exterius, caloris animalium per interius, foeni conclusi; calorum aridorum, cineris, calcis, arenae tepidae; denique calorum cujusvis generis cum gradibus eorum.

[724] This word does not occur in Du Cange, but in Calepinus I find: '*spagirus*, alchymista, qui, metalla coquens, purum ab impuro separat. Unde *spagiricus*, ad spagirum pertinens.' These and the allied words are of common occurrence in Paracelsus. In the De Natura Rerum, Libro VIII. (Op. Omn. Genev. 1658, Vol. II. p. 104), he elaborately praises the 'Medici Spagyrici' in comparison with the other Medici.

There is a long and interesting account of this word in Kopp's Beitrage zur Geschichte der Chimie, Braunschweig, 1869, PP. 63-4, note. It was usually derived from σπᾷν καὶ ἀγείρειν, to separate and combine. [TF]

[725] 'Those fires,' as in Aen. VII. 77: 'Ac totis Vulcanum spargere tectis.' [TF]

[726] See II. 35. [TF]

[727] CP. Book I. 3. [TF]

[728] Sesqui-oxide of iron. ‘Crocus’ was a term applied by the older chemists to many metallic compounds, as Crocus Antimonii, Crocus Veneris, etc. [TF]

[729] 'Verdigris and white-lead.’ Both these are classical terms. [TF]

[730] See II. 48 (4) ad fin. with note. [TF]

[731] ‘This is properly “balneum maris;” that is, a mode of communicating heat to any substance by putting it into a vessel which is placed in another containing water. The latter being put on the fire, the former and its contents become gradually and moderately heated. The reason of the name is obvious. From “balneum maris” the French made by a kind of transition (the finals not being sounded) “bain marie;” and the form in the text is, I think, merely a retranslation of the French phrase, the meaning of the second word being mistaken. Balneum Mariae is however, I believe, a common phrase with old writers on chemistry.’ Mr. Ellis’ note.

The expression ‘Balneum Maris’ occurs in Paracelsus, as, for instance, in the De Transmutatione Rerum, lib, VII. (Op. Omn. Genevae, 1658, Vol. II. p. 99 b). In turning over several old Manuals of Chemistry, I have found the expression ‘Balneum Mariae’ in Roflingius, Chimia, Geneva, 1671, p. 117. The modem equivalent is ‘water-bath.’ [TF]

Praecipue vero tentanda est inquisitio et inventio effectuum et opificiorum caloris accedentis et recedentis graduatim, et ordinatim, et periodice, et per debita spatia et moras. Ista enim inaequalitas ordinata revera filia coeli [732] est, et generationis mater; neque a calore aut vehementi, aut praecipiti, aut subsultorio, aliquid magni expectandum est. Etenim et in vegetabilibus hoc manifestissimum est; atque etiam in uteris animalium magna est caloris inaequalitas, ex motu, somno, alimentationibus et passionibus foemellarum quae uterum gestant; denique in ipsis matricibus terrae, iis nimirum in quibus metalla et fossilia efformantur, locum habet et viget ista inaequalitas. Quo magis notanda est inscitia aliquorum alchymistarum ex reformatis [733], qui per calores aequabiles lampadum et hujusmodi, perpetuo uno tenore ardentium, se voti compotes fore existimarunt. Atque de opificiis et effectibus caloris haec dicta sint. Neque vero tempestivum est illa penitus scrutari, antequam rerum formae et corporum schematismi ulterius investigati fuerint, et in lucem prodierint. Tum enim quaerenda et adoperanda [734] et aptanda sunt instrumenta, quando de exemplaribus [735] constiterit.

[732] The heavenly bodies acting in this manner, as in the daily course of the sun, the seasons, and the imagined influence of the moon and stars. [TF]

[733] ‘Of the reformed school’ I suppose that Bacon alludes to Paracelsus and his disciples. They are described as the ‘reformed school,’ I presume, because they hoped to gain their ends by means of ‘the lamp’ rather than by the ‘philosopher’s stone.’ But what Bacon complains of is that they thought their ends might be achieved without sufficiently varying the heat employed. It may be noticed that Paracelsus (who, however,

still believed in the efficacy of the philosopher's stone; see, for instance, p. 100 a. of the treatise quoted below) enumerates various 'gradus ignis Alchymistici,' of which the 'jugis ignis candelae et lychni' is only one. See De Transmutatione Rerum, Libro VII. (Op. Omn., Vol. II. pp. 99, 100).

The student will find a good account of the reforms introduced into chemistry in the sixteenth century at the beginning of the second volume of Hoefer's Histoire de la Chimie. He enumerates three distinct schools: the dcole chdmiatrique of Paracelsus, the dcole mdtallurgique of George Agricola, and the dcole technique of Bernard Palissy. It must be to the first of these, or at least to this mainly, I think, that Bacon is here alluding. [TF]

[734] = adhibenda. See Du Cange, sub voce 'adoprare.' [TF]

[735] He must mean the exemplars or models ('rerum formae et corporum schematismi'), the operations of which the ' instrumenta ' are to attempt to imitate. [TF]

(4) Quartus modus operandi est per moram, quae certe et promus et condus [736] naturae est, et quaedam dispensatrix. Moram appellamus, cum corpus aliquod sibi permittitur ad tempus notabile, munitum interim et defensum ab aliqua vi externa. Tum enim motus intestini se produnt et perficiunt, cum motus extranei et adventitii cessant. Opera autem aetatis sunt longe subtiliora quam ignis [737]. Neque enim possit fieri talis clarificatio vini per ignem, qualis fit per moram; neque etiam incinerationes per ignem tam sunt exquisitae, quam resolutiones et consumptiones per saecula. Incorporationes etiam, et mistiones subitae et praecipitatae per ignem, longe inferiores sunt illis, quae fiunt per moram. At dissimilares et varii schematismi, quos corpora per moras tentant (quales sunt putredines), per ignem aut calorem vehementiorem destruuntur. Illud interim non abs re fuerit notare; motus corporum penitus conclusorum habere nonnihil ex violento. Incarceratio enim illa impedit motus spontaneos corporis. Itaque mora in vase aperto plus facit ad separationes; in vase penitus clauso ad commistiones; in vase nonnihil clauso, sed subintrante aëre, ad putrefactiones. Utcunque de opificiis et effectibus morae undique sunt diligenter conquirendae instantiae.

[736] 'Distributer and store-keeper.' CP. Plautus, Pseud. Act. II. Sc. 2. 1. 14: 'Condus promus sum,' [TF]

[737] This comparison of time with fire is not uncommon. CP. the end of Ovid's Metamorphoses (xv. 871-2):

> 'Jamque opus exegi, quod nec Jovis ira, nec ignes,
> Nec poterit ferrum, mec edax abolere vetustas.' [TF]

(5) At regimen motus (quod est quintus ex modis operandi) non parum valet. Regimen autem motus vocamus, cum corpus aliud occurrens corporis alterius motum spontaneum impedit, repellit, admittit, dirigit. Hoc vero plerunque in figuris et situ

vasorum consistit. Etenim conus erectus juvat ad condensationem vaporum in alembicis [738]; at conus inversus juvat defaecationem sacchari in vasis resupinatis [739]. Aliquando autem sinuatio requiritur, et angustiatio, et dilatatio per vices, et hujusmodi [740]. Etiam omnis percolatio huc spectat; scilicet cum corpus occurrens uni parti corporis alterius viam aperit, alteri obstruit. Neque semper percolatio aut aliud regimen motus fit per extra; sed etiam per corpus in corpore: ut cum lapilli immittuntur in aquas ad colligendam limositatem ipsarum; syrupi clarificantur cum albuminibus ovorum, ut crassiores partes adhaerescant, et postea separari possint. Etiam huic regimini motus satis leviter et inscite attribuit Telesius [741] figuras animalium, ob rivulos scilicet et loculos matricis. Debuerat autem notare similem efformationem in testis ovorum, ubi non sunt rugae aut inaequalitas. At verum est regimen motus efformationes perficere in modulis et proplasticis [742].

[738] A description of the Alembic, illustrated by a figure, will be found in Watts' Dictionary of Chemistry, sub voce. The instrument is now superseded by the Retort. It is possible, however, that Bacon is not speaking of the entire instrument, but only of the conical head. [TF]

[739] The ordinary wine- strainer will give a sufficiently good idea of what Bacon means. [TF]

[740] As in the Retort, called by the French 'cornue.' Old Books of Chemistry, as, for instance, the Clavis of Gerardus Dorneus, Francf. 1583, show this instrument to have been in common use in Bacon's time. [TF]

[741] 'Telesius's doctrine of the formation of the embryo is essentially the same as Galen's, namely that a system of arteries must be first of all formed in the germ, and that these, by applying themselves to corresponding parts on the surface of the matrix, determine the channels through which nourishment is supplied, and therefore (mediately) the development of the different members of the foetus. But it does not seem that he would have admitted that the smoothness of the shells of eggs was an objection to his theory- At any rate, he illustrates it by reference to the appearances presented by an egg opened, during incubation. De rerum natura, vi. Chapters 4 and 40.' Mr. Ellis' note. [TF]

[742] Mr, Ellis says: The proper word for what we call a model is "proplasma," which is used in a Latin form by Pliny. I have not seen any authority for such an adjective as "proplasticus." [742.1] What Bacon means is not exactly a model, but a mould for casting.' The reference to Pliny is Naturalis Historia xxxv. 12 (45), sect. 155. In Cicero, Epist. ad Atticum, xii. 41, the word is written in Greek. [TF]

[742.1] "modulis et proplasticis" can be taken as "modeling/moulding forms". [HJ]

(6) Operationes vero per consensus aut fugas (qui sextus modus est) latent saepenumero in profundo. Istae enim (quas vocant) proprietates occultae, et specificae [743], et

sympathiae, et antipathiae [744], sunt magna ex parte corruptelae philosophiae. Neque de consensibus rerum inveniendis multum sperandum est, ante inventionem formarum et schematismorum simplicium. Consensus enim nil aliud est quam symmetria formarum et schematismorum ad invicem.

[743] CP. Book I. 66, and note 49. [TF]

[744] The remarks which Bacon presently proceeds to make are alone sufficient to show how little right he had to complain of the fanciful views entertained by others on this class of questions. On the same subject, CP. Aditus ad Historiam Sympathiae et Antipathiae Rerum (Ellis and Spedding, Vol. II. p. 81); Cogitata et Visa (Ellis and Spedding; Vol. III. p. 606); Sylva Sylvarum, Exps. 95-97; and, on the kindred subject of Natural Magic, Novum Organum II. 9 ad fin., and II. 31 ad fin., with the note on the latter passage, and the other places there referred to. [TF]

Atqui majores et magis catholici rerum consensus non prorsus obscuri sunt. Itaque ab iis ordiendum. Eorum prima et summa diversitas ea est; ut quaedam corpora copia et raritate materiae admodum discrepent, schematismis consentiant: alia contra copia et raritate materiae consentiant, schematismis discrepent. Nam non male notatum est a chymicis, in principiorum suorum triade [745], sulphur et mercurium quasi per universitatem rerum permeare. (Nam de sale inepta ratio est, sed introducta ut possit comprehendere corpora terrea, sicca, et fixa [746].) At certe in illis duobus videtur consensus quidam naturae ex maxime catholicis conspici. Etenim consentiunt sulphur; oleum, et exhalatio pinguis; flamma; et fortasse corpus stellae [747]. Ex altera parte consentiunt mercurius; aqua et vapores aquei; aër; et fortasse aether purus et interstellaris. Attamen istae quaterniones geminae, sive magnae rerum tribus (utraque intra ordines suos), copia materiae atque densitate immensum differunt, sed schematismo valde conveniunt; ut in plurimis se produnt. At contra metalla diversa copia et densitate multum conveniunt (praesertim respectu vegetabilium, etc.), sed schematismo multifariam differunt; et similiter vegetabilia et animalia diversa schematismis quasi infinitis variantur, sed intra copiam materiae sive densitatem paucorum graduum continentur.

[745] This doctrine, that all bodies are composed of sulphur, mercury, and salt, seems to have been first introduced by Basilius Valentinus (whose works cannot, perhaps, be dated before the end of the fifteenth century. See the curious discussion on his personality, date, and writings in the Bio- graphic Universelle), though it was largely developed by Paracelsus, and was the foundation of many of his chemical and medical speculations. See, especially, the Treatise 'De origine Morborum ex tribus primis substantiis,' Op. Omn. Vol. I. p. 31, etc. The following extracts taken from Libro I. Cap. 2 may be interesting and amusing to the reader: 'Nani si lignum manibus teneas, tunc oculorum judicio unum saltern corpus habes. Et hoc scire tibi nullo usui est. Idem et rustici sciunt videntque. Eo usque descendere et penetrare debes, at scias, manibus te premere Sulphur, Mercurium et Sal. Quas tres res, si aspectu ipso,' et tactu atque palpatu, unamquamlibet ab alia separatum, sentis: tum demum oculos eos nactus es,

quibus Medicns videre debet. Hi oculi in tribus his pervidendis tarn perspicaces esse debent, quam certo lignum videt rusticus crudum. Hoc exemplum eo tibi faciat, ut ipsum hominem quoque in his tribus cognoscas, non minus ac ipsum lignum: hoc est, ipsum hominem simili forma conditum habeas. * * * * * * Id quod ardet, est sulphur. Praeter sulphur, nihil flagrat. Quod fumat, est Mercurius. Nihil sublimatur, praeter unum Mercurium. Quod in cinerem abit, Sal est. Nihil cinerescit, nisi sal sit.' The members of this triad, however, were not the common, visible substances of sulphur, mercury, and salt, but certain pure substances, analogous to these, and possessing in perfection the respective properties of burning, of being volatile, and of being fixed. See, for a further account, Kopp's Geschichte der Chemie, Braunschweig, 1843, Th. I. pp. 88-9; 96-7.

The earlier view of Geber (who lived in the eighth century), adopted apparently from his predecessors, was that the metals were composed of only two substances (these, as in the theory of Paracelsus, being pure, not the common, visible, substances), namely, sulphur and mercury. See Kopp, Th. I. pp. 44-6. To this earlier view Bacon recurs, applying it, however, apparently, to bodies in general.

In the Cogitata et Visa (Ellis and Spedding, Vol. hi. p. 605), Bacon says: 'Utcunque enim Principiorum Trias inventum non inutile fuerit, sed rebus aliqua ex parte hnitimum.' CP. Temporis Partus Masculus (Ellis and Spedding, Vol. III. pp. 532-3): ' Principiorum aiitem triadem, commentum baud ita prorsus inutile et rebus aliqua ex parte finitimum, quam importune inculcate homo imposturae peritissimtis?' See also Sylva Syivarum, Exp. 354, and Aditus ad Historiam Sulphuris, Mercurii, et Saiis (Ellis and Spedding, II. pp. 82-3). [TF]

[746] As opposed to volatile. See last note. [TF]

[747] The idea of 'quaternions' is still further and more dearly developed in the Aditus ad Historiam Sulphuris, etc., just referred to. There, he regards sulphur and mercury, which properly belong to the subterranean world, as taking the forms respectively of oil and water in the animal and vegetable world, of flame and air respectively 'in pneumaticis inferioribus,' and, lastly (though on this point he does not pronounce decisively), of starry matter and pure aether respectively 'in coelestibus.'Salt he regards as compounded of sulphur and mercury, by means of a strong spirit. The reader should carefully compare this 'Aditus' with the present passage, and with what was said about the Triad in the last note but one.

I have not been able to find in the works of Paracelsus any single passage or any combination of passages containing the precise theory propounded in the text. But the following quotations, which are necessarily very brief, will show that much of this nonsense was either derived directly from Paracelsus, or indirectly suggested by his works:

'Sulphurum multa sunt: Resina, Gummi, Botin [id est Terpentina], Axungia, pinguedo, butjnrum, oleum, vinum ardens, etc.

‘Scitote ergo, salia multa esse. Quaedam sunt calces: quaedam cineres: quaedam Arsenicalia: quaedam Antimonicalia, etc.’ Op. Omn. Vol. I. p. 36a.

‘Sal albus est: et omnes in se colores habet. Sulphur ardet Ideo omnia olea continet. Mercurius diffluit. Ergo omnes in se humores claudit. Et sic de caeteris quoque, quae ad philosophiam remittimus.’ I. p. 52 b.

‘Pinguedo autem quaevis nihil est aliud quam sulphur modis ac naturis variis divisum. *** Videtis nimirum per tempestates coelum fulgurare. Isto autem loco sulphur nullum videri potest Et tamen cum ardeat, id necessario a solo sulphur e fit’ I. 710 a.

Even these absurdities are outdone by the quaint theory of Paracelsus about the stars (and here Bacon ceases to follow): ‘Sydera omnia Hyemis vivunt in Mercurio, et sydera omnia aestatis in sulphure, et juxta se invicem ita manent jugiter.’ I. 824 b.

I cannot but think that Bacon, in his modifications of the doctrine of Paracelsus, was influenced by the theory of Telesius, deriving all things from heat and cold; sulphur would answer to the former, mercury to the latter. The manner in which Bacon constructs his ‘Quaternions’ would certainly support this hypothesis. [TF]

Sequitur consensus maxime post priorem catholicus, videlicet corporum principalium et fomitum suorum; videlicet menstruorum [748], et alimentorum. Itaque exquirendum, sub quibus climatibus, et in qua tellure, et ad quam profunditatem metalla singula generentur; et similiter de gemmis, sive ex rupibus, sive inter mineras natis; in qua gleba terrae, arbores singulae, et frutices, et herbae potissimum proveniant, et tanquam gaudeant; et insimul quae impinguationes, sive per stercorationes cujuscunque generis, sive per cretam, arenam maris, cineres, etc., maxime juvent; et quae sint ex his pro varietate glebarum magis aptae et auxiliares. Etiam insitio et inoculatio arborum et plantarum, earumque ratio, quae scilicet plantae super quas foelicius inserantur, etc., multum pendet de consensu. In qua parte non injucundum foret experimentum [749], quod noviter audivimus esse tentatum, de insitione arborum sylvestrium (quae hucusque in arboribus hortensibus fieri consuevit), unde folia et glandes majorem in modum amplificantur, et arbores fiunt magis umbrosae. Similiter, alimenta animalium respective notanda sunt in genere, et cum negativis. Neque enim carnivora sustinent herbis nutriri; unde etiam Ordo Folitanorum [750] (licet voluntas humana plus possit quam animantium caeterorum super corpus suum [751]), post experientiam factam (ut aiunt), tanquam ab humana natura non tolerabilis, fere evanuit. Etiam materiae diversae putrefactionum, unde animalcula generantur, notandae sunt.

[748] ‘By “menstrua” are meant the substances out of which any species of mineral is generated, or, in other words, the causa materialis of its existence. See, on the generation of metals and other minerals, the fourth and fifth books of [Georgius] Agricola's work De ortu et causis Fossllium [? subterraneorum]. He gives an account of the opinions of Aristotle, Theophrastus, etc. In modern chemistry the word menstruum

is nearly equivalent to solvent. By the school of Paracelsus the word is used so vaguely that it is difficult to determine what idea they attached to it, or how they derived their sense of the word from its original signification. When the word is used as in the text, the metaphor seems to be taken from the Aristotelian theory of generation, in which κατὰ τὴν πρώτην ὕλην ἐστὶν ἡ τῶν καταμηνίων φύσις. [De Gen. An. I. 20 ad fin. p. 729 a, 32.] Mr. Ellis' note. [TF]

[749] See Sylva Syivarum, Exp. 475. [TF]

[750] Bacon alludes to these monks on two other occasions, namely in the Historia Vitae et Mortis (Ellis and Spedding, Vol. II. p. 131), where he calls them Foliatani, and in the Sylva Sylvarum, Exp. 45, where he calls them Foliatanes.

I borrow the following note from Mr. Ellis: 'Bacon doubtless refers to the austerities of the order of Feüilians. Jean de la Barriere, after holding the Cistercian abbey of Feüilians in commendam for eleven years, renounced the world in I573, and in the course of a few years introduced a most austere rule of life into the abbey of which he was the head. His monks knelt on the door during their refections, and some of them were in the habit of drinking out of skulls. They abstained from eggs, fish, butter, oil, and even salt, and confined themselves to pottage made of herbs boiled in water, and bread so coarse and black that beasts refused to eat of it. After a while they gave up wine also. Clement VIII permitted the society to draw up constitutions for the establishment of their rule. By these the excessive rigour of their way of life was checked, which was done in obedience to the Pope, and in consequence of the deaths of fourteen monks in a single week at Feüilians. These constitutions were ratified in 1595. Assuming, of which there seems no doubt, that the Folitani of Bacon are the Feüilians, I may remark that the Latinised form of Feüilians used is Fuliensis, as an adjective; the proper style of the society being "Congregatio Cistertiomonastica B, Mariae Fuliensis." I have not seen the work of Morotius to which Helyot, from whom the preceding account is taken, refers; but in that of C. Henri que, also mentioned by Helyot, I do not find any authority for Folitani. It is probable that Bacon's chief information on the subject was gathered orally during his residence in France, before the Feüilians had ceased from their first love. The expression "ordo * * * fere evanuit" must be taken to mean that the severe rule that they had at first was given up. See Helyot, Hist, des Ordres Monastiques, iv^{me} partie, c. 38. [Tome v.] Spondanus, An. 1586, IV. For some particulars of the early history of the Abbey of Feüilians, and especially for the will of Jean de la Barri^re, see Voyage Litteraire de deux Benddictins, II. p. 16.'

The Histoire des Ordres Monastiques was published anonymously at Paris, in 8 vols., the first appearing in 1714. In the Voyage Litteraire, etc. (which was written by Edm. Martdne and Urs. Durand), there occurs a copy of a Bull, in which the Latinised form of the Order is Congregatio Feuiilensis. I have looked through the book of Morotius (a copy of which is in the Bibliothèque Nationale), entitled 'Cistercii Reflorescentis, sen Cong. Cistercio-Monasticarum B. Mariae Fuliensis in Gallia et Reformatorum S. Bernardi in Italia,

Chronologica Historia,' Turin, 1690, and find that these monks are there styied 'Fulienses,' and never, so far as my observation extends, Folitani. [TF]

[751] On the reciprocal action of Mind and Body, see De Augmentis Scientiarum, IV. i (Ellis and Spedding, Vol. I. pp. 583-6). [TF]

Atque consensus corporum principalium erga subordinata sua [752] (tales enim ii possint censeri quos notavimus) satis in aperto sunt. Quibus addi possunt sensuum consensus erga objecta sua. Qui consensus, cum manifestissimi sint, bene notati, et acriter excussi, etiam aliis consensibus qui latent magnam praebere possint lucem.

[752] These words are somewhat obscure, but what is meant, I think, is the consent between the 'corpora principalia' and their 'fomites,' the latter being regarded as 'subordinate' to the use of the former. The sentence, therefore, is simply a reference back to the last paragraph. [TF]

At interiores corporum consensus et fugae, sive amicitiae et lites (taedet enim nos fere vocabulorum sympathiae et antipathiae, propter superstitiones et inania), aut falso ascriptae, aut fabulis conspersae, aut per neglectum [753] rarae admodum sunt. Etenim si quis asserat inter vineam et brassicam [754] esse dissidium, quia juxta sata minus laete proveniunt, praesto ratio est: quod utraque planta succulenta sit et depraedatrix, unde altera alteram defraudat. Si quis asserat esse consensum et amicitiam inter segetes et cyaneum [755], aut papaver sylvestre, quia herbae illae fere non proveniunt nisi in arvis cultis: debuit is potius asserere dissidium esse inter ea, quia papaver et cyaneus emittuntur et creantur ex tali succo terrae qualem segetes reliquerint et repudiaverint; adeo ut satio segetum terram praeparet ad eorum proventum. Atque hujusmodi falsarum ascriptionum magnus est numerus. Quoad fabulas vero, illae omnino sunt exterminandae. Restat tenuis certe copia eorum consensuum, qui certo probati sunt experimento; quales sunt magnetis et ferri, atque auri et argenti vivi, et similium. At in experimentis chymicis circa metalla inveniuntur et alii nonnulli observatione digni. Maxima vero frequentia eorum (ut in tanta paucitate) invenitur in medicinis nonnullis [756], quae, ex proprietatibus suis occultis (quas vocant) et specificis, respiciunt aut membra, aut humores, aut morbos, aut quandoque naturas individuas [757]. Neque omittendi sunt consensus inter motus et affectus lunae et passiones corporum inferiorum, prout ex experimentis agriculturae [758], nauticae [759], et medicinae [760], aut alias [761] cum delectu severo et sincero colligi et recipi possint. Verum instantiae universae consensuum secretiorum, quo magis sunt infrequentes, eo majori cum diligentia sunt inquirendae, per traditiones, et narrationes fidas et probas; modo hoc fiat absque ulla levitate, aut credulitate, sed fide anxia et quasi dubitabunda. Restat consensus corporum modo operandi tanquam inartificialis, sed usu polychrestus, qui nullo modo omittendus est, sed sedula observatione investigandus. Is est coitio sive unio corporum, proclivis aut difficilis, per compositionem, sive appositionem simplicem [762]. Etenim corpora nonnulla facile et libenter commiscentur et incorporantur, alia autem aegre et perverse: veluti pulveres melius incorporantur cum aquis; calces et cineres, cum oleis; et sic de similibus. Neque tantum sunt colligendae instantiae *propensionis* aut

aversionis corporum erga misturam, sed etiam collocationis partium, et distributionis, et digestionis, postquam commista sint; denique et praedominantiae post misturam transactam.

[753] That is, through negligence in observing them. Some of the later editions have a comma after 'neglectum,' which makes the passage unintelligible. [TF]

[754] The cabbage. For its medicinal properties, and its varieties, see Cato de Re Rustica, 156-7, He says: 'Si voles in convivio multum bibere, coenareque libenter, ante coenam esto crudam quantum voles ex aceto. Et item uhi coenaveris, comesto aliqua, Ubi folia reddent te quasi nihil ederis; biberisque bibesque quantum voies.^ CP. Columella, xii. 3.

Dr. Kitchin refers to Cicero, De Natura Deorum, II. 47: 'Age ut a caelestibus rebus ad terrestres veniamus; quid est in his, in quo non naturae ratio intelligentis appareat? *** Jam vero vites sic clavicuiis , adminiciila, tanquam manibus, apprehendunt, atque se ita erigunt, ut animantes. Quin etiam a caulibus brassicisque, si propter sati sint, ut a peslTeris, et nocentibus, refugere dicuntur, nec eos ulla ex parte contingere.' For the virtues of Brassica (κράμβη) as a remedy against the effects of intoxication, Dr. Kitchin refers to Athenaeus, Deipn, I. p. 34 C-F (end of Book i). Athenaeus gives a number of authorities, and, as a proof of the addiction of the Egyptians to wine, says that they invariably commence their chief meal (δεῖπνον) by eating boiled cabbage.

Pliny frequently speaks of 'brassica.' See, for instance, Naturalis Historia xx. 9 (33-8), sect. 78, etc., where he notices the opinion 'vino adversari ut inimicum vitibus, antecedente in cibis caveri ebrietatem, postea sumpta crapulam discuti.' Again, in XXIV. I. sect, i, he says: 'Pemicialia et brassicae cum vite odia; ipsum olus, quo vitis fugatur, adversum cyclamino et origano arescit.' In the pseudo-Aristotelian treatise, the Problems, we find the question put: Διὰ τί ἡ κράμβη παύει τὴν κραιπάλην; Prob. III. 17 (873 a. 37).

As to later writers, Mr. Ellis refers to Lemnius, De Occultis Naturae Miraculis, II. 17. I have no doubt that other authorities might, easily be found, but this note is already too long.

On similar 'discordiae atque concordiae,' as, for instance, the enmity between the olive and the oak, see Pliny, XXIV. I. Mr. Ellis refers to Lemnius, De Occultis, etc., IV. 10, to Cardan, De Rerum Varietate (see, for instance, Libro I. Cap. i), and to the Theatrum Sympatheticum. The last book, which is very curious, and, amongst other things, treats of Digby's Sympathetic Powder, was published at Nuremberg in 1660. [TF]

[755] Properly cyanus, κνανος, the corn-flower. See Pliny, Naturalis Historia xxi. 8 (24), sect. 48; II (39), sect. 68. [TF]

[756] Ancient medicine is so full of these absurd analogies, that it is almost superfluous to give any instances. See, for example, Paracelsus, passim, and especially the treatises De Origine Morborum and De Morbis Tartareis, as well as the works referred to at the end of the last note but one. The 'Doctrine of Signatures ' one of the most absurd forms

under which this conceit appeared. See Paracelsus, De Signatura Rerum (Op. Omii., Vol. II. pp. 106-16), and, for a good modern account of the theory, Dr. Paris' Pharmacol ogia, p. 47, etc. From the latter work, I have extracted several sentences on this subject in the last chapter of my Inductive Logic (see 4th Ed., pp. 348-50). Dr. Paris defines the doctrine as a 'belief that *every natural substance, which possesses any medicinal virtues, indicates, by an obvious and well-marked external character, the disease for which it is a remedy, or the object for which it should be employed*.' He instances mandrake as a cure for sterility, the lungs of a fox as a specific for asthma, poppies for diseases of the head, turmerick for jaundice, euphrasia (eye-bright) for complaints of the eye, blood-stone for bleeding at the nose, etc., etc. [TF]

[757] Of this kind was the sympathetic powder, invented at a later period by Sir Kenelm Digby. See last note on Aphorism 31, The particular weapon which had inflicted the wound was anointed for the purpose of curing the particular person suffering. To the same head belong incantations practised on an effigy of the person whom it was intended to affect, or on his clothes, or on his cut hair or nails, etc.

Of a similar character was the belief that particular cures could only be performed by particular people, as in the case of the King's Evil. [TF]

[758] See Hesiod, Opera et Dies, 765-828; Virgil, Georgies, I. 276-86; Pliny, Natural Hist, xviii. 32 (75), 28 (68), and other passages; Aulus Geliius, XX. 8. Some of the directions given by Pliny are of a very odd character. Thus, 'stercus nisi decrescente luna ne tangito * * * ova luna nova subponito. scrobis luna plena noctu facito. arborum radices luna plena operito,' etc.

Cp. Tyloris Primitive Culture, Vol. i, p. 130 (2nd Ed.). He quotes Tusser's Five Hundred Points of Husbandry:

> 'Sowe peason and beans in the wane of the moone,
> Who soweth them sooner, he soweth too soone:
> That they, with the planet, may rest and rise,
> And flourish with bearing, most plentiful wise,'

Cardan (De Rerum Varietate, Libro II. Cap. 13) has some curious remarks on the same subject. [TF]

[759] He here alludes to the supposed correspondence between the appearances of the moon and the weather. See Virgil, Georgies, I. 424-37, and the corresponding passage in Aratus, Διοσημεῖα, p. 46, etc.; Pliny, Nat, History n. 47 (48); xviii. 28 (68), 35 (79), and other passages. The last passage cited from Pliny contains an interesting extract from Varro. To the same head belongs the influence of the moon on the Tides, so far as that was recognised in the older systems of Physics. [TF]

[760] See, for instance, Pliny, Naturalis Historia II. 99 (102), sect. 221: ‘Quo vera conjectatio exsistit, baud frustra spirituus sidus Lunam existimari. Hoc esse quod terras saturet, accedensque corpora impleat, abscedens inaniat. Ideo cum incremento ejus augeri conchylia; et maxime spiritum sentire, quibus sanguis non sit. Sed et sanguinem hominum etiam cum lumine ejus augeri ac minui: frondes quoque ac pabula (ut suo loco dicetur) sentire, in omnia eadem penetrante vi.’ Hence, the idea that blood should be let or herbs gathered at certain phases of the moon, or that it was more dangerous to be wounded under certain signs or at certain phases of the moon than at others. Paracelsus combats the latter theories in his work De Phlebotomia (Op. Omn., Vol. I. p. 766, etc.): ‘ Morbus spectandus est, non coelum.’ But he adheres to the old opinion as to the season for gathering herbs. See the treatise De Philosophia (Op. Omn., Vol. II. pp. 502-3): ‘Ex Lunae facie, ipsum decrementum (sc. optimum esse), maxime quod tribus ultimis diebus finitur, mane nimirum, sub diei auspicium. Sicut enim homo diei decursu laborat, eoque labore confecto lassus ,et enervis noctuma quiete sese reficit, et instaurat vires: sic etiam fructus omnes et nascentia terrae, radices, herbae,’ «etc., with much more to the same purport.

On the beliefs that warts could be eradicated by exposing them to the rays of the moon, and that the wounded should not be exposed to these rays, 'ne livor succedat, et sanatio procrastinetur,' see the Theatrum Sympatheticum, pp. 210-2, and CP. Sir Thomas Browne’s Vulgar and Common Errors, Vol. III. pp. 182-3.

Lunacy, the intervals and paroxysms of which were supposed to vary with the phases of the moon, is another instance in point. The madness was supposed to culminate with the Full Moon, and to receive a reinforcement, as it were, with the New Moon. For a very curious account and explanation of these theories, see Paracelsus, De Morbis Amentntium, Op. Omn. I. 573. [TF]

[761] See, for instances, Pliny, Natural Hist, XXVIII. 7 (23); XIV. 21 (27); II. 9 (6), 101 (104). [TF]

[762] That is, by chemical mixture or mechanical composition. [TF]

(7) Superest ultimo loco ex modis septem operandi septimus et postremus: operatio scilicet per alternationem [763] et vicissitudines priorum sex; de quo antequam in singulos illos paulo altius fuerit inquisitum, tempestivum non foret exempla proponere. Series autem sive catena hujusmodi alternationis, prout ad singula effecta accommodari possit, res est et cognitu maxime difficilis, et ad opera maxime valida. Summa autem detinet et occupat homines impatientia hujusmodi tam inquisitionis, quam praxeos; cum tamen sit instar fili labyrinthi [764], quoad opera majora. Atque haec sufficiant ad exemplum Polychresti.

[763] That is, by bringing these six different methods to bear in judicious order on each subject, and so shifting that order as to gather different results — as, e.g. using Heat before or after pressure,’ etc. Dr. Kitchin’s note. [TF]

[764] This is the title of no less than three of Bacon's smaller works. They will be found in the second and third volumes of Ellis and Spedding's Edition. [TF]

LI.

Inter *praerogativas instantiarum*, ponemus loco vicesimo septimo atque ultimo *Instantias Magicas* [765]. Hoc nomine illas appellamus, in quibus materia aut efficiens tenuis aut parva est, pro magnitudine operis et effectus qui sequitur; adeo ut etiamsi fuerint vulgares, tamen sint instar miraculi; aliae primo intuitu, aliae etiam attentius contemplanti. Has vero natura ex sese subministrat parce; quid vero factura sit sinu excusso, et post inventionem formarum, et processuum, et schematismorum, futuris temporibus apparebit. At ista effecta magica (quantum adhuc conjicimus) fiunt tribus modis: aut per multiplicationem sui [766], ut in igne, et venenis, quae vocant specifica [767]; necnon in motibus, qui transeunt et fortificantur de rota in rotam [768]: aut per excitationem [769] sive invitationem in altero, ut in magnete, qui excit acus innumeras, virtute nullatenus deperdita aut diminuta; aut in fermento, et hujusmodi: aut per anteversionem motus [770], ut dictum est de pulvere pyrio, et bombardis, et cuniculis: quorum priores duo modi indagationem consensuum requirunt; tertius, mensurae motuum. Utrum vero sit aliquis modus mutandi corpora per minima [771] (ut vocant), et transponendi [772] subtiliores materiae schematismos (id quod ad omnimodas corporum transformationes pertinet, ut ars brevi tempore illud facere possit, quod natura per multas ambages molitur), de eo nulla hactenus nobis constant indicia. Quemadmodum autem in solidis et veris aspiramus ad ultima et summa; ita vana et tumida perpetuo odimus, et quantum in nobis est profligamus.

[765] These 'instances' occur, where great effects are produced by means apparently inadequate. Bacon hoped that, as we come to know more of ' Forms,' of the inner constitution of bodies, and of the latent processes by which changes in their constitution are brought about, these instances will become far more numerous, [TF]

[766] See Aphorism 48 (11). [TF]

[767] By a Specific Poison is properly meant a poison which is invariably attended by the same group of sequelae, in opposition to a poison, the effect of which is different under different circumstances and on different constitutions. Most specific poisons, such as small-pox, measles, the Morbus Gallicus, etc., possess the power of self-multiplication, but this is not an invariable property of such poisons. Thus, in lucifer-match manufactories, phosphorus produces necrosis of the lower jaw, and may, therefore, be regarded as a specific poison, but it does not act by way of self-multiplication.

In II. 48 (12), Bacon refers the action of 'some poisons' to the 'motus excitationis.' [TF]

[768] This is the principle of the Wheel and Axle. But, as Dr, Kitchin observes, the 'fortificatio motus' takes place at the expense of speed. [TF]

[769] See Aphorism 48 (12). [TF]

[770] See II. 36 (7), 48 (10). The motion of the nitre, from its abhorrence of flame, is supposed to 'anticipate' that of the sulphur. [TF]

[771] In their smallest portions, or particles. CP. the expression 'latio per minima' in I. 50. This is the second of the two modes of transformation, spoken of at the beginning of II. 5. [TF]

[772] We have already seen that the transformation of bodies was a cherished idea of Bacon. See especially my Introduction, § 6, and the Aphorisms at the beginning of this Book, with the notes. On the transmutation of the metals, there are some very curious and interesting remarks in the Historia Densi et Rari, Ellis and Spedding, Vol. II. pp. 250-1. There he gives it as his opinion that other bodies cannot be turned into Gold, on account of its superior density, but that we may hope to effect the conversion of lead or quicksilver into silver. Cp., on this subject, De Augmentis Scientiarum, Libro III. Cap. 5 (Ellis and Spedding, Vol. I. p. 574). In the Sylva Sylvarum, Exps. 326-8, he seems to be more hopeful, and actually proposes a recipe for the making of gold.

The last sentence of the Aphorism is an attack on the Alchemists, who hoped to obtain their ends by means of an Elixir or the Philosopher's Stone. [TF]

LII.

Atque de Dignitatibus sive *Praerogativis Instantiarum* haec dicta sint. Illud vero monendum [773], nos in hoc nostro Organo tractare logicam, non philosophiam. Sed cum logica nostra doceat intellectum et erudiat ad hoc, ut non tenuibus mentis quasi claviculis rerum abstracta captet et prenset (ut logica vulgaris), sed naturam revera persecet [774], et corporum virtutes et actus [775] eorumque leges in materia determinatas inveniat; ita ut non solum ex natura mentis, sed ex natura rerum [776] quoque haec scientia emanet: mirum non est, si ubique naturalibus contemplationibus et experimentis, ad exempla artis nostrae, conspersa fuerit et illustrata [777]. Sunt autem (ut ex iis quae dicta sunt patet) *Praerogativae Instantiarum* numero 27; nominibus: *Instantiae Solitariae: Instantiae Migrantes: Instantiae Ostensivae: Instantiae Clandestinae: Instantiae Constitutivae: Instantiae Conformes: Instantiae Monodicae: Instantiae Deviantes: Instantiae Limitaneae: Instantiae Potestatis: Instantiae Comitatus et Hostiles: Instantiae Subjunctivae: Instantiae Foederis: Instantiae Crucis: Instantiae Divortii: Instantiae Januae: Instantiae Citantes: Instantiae Viae: Instantiae Supplementi: Instantiae Persecantes: Instantiae Virgae: Instantiae Curriculi: Doses Naturae: Instantiae Luctae: Instantiae Innuentes: Instantiae Polychrestae: Instantiae Magicae*. Usus autem harum instantiarum, in quo instantias vulgares excellunt, versatur in genere aut circa partem informativam; aut circa operativam; aut circa utramque. Atque quoad informativam, juvant illae aut sensum, aut intellectum. Sensum, ut quinque *Instantiae Lampadis* [778]: intellectum, aut accelerando exclusivam formae, ut *Solitariae*; aut

angustiando et propius indicando affirmativam formae, ut *Migrantes*, *Ostensivae*, *Comitatus*, cum *Subjunctivis*; aut erigendo intellectum, et ducendo ad genera et naturas communes; idque aut immediate, ut *Clandestinae*, *Monodicae*, *Foederis*; aut gradu proximo, ut *Constitutivae*; aut gradu infimo, ut *Conformes*; aut rectificando intellectum a consuetis, ut Deviantes; aut ducendo ad Formam Magnam, sive Fabricam Universi [779], ut *Limitaneae*; aut cavendo de formis et causis falsis, ut *Crucis et Divortii*. Quod vero ad Operativam attinet; illae practicam aut designant, aut mensurant, aut sublevant. Designant aut ostendendo a quibus incipiendum, ne actum agamus, ut *Instantiae Potestatis*; aut ad quid aspirandum, si detur facultas, ut *Innuentes*: mensurant quatuor illae *Mathematicae* [780]: sublevant *Polychrestae* et *Magicae*.

[773] This is a good statement of the objects of the Baconian reform, which was intended, in the first instance, to bring about a change of method rather than a change of doctrine; but a change of doctrine. Bacon felt assured, would soon follow the change of method. [TF]

[774] CP. I. 51, and I. 13. [TF]

[775] That is, 'actus puros,' manifestations. See I. 51, with the note on this expression. [TF]

[776] As every true system of logic ought to do. Logic, like any other science, unless its generalisations are constantly brought to the bar of experience, and submitted to the test of facts, external as well as internal, must become abstract, barren, and worthless. CP. notes on I. 127. [TF]

[777] And yet we cannot but regret that Bacon has not also supplied us, in pursuance of what he says in I. 127, with examples from the mental, moral, and political sciences, in which his experience was so rich. [TF]

[778] See Aphorisms 38-43. [TF]

[779] That is, the κόσμος. CP. Aphorism 30: 'optime enim indicant corhpositionem et fabricam rerum.' [TF]

[780] Namely, the Instantiae Virgae, Instantiae Curriculi, Instantiae Quanti. and Instantiae Luctae. [TF]

Rursus ex istis *instantiis* 27, nonnullarum (ut superius diximus de aliquibus) facienda est collectio jam ab initio, nec expectanda particularis inquisitio naturarum. Cujus generis sunt *instantiae conformes*, *monodicae, deviantes, limitaneae, potestatis, januae, innuentes, polychrestae, magicae*. Hae enim aut auxiliantur et medentur intellectui et sensui, aut instruunt praxin in genere. Reliquae tum demum conquirendae sunt, cum conficiemus *tabulas comparentiae* ad opus interpretis circa aliquam naturam particularem. Sunt enim *instantiae praerogativis istis* insignitae et donatae animae

instar, inter vulgares instantias comparentiae; et ut ab initio diximus [781], paucae illarum sunt vice multarum; quocirca cum *tabulas* conficimus, illae omni studio sunt investigandae, et in *tabulas* referendae. Erit etiam earum mentio necessaria in iis quae sequuntur. Praeponendus itaque erat earum tractatus. Nunc vero ad *adminicula et rectificationes Inductionis*, et deinceps ad *concreta* [782], et *latentes processus*, et *latentes schematismos*, et reliqua quae Aphorismo 21. ordine proposuimus, pergendum; ut tandem (tanquam curatores probi et fideles) tradamus hominibus fortunas suas, emancipato intellectu, et facto tanquam majore: unde necesse est sequi emendationem status hominis, et ampliationem potestatis ejus super naturam [783]. Homo enim per lapsum [784] et de statu innocentiae decidit, et de regno in creaturas. Utraque autem res etiam in hac vita nonnulla ex parte reparari potest; prior per religionem et fidem, posterior per artes et scientias. Neque enim per maledictionem facta est creatura prorsus et ad extremum rebellis. Sed in virtute illius diplomatis, In *sudore vultus comedes panem tuum*, per labores varios (non per disputationes certe, aut per otiosas ceremonias magicas), tandem et aliqua ex parte ad panem homini praebendum, id est, ad usus vitae humanae subigitur.

[781] See Aphorism 22. [TF]

[782] As I have already observed in a note on Aphorism 21, 'ad concreta' seems to answer to the 'Variatio Inquisitionis pro Natura Subjecti' of that Aphorism, and, perhaps, 'Latentes Processus et Latentes Schematismi' to the 'Deductio ad Praxin.' [TF]

[783] These words are probably meant to correspond with the opening words the Preface to the Instauratio Magna: 'De statu scientiarum, quod non sit foelix aut majorem in modum auctus; quodque alia omnino quam prioribus cognita fuerit via aperienda sit intellectm humano et alia comparanda auxilia, ut mens suo jure in rerum naturam uti possit.' [TF]

[784] CP. De Augmentis Scientiarum, Libro I. (Ellis and Spedding, Vol. I. p. 465), Preface to Instauratio Magna (p. 168), and Valerius Terminus (Ellis and Spedding, Vol. III. pp. 217-8, 222). [TF]

Finis Libri Secundi Novi Organi.

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Francis Bacon's *Novum Organum* (1620) is often seen as a major milestone in the history of the philosophy of science. Figures of the Renaissance such as Leonardo da Vinci (1452–1519) and Nicolaus Copernicus (1473–1543) had already begun to break away from the intellectual frameworks that had dominated the Middle Ages, particularly those endorsed by the Catholic Church. However, it was Bacon who provided a systematic critique of the Aristotelian model of deductive reasoning that underpinned scholastic thought. In its place, he proposed a new method of inquiry grounded in observation, experimentation, and inductive reasoning.

Although Bacon's method is distinct from Plato's, I believe there is a meaningful philosophical parallel between his conception of inductive science and the first part of Plato's *Allegory of the Cave*. In that allegory, prisoners mistake shadows on the wall for reality, just as Bacon believed the human mind often mistakes illusions — the "idols" of tradition, language, and false authority — for knowledge. The task of the thinker is to escape this mental confinement and gradually approach "truth"[1].

This idea finds a modern expression in the work of R. A. Fisher and the foundations of modern frequentist statistics. In frequentist statistical science, it is acknowledged that "truth" — for example, the full nature of a biological population such as "sheep" or "iris" — exists in principle but cannot be observed directly, since it is impossible to examine every instance that has ever existed or will exist. Instead, repeated sampling and statistical inference are used to approximate that "truth". This is, in a sense, like observing the shadows of a chair again and again until its shape gradually becomes more intelligible — somewhat analogous to the prisoners in Plato's *Allegory of the Cave*. Bacon's inductive method and Fisher's statistical logic, though separated by centuries and differing in form, both embody a shared commitment: to move from the uncertain and fragmentary toward a clearer understanding of the world, not through abstract speculation, but through disciplined, empirical engagement.

[1] Here, the term *"truth"* is used in its general — and perhaps philosophical — sense, not to a metaphysically fixed or observable entity.