

Experiments and Considerations Touching Colours (1664) eBook

Experiments and Considerations Touching Colours (1664) by Robert Boyle

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CHAP. IV

1. Of greater Moment in the Investigation of the Nature of Colours is the Controversie, Whether those of the Rain-bow, and those that are often seen in Clouds, before the Rising, or after the Setting of the Sun; and in a word, Whether those other Colours, that are wont to be call'd Emphatical, ought or ought not to be accounted True Colours. I need not tell you that the Negative is the Common Opinion, especially in the Schools, as may appear by that Vulgar distinction of Colours, whereby these under Consideration are term'd Apparent, by way of Opposition to those that in the other Member of the Distinction are call'd True or Genuine. This question I say seems to me of Importance, upon this Account, that it being commonly Granted, (or however, easie enough to be Prov'd) that Emphatical Colours are Light it self Modify'd by Refractions chiefly, with a concurrence sometimes of Reflections, and perhaps some other Accidents depending on these two; if these Emphatical Colours be resolv'd to be Genuine, it will seem consequent, that Colours, or at least divers of them, are but Diversify'd Light, and not such Real and Inherent qualities as they are commonly thought to be.

2. Now since we are wont to esteem the Echoes and other Sounds of Bodies, to be True Sounds, all their Odours to be True Odours, and (to be short) since we judge other Sensible Qualities to be True ones, because they are the proper Objects of some or other of our Senses, I see not why Emphatical Colours, being the proper and peculiar Objects of the Organ of Sight, and capable to Affect it as Truly and as Powerfully as other Colours, should be reputed but Imaginary ones.

And if we have (which perchance you'l allow) formerly evinc'd Colour, (when the word is taken in its more Proper sense) to be but Modify'd Light, there will be small Reason to deny these to be true Colours, which more manifestly than others disclose themselves to be produc'd by Diversifications of the Light.

3. There is indeed taken notice of a Difference betwixt these Apparent colours, and those that are wont to be esteem'd Genuine, as to the Duration, which has induc'd some Learned Men to call the former rather Evanid than Fantastical. But as the Ingenious *Gassendus* does somewhere Judiciously observe, if this way of Arguing were Good, the Greenness of a Leaf ought to pass for Apparent, because, soon Fading into a Yellow, it Scarce lasts at all, in comparison of the Greenness of an Emerauld. I shall add, that if the Sun-beams be in a convenient manner trajected through a Glass-prism, and thrown upon some well-shaded Object within a Room, the Rain-bow thereby Painted on the Surface of the Body that Terminates the Beams, may oftentimes last longer than Some Colours I have produc'd in certain Bodies, which would justly, and without scruple be accounted Genuine Colours, and yet suddenly Degenerate, and lose their Nature.



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4. A greater Disparity betwixt Emphatical Colours, and others, may perhaps be taken from this, that Genuine Colours seem to be produc'd in Opacous Bodies by Reflection, but Apparent ones in Diaphanous Bodies, and principally by Refraction, I say Principally rather than Solely, because in some cases Reflection also may concurr, but still this seems not to conclude these Latter Colours not to be True ones. Nor must what has been newly said of the Differences of True and Apparent Colours, be interpreted in too Unlimited a Sense, and therefore it may perhaps somewhat Assist you, both to Reflect upon the two fore-going Objections, and to judge of some other Passages which you'll meet with in this Tract, if I take this Occasion to observe to you, that if Water be Agitated into Froth, it exhibits you know a White colour, which soon after it Loses upon the Resolution of the Bubbles into Air and Water, now in this case either the Whiteness of the Froth is a True Colour or not, if it be, then True Colours, supposing the Water pure and free from Mixtures of any thing Tenacious, may be as Short-liv'd as those of the Rain-bow; also the Matter, wherein the Whiteness did Reside, may in a few moments perfectly Lose all foot-steps or remains of it. And besides, even Diaphanous Bodies may be capable of exhibiting True Colours by Reflection, for that Whiteness is so produc'd, we shall anon make it probable. But if on the other side it be said, that the Whiteness of Froth is an Emphatical Colour, then it must no longer be said, that Fantastical Colours require a certain Position of the Luminary and the Eye, and must be Vary'd or Destroy'd by the Change thereof, since Froth appears White, whether the Sun be Rising or Setting, or in the Meridian, or any where between it and the Horizon, and from what (Neighbouring) place soever the Beholders Eye looks upon it. And since by making a Liquor Tenacious enough, yet without Destroying its Transparency, or Staining it with any Colour, you may give the Little Films, whereof the Bubbles consist, such a Texture, as may make the Froth last very many Hours, if not some Days, or even Weeks, it will render it somewhat Improper to assign Duration for the Distinguishing Character to Discriminate Genuine from Fantastical Colours. For such Froth may much outlast the Undoubtedly true Colours of some of Nature's Productions, as in that Gaudy Plant not undeservedly call'd the Mervail of *Peru*, the Flowers do often Fade, the same Day they are Blown; And I have often seen a *Virginian* Flower, which usually Withers within the compass of a Day; and I am credibly Inform'd, that not far from hence a curious Herborist has a Plant, whose Flowers perish in about an Hour. But if the Whiteness of Water turn'd into Froth must therefore be reputed Emphatical, because it appears not that the Nature of the Body is Alter'd, but only that the Disposition of its Parts in reference to the Incident Light is Chang'd, why may not the Whiteness be accounted Emphatical too, which I



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shall shew anon to be Producible, barely by such another change in Black Horn? and yet this so easily acquir'd Whiteness seems to be as truly its Colour as the Blackness was before, and at least is more Permanent than the Greenness of Leaves, the Redness of Roses, and, in short, than the Genuine Colours of the most part of Nature's Productions. It may indeed be further Objected, that according as the Sun or other Luminous Body changes place, these Emphatical Colours alter or vanish. But not to repeat what I have just now said, I shall add, that if a piece of Cloath in a Drapers Shop (in such the Light being seldome Primary) be variously Folded, it will appear of differing Colours, as the Parts happen to be more Illuminated or more Shaded, and if you stretch it Flat, it will commonly exhibit some one Uniform Colour, and yet these are not wont to be reputed Emphatical, so that the Difference seems to be chiefly this, that in the Case of the Rain-bow, and the like, the Position of the Luminary Varies the Colour, and in the Cloath I have been mentioning, the Position of the Object does it. Nor am I forward to allow that in all Cases the Apparition of Emphatical Colours requires a Determinate position of the Eye, for if Men will have the Whiteness of Froth Emphatical, you know what we have already Inferr'd from thence. Besides, the Sun-beams trajected through a Triangular Glass, after the manner lately mention'd, will, upon the Body that Terminates them, Paint a Rain-bow, that may be seen whether the Eye be plac'd on the Right Hand of it or the Left, or Above or Beneath it, or Before or Behind it; and though there may appear some Little Variation in the Colours of the Rain-bow, beheld from Differing parts of the Room, yet such a Diversity may be also observ'd by an Attentive Eye in Real Colours, look'd upon under the like Circumstances, Nor will it follow, that because there remains no Footsteps of the Colour upon the Object, when the Prism is Remov'd, that therefore the Colour was not Real, since the Light was truly Modify'd by the Refraction and Reflection it Suffer'd in its Trajection through the Prism; and the Object in our case serv'd for a Specular Body, to Reflect that Colour to the Eye. And that you may not be Startled, *Pyrophilus*, that I should Venture to say, that a Rough and Coiour'd Object may serve for a *Speculum* to Reflect the Artificial Rain-bow I have been mentioning, consider what usually happens in Darkned Rooms, where a Wall, or other Body conveniently Situated within, may so Reflect the Colours of Bodies, without the Room, that they may very clearly be Discern'd and Distinguish'd, and yet 'tis taken for granted, that the Colours seen in a Darkned Room, though they leave no Traces of themselves upon the Wall or Body that Receives them, are the True Colours of the External Objects, together with which the Colours of the Images are Mov'd or do Rest. And the Errour is not in the Eye, whose Office is only to perceive the Appearances of



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things, and which does Truly so, but in the Judging or Estimative faculty, which Mistakingly concludes that Colour to belong to the Wall, which does indeed belong to the Object, because the Wall is that from whence the Beams of Light that carry the Visible *Species*, do come in Straight Lines directly to the Eye, as for the same Reason we are wont at a certain Distance from Concave Sphaerical Glasses, to perswade our Selves that we see the Image come forth to Meet us, and Hang in the Air betwixt the Glass and Us, because the Reflected Beams that Compose the image cross in that place, where the Image seems to be, and thence, and not from the Glass, do in Direct Lines take their Course to the Eye, and upon the like Cause it is, that divers Deceptions in Sounds and other Sensible Objects do depend, as we elsewhere declare.

5. I know not, whether I need add, that I have purposely Try'd, (as you'll find some Pages hence, and will perhaps think somewhat strange) that Colours that are call'd Emphatical, because not Inherent in, the Bodies in which they Appear, may be Compounded with one another, as those that are confessedly Genuine may. But when all this is said, *Pyrophilus*, I must Advertise you, that it is but Problematically Spoken, and that though I think the Opinion I have endeavour'd to fortifie Probable, yet a great part of our Discourse concerning Colours may be True, whether that Opinion be so or not.

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CHAP. V.

1. There are you know, *Pyrophilus*, besides those Obsolete Opinions about Colours which have been long since Rejected, very Various Theories that have each of them, even at this day, Eminent Men for its Abettors; for the Peripatetick Schools, though they dispute amongst themselves divers particulars concerning Colours, yet in this they seem Unanimously enough to Agree, that Colours are Inherent and Real Qualities, which the Light doth but Disclose, and not concurr to Produce. Besides there are *Moderns*, who with a slight Variation adopt the Opinion of *Plato*, and as he would have Colour to be nothing but a Kind of Flame consisting of Minute Corpuscles as it were Darted by the Object against the Eye, to whose Pores their Littleness and Figure made them congruous, so these would have Colour to be an Internal Light of the more Lucid parts of the Object, Darkned and consequently Alter'd by the Various Mixtures of the less Luminous parts. There are also others, who in imitation of some of the Ancient *Atomists*, make Colour not to be Lucid steam, but yet a Corporeal *Effluvium* issuing out of the Colour'd Body, but the Knowingst of these have of late Reform'd their Hypothesis, by acknowledging and adding that some External Light is necessary to Excite, and as *they* speak, Sollicit these Corpuscles of Colour as *they* call them, and Bring them to the Eye. Another and more principal Opinion of the *Modern* Philosophers,



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to which this last nam'd may by a Favourable explication be reconcil'd, is that which derives Colours from the Mixture of Light and Darkness, or rather Light and Shadows. And as for the *Chymists* 'tis known, that the generality of them ascribes the Origine of Colours to the Sulphureous Principle in Bodies, though I find, as I elsewhere largely shew, that some of the Chiefest of them derive Colours rather from Salt than Sulphur, and others, from the third Hypostatical Principle, *Mercury*. And as for the *Cartesians* I need not tell you, that they, supposing the Sensation of Light to bee produc'd by the Impulse made upon the Organs of Sight, by certain extremely Minute and Solid Globules, to which the Pores of the Air and other Diaphanous bodies are pervious, endeavour to derive the Varieties of Colours from the Various Proportion of the Direct Progress or Motion of these Globules to their Circumvolution or Motion about their own Centre, by which Varying Proportion they are by this Hypothesis suppos'd qualify'd to strike the Optick Nerve after several Distinct manners, so to produce the perception of Differing Colours.

2. Besides these six principal Hypotheses, *Pyrophilus*, there may be some others, which though Less known, may perhaps as well as these deserve to be taken into consideration by you; but that I should copiously debate any of them at present, I presume you will not expect, if you consider the Scope of these Papers, and the Brevity I have design'd in them, and therefore I shall at this time only take notice to you in the general of two or three things that do more peculiarly concern the Treatise you have now in your hands.

3. And first, though the Embracers of the Several Hypotheses I have been naming to you, by undertaking each Sect of them to explicate Colours indefinitely, by the particular Hypotheses they maintain, seem to hold it forth as the only Needful Theory about that Subject, yet for my part I doubt whether any one of all these Hypotheses have a right to be admitted Exclusively to all others, for I think it Probable, that Whiteness and Blackness may be explicated by Reflection alone without Refraction, as you'll find endeavour'd in the Discourse you'll meet with e're long Of the Origine of Whiteness and Blackness, and on the other side, since I have not found that by any Mixture of White and True Black, (for there is a Blewish Black which many mistake for a Genuine) there can be a Blew, a Yellow, or a Red, to name no other Colours, produced, and since we do find that these Colours may be produc'd in the Glass-prism and other Transparent bodies, by the help of Refractions, it seems that Refraction is to be taken in into the Explication of some Colours, to whose Generation they seem to concurr, either by making a further or other Commixture of Shades with the Refracted Light, or by some other way not now to be discours'd. And as it seems not improbable, that in case the Pores of the Air, and



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other Diaphanous bodies be every where almost fill'd with such *Globuli* as the *Cartesians* suppose, the Various kind of Motion of these *Globuli*, may in many cases have no small stroak in Varying our Perception of Colour, so without the Supposition of these *Globuli*, which 'tis not so easie to evince, I think we may probably enough conceive in general, that the Eye may be Variously affected, not only by the Entire Beams of Light that fall upon it as they are such, but by the Order, and by the Degree of Swiftnes, and in a word by the Manner according to which the Particles that compose each Particular Beam arrive at the Sensory, so that whatever be the Figure of the Little Corpuscles, of which the Beams of Light consist, not only the Celerity or Slowness of their Revolution or Rotation in reference to their Progressive Motion, but their more Absolute Celerity, their Direct or Undulating Motion, and other Accidents, which may attend their Appulse to the Eye, may fit them to make Differing Impressions on it.

4. Secondly, For these and the like Considerations, *Pyrophilus*, I must desire that you would look upon this little Treatise, not as a Discourse written Principally to maintain any of the fore-mention'd Theories, Exclusively to all others, or substitute a New one of my Own, but as the beginning of a History of Colours, upon which, when you and your Ingenious friends shall have Enrich'd it, a Solid Theory may be safely built. But yet because this History is not meant barely for a Register of the things recorded in it, but for an *Apparatus* to a sound and comprehensivite Hypothesis, I thought fit, so to temper the whole Discourse, as to make it as conducible, as conveniently I can to that End, and therefore I have not scrupled to let you see that I was willing, as to save you the labour of Cultivating some Theories that I thought would never enable you to reach the Ends you aim at, so to contract your Enquiries into a Narrow compass, for both which purposes I thought it requisite to do these two things, the *One*, to set down some Experiments which by the help of the Reflections and Insinuations that attend them, may assist you to discover the Infirminess and Insufficiency both of the common Peripatetick Doctrine, and of the now more applauded Theory of the *Chymists* about Colour, because those two Doctrines having Possess'd themselves, the one of the most part of the Schools, and the other of the Esteem of the Generality of Physicians and other Learned Men, whose Professions and Ways of Study do not exact that they should Scrupulously examine the very First and Simplest Principles of Nature, I fear'd it would be to little purpose, without doing something to discover the Insufficiency of these Hypotheses, that I should, (which was the *Other* thing I thought requisite for me to do) set down among my other Experiments those in the greatest Number, that may let you see, that, till I shall be Better Inform'd, I encline to take Colour to be a Modification of Light, and would invite you chiefly to Cultivate that Hypothesis, and Improve it to the making out of the Generation of Particular Colours, as I have Endeavour'd to apply it to the Explication of Whiteness and Blackness.



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5. Thirdly. But, *Pyrophilus*, though this be at present the Hypothesis I prefer, yet I propose it but in a General Sense, teaching only that the Beams of Light, Modify'd by the Bodies whence they are sent (Reflected or Refracted) to the Eye, produce there that Kind of Sensation, Men commonly call Colour; But whether I think this Modification of the Light to be perform'd by Mixing it with Shades, or by Varying the Proportion of the Progress and Rotation of the *Cartesian Globuli Caelestes*, or by some other way which I am not now to mention, I pretend not here to Declare. Much less do I pretend to Determine, or scarce so much as to Hope to know all that were requisite to be Known, to give You, or even my Self, a perfect account of the Theory of Vision and Colours, for in Order to such an undertaking I would first Know what Light is, and if it be a Body (as a Body or the Motion of a Body it seems to be) what Kind of Corpuscles for Size and Shape it consists of, with what Swiftmess they move Forwards, and Whirl about their own Centres. Then I would Know the Nature of Refraction, which I take to be one of the Abstrusest things (not to explicate Plausibly, but to explicate Satisfactorily) that I have met with in Physicks; I would further Know what Kind and what Degree of Commixture of Darkness or Shades is made by Refractions or Reflections, or both, in the Superficial particles of those Bodies, that being Shin'd upon, constantly exhibit the one, for Instance, a Blew, the other a Yellow, the third a Red Colour; I would further Know why this Contemperation of Light and Shade, that is made, for Example, by the Skin of a Ripe Cherry, should exhibit a Red, and not a Green, and the Leaf of the same Tree should exhibit a Green rather than a Red; and indeed, Lastly, why since the Light that is Modify'd into these Colours consists but of Corpuscles moved against the *Retina* or Pith of the Optick Nerve, it should there not barely give a Stroak, but produce a Colour, whereas a Needle wounding likewise the Eye, would not produce Colour but Pain. These, and perhaps other things I should think requisite to be Known, before I should judge my Self to have fully Comprehended the True and Whole Nature of Colours; and therefore, though by making the Experiments and Reflections deliver'd in this Paper, I have endeavour'd somewhat to Lessen my Ignorance in this Matter, and think it far more Desireable to discover a Little, than to discover Nothing, yet I pretend but to make it Probable by the Experiments I mention, that some Colours may be Plausibly enough Explicated in the General by the Doctrine here propos'd; For whensoever I would Descend to the Minute and Accurate Explication of Particulars, I find my Self very Sensible of the great Obscurity of things, without excepting those which we never see but when they are Enlightned, and confess with *Scaliger*[5], *Latet natura haec*, (says he, Speaking of that of Colour) *& sicut aliarum rerum species in profundissima caligine inscitiae humanae.*



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[5] Exercitat. 325 Parag. 4

* * * * *

THE
EXPERIMENTAL HISTORY
OF COLOURS.

* * * * *

PART. II.

*Of the Nature of Whiteness and
Blackness.*

CHAP. I.

1. Though after what I have acknowledged, *Pyrophilus*, of the Abstruse Nature of Colours in *particular*, you will easily believe, that I pretend not to give you a Satisfactory account of Whiteness and Blackness; Yet not wholly to frustrate your Expectation of my offering something by way of Specimen towards the Explication of some Colours in particular, I shall make choice of These as the most Simple Ones, (and by reason of their mutual Opposition the Least hardly explicable) about which to present you my Thoughts, upon condition you will take them at most to be my Conjectures, not my Opinions.

2. When I apply'd my Self to consider, how the cause of Whiteness might be explain'd by Intelligible and Mechanical Principles, I remembred not to have met with any thing among the Antient *Corpuscularian* Philosophers, touching the Quality we call Whiteness, save that *Democritus* is by *Aristotle* said to have ascrib'd the Whiteness of Bodies to their Smoothness, and on the contrary their Blackness to their Asperity.[6] But though about the Latter of those Qualities his Opinion be allowable, as we shall see anon, yet that he heeds a Favourable Interpretation in what is Deliver'd concerning the First, (at least if his Doctrine be not Mis-represented in this point, as it has been in many others) we shall quickly have Occasion to manifest. But amongst the *Moderns*, the most Learned *Gassendus* in his Ingenious Epistle publish'd in the Year 1642. *De apparente Magnitudine solis humilis & sublimis*, reviving the *Atomical* Philosophy, has, though but Incidentally, deliver'd something towards the Explication of Whiteness upon Mechanical Principles: And because no Man that I know of, has done so before him, I shall, to be sure to do him Right, give you his Sense in his own Words:[7] *Cogites velim* (says he) *lucem quidem in Diaphano nullius coloris videri, sed in Opaco tamen terminante Candicare, ac tanto magis, quanto densior seu collectior fuerit. Deinde aquam non esse quidem coloris ex se candidi & radium tamen ex ea reflexum versus oculum candicare. Rursus cum plana aquae Superficies non nisi ex una parte eam*



reflexionem faciat: si contigerit tamen illam in aliquot bullas intumescere, bullam unamquamque reflectionem facere, & candoris speciem creare certa Superficie parte. Ad haec Spumam ex aqua pura non alia ratione videri candescere & albescerere quam quod sit congeries confertissima minutissimarum bullarum, quarum unaquaeque suum radium reflectit, unde continens candor alborve apparet. Denique Nivem nihil aliud videri quam speciem purissimae spumae ex bullulis quam minutissimis & confertissimis cohaerentis. Sed ridiculam me exhibeam, si tales meas nugae uberius proponem.



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[6] *Album quippe & agrum, hoc quidem asperum esse dicit, hoc vero laeve. de Sensu & Sensib. 3. 3.*

[7] Epist. 2. pag. 45.

3. But though in this passage, that very Ingenious Person has Anticipated part of what I should say; Yet I presume you will for all that expect, that I should give you a fuller Account of that Notion of Whiteness, which I have the least Exceptions to, and of the Particulars whence I deduce it, which to do, I must mention to you the following Experiments and Observations.

Whiteness then consider'd as a Quality in the Object, seems chiefly to depend upon this, That the Superficies of the Body that is call'd White, is Asperated by almost innumerable Small Surfaces, which being of an almost Specular Nature, are also so Plac'd, that some Looking this way, and some that way, they yet Reflect the Rays of Light that fall on them, not towards one another, but outwards towards the Spectators Eye. In this Rude and General account of Whiteness, it seems that besides those Qualities, which are common to Bodies of other Colours, as for instance the Minuteness and Number of the Superficial parts, the two chief things attributed to Bodies as White are made to be, First, that its Little Protuberances and Superficial parts be of somewhat a Specular Nature, that they may as little Looking-glasses each of them Reflect the Beams it receives, (or the little Picture of the Sun made on it) without otherwise considerably Altering them; whereas in most other Colours, they are wont to be much Chang'd, by being also Refracted, or by being Return'd to the Eye, mixt with Shades or otherwise. And next, that its Superficial parts be so Situated, that they Retain not the Incident Rays of Light by Reflecting them Inwards, but Send them almost all Back, so that the Outermost Corpuscles of a White Body, having their Various Little Surfaces of a Specular Nature, a Man can from no place Behold the Body, but that there will be among those Innumerable *Superficieculae*, that Look some one way, and some another, enough of them Obverted to his Eye, to afford like a broken Looking-glass, a confused Ideaa, or Representation of Light, and make such an Impression on the Organ, as that for which Men are wont to call a Body White. But this Notion will perhaps be best Explan'd by the same Experiments and Observations, on which it is Built, And therefore I shall now advance to *Them*.

4. And in the first place I consider, that the Sun and other Powerfully Lucid Bodies, are not only wont to Offend, which we call to Dazle our Eyes, but that if any Colour be to be Ascrib'd to them as they are Lucid, it seems it should be Whiteness: For the Sun at Noon-day, and in Clear weather, and when his Face is less Troubled, and as it were Stained by the Steams of Sublunary Bodies, and when his Beams have much less of the Atmosphere to Traject in their Passage to our Eyes, appears of a Colour more approaching



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to White, than when nearer the Horizon, the Interposition of certain Sorts of Fumes and Vapours make him oftentimes appear either Red, or at least more Yellow. And when the Sun Shines upon that Natural Looking-glass, a Smooth water, that part of it, which appears to this or that particular Beholder, the most Shin'd on, does to his Eye seem far Whiter than the rest. And here I shall add, that I have sometimes had the Opportunity to observe a thing, that may make to my present purpose, namely, that when the Sun was Veil'd over as it were, with a Thin White Cloud, and yet was too Bright to be Look'd upon Directly without Dazling, by casting my Eyes upon a Smooth water, as we sometimes do to observe Eclipses without prejudice to our Eyes, the Sun then not far from the Meridian, appear'd to me not Red, but so White, that 'twas not without some Wonder, that I made the Observation. Besides, though we in *English* are wont to say, a thing is Red hot, as an Expression of its being Superlatively *Ignitum*, (if I may so Speak for want of a proper *English* word) yet in the Forges of Smiths, and the Furnaces of other Artificers, by that which they call a White heat, they mean a further Degree of *Ignition*, than by that which both they and we call a Red heat.

5. Secondly, I consider, that common Experience informs us, that as much Light Overpowers the Eye, so when the Ground is covered with Snow, (a Body extremely White) those that have Weak Eyes are wont to complain of too much Light: And even those that have not, are generally Sensible of an Extraordinary measure of Light in the Air; and if they are fain to Look very long upon the Snow, find their Sight Offended by it. On which occasion we may call to mind what *Xenophon* relates, that his *Cyrus* marching his Army for divers days through Mountains covered with Snow, the Dazling splendor of its Whiteness prejudic'd the Sight of very many of his Souldiers, and Blinded some of them; and other Stories of that Nature be met with in Writers of good Note. And the like has been affirm'd to me by credible Persons of my own Acquaintance, and especially by one who though Skill'd in Physick and not Ancient confess'd to me when I purposely ask'd him, that not only during his stay in *Muscovy*, he found his Eyes much Impair'd, by being reduc'd frequently to Travel in the Snow, but that the Weakness of his Eyes did not Leave him when he left that Country, but has follow'd him into these Parts, and yet continues to Trouble him. And to this doth agree what I as well as others have observ'd, namely, that when I Travell'd by Night, when the Ground was all cover'd with Snow, though the Night otherwise would not have been Lightsome, yet I could very well see to Choose my way. But much more Remarkable to my present purpose is that, which I have met with in *Olaus Magnus*,^[8] concerning the way of Travelling in Winter in the *Northern* Regions, where the Days of that Season are so very



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Short; for after other things not needfull to be here Transcribed: *Iter*, says he, *Diurnum duo scilicet montana milliaria (quae 12 Italica sunt) consiciunt. Nocte vero sub splendissima luna, duplatum iter consumunt aut triplatum. Neque id incommode fit, cum nivium reverberatione lunaris splendoris sublimes & declives campos illustret, ac etiam montium praecipitia ac noxias feras a longe prospiciant evitandas.* Which Testimony I the less Scruple to allege, because that it agrees very well with what has been Affirm'd to me by a Physician of *Mosco*, whom the Notion I have been Treating of concerning Whiteness invited me to ask whether he could not See much farther when he Travell'd by Night in *Russia* than he could do in *England*, or elsewhere, when there was no Snow upon the Ground; For this Ingenious Person inform'd me, that he could See Things at a farr greater Distance, and with more Clearness, when he Travell'd by Night on the *Russian* Snow, though without the Assistance of Moon-shine, than we in these Parts would easily be perswaded. Though it seems not unlikely to me, that the Intenseness of the Cold may contribute something to the considerableness of the Effect, by much Clearing the Air of Darkish Steams, which in these more Temperate Climates are wont to Thicken it in Snowy weather: For having purposely inquir'd of this Doctor, and consulted that Ingenious Navigator Captain *James's* Voyage hereafter to be further mention'd, I find both their Relations agree in this, that in Dark Frosty Nights they could Discover more Stars, and See the rest Clearer than we in *England* are wont to do.

[8] Gent. Septen. Histor. lib. 4 cap. 13.

6. I know indeed that divers Learned Men think, that Snow so strongly Affects our Eye, not by a Borrow'd, but a Native Light; But I venture to give it as a Proof, that White Bodies reflect more Light than Others, because having once purposely plac'd a parcel of Snow in a Room carefully Darkned, that no Celestial Light might come to fall upon it; neither I, nor an ingenious Person, (Skill'd in Opticks) whom I desir'd for a Witness, could find, that it had any other Light than what it receiv'd. And however, 'tis usual among those that Travel in Dark Nights, that the Guides wear something of White to be Discern'd by, there being scarce any Night so Dark, but that in the Free Air there remains some Light, though Broken and Debilitated perhaps by a thousand Reflections from the Opacous Corpuscles that Swim in the Air, and lend it to one another before it comes to arrive at the Eye.



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7. Thirdly, And the better to shew that White Bodies reflect store of Light, in comparison of those that are otherwise Colour'd, I did in the Darkn'd Room, formerly mention'd, hold not far from the Hole, at which the Light was admitted, a Sheet only of White Paper, from whence casting the Sun-beams upon a White Wall, whereunto it was Obverted, it manifestly appear'd both to Me, and to the Person I took for a Witness of the Experiment, that it Reflected a far greater Light, than any of the other Colours formerly mention'd, the Light so thrown upon one Wall notably Enlightning it, and by it a good part of the Room. And yet further to show you, that White Bodies Reflect the Beams From them, and not Towards themselves, Let me add, that Ordinary Burning-glasses, such as are wont to be employ'd to light Tobacco, will not in a great while Burn, or so much as Discolour a Sheet of White Paper. Insomuch that even when I was a Boy, and Lov'd to make Tryals with Burning-glasses, I could not but wonder at this Odd *Phaenomenon*, which set me very Early upon Guessing at the Nature of Whiteness, especially because I took notice, that the Image of the Sun upon a White Paper was not so well Defin'd (the Light seeming too Diffus'd) as upon Black, and because I try'd, that Blacking over the Paper with Ink, not only the Ink would be quickly Dry'd up, but the Paper that I could not Burn before, would be quickly set on Fire. I have also try'd, that by exposing my Hand with a Thin Black Glove over it to the Warm Sun, it was thereby very quickly and considerably more Heated, than if I took off the Glove, and held my Hand Naked, or put on it another Glove of Thin but White Leather. And having thus shewn you, *Pyrophilus*, that White Bodies reflect the most Light of any, let us now proceed, to consider what is further to be taken notice of in them, in order to our present Enquiry.

8. And Fourthly, whereas among the Dispositions we attributed to White Bodies, we also intimated this, That such Bodies are apt, like *Speculums*, though but Imperfect ones, to Reflect the Light that falls on them Untroubled or Unstain'd, we shall besides other particulars to be met with in these Papers, offer you this in favour of the Conjecture; That in the Darkned Room several times mention'd in this Treatse, we try'd that the Sun-beams being cast from a Coloured Body upon a neighbouring White Wall, the Determinate Colour of the Body was from the Wall reflected to the Eye; whereas we could in divers cases manifestly Alter the Colour arriving at the Eye, by Substituting at a convenient Distance, a (conveniently) Colour'd (and Glossy) Body instead of the White Wall. As by throwing the Beams from a Yellow Body upon a Blew, there would be Exhibited a kind of Green, as in the Experiments about Colours is more fully Declar'd.



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9. I know not whether I should on this Occasion take notice, that when, as when looking upon the Calm and Smooth Surface of a River betwixt my Eye and the Sun, it appear'd to be a natural *Speculum*, wherein that Part which Reflected to my Eye the Entire and defin'd Image of the Sun, and the Beams less remote from those which exhibited That Image, appear'd indeed of a great and Whitish Brightness, but the rest Comparatively Dark enough: if afterwards the Superficies chanc'd to be a little, but not much troubled, by a gentle Breath of Wind, and thereby reduc'd into a Multitude of Small and Smooth *Speculums*, the Surface of the River would suitably to the Doctrine lately deliver'd, at a Distance appear very much of Kin to White, though it would lose that Brightness or Whiteness upon the Return of the Surface to Calmness and an Uniform Level. And I have sometimes for Tryals sake brought in by a Lenticular Glass, the Image of a River, Shin'd upon by the Sun, into an Upper Room Darkn'd, and Distant about a Quarter of a Mile from the River, by which means the Numerous Declining Surfaces of the Water appear'd so Contracted, that upon the Body that receiv'd the Images, the whole River appear'd a very White Object at two or three paces distance. But if we drew Near it, this Whiteness appear'd to proceed from an Innumerable company of Lucid Reflections, from the several Gently wav'd Superficies of the Water, which look'd Near at hand like a Multitude of very Little, but Shining Scales of Fish, of which many did every moment Disappear, and as many were by the Sun, Wind and River generated anew. But though this Observation seem'd Sufficiently to discover, how the Appearing Whiteness in that case was Produc'd, yet in some other cases Water may have the Same, though not so Vivid a Colour upon other Accounts; for oftentimes it happens that the Smooth Surface of the Water does appear Bright or Whitish, by reason of the Reflection not immediatly of the Images of the Sun, but of the Brightness of the Sky; and in such cases a Convenient Wind may where it passes along make the Surface look Black, by causing many such Furrows and Cavities, as may make the Inflected Superficies of the Water reflect the Brightness of the Sky rather Inward than Outward. And again if the Wind increase into a Storm, the Water may appear White, especially near the Shore and the Ship, namely because the Rude Agitation Breaks it into Fome or Froth. So much do Whiteness and Blackness depend upon the Disposition of the Superficial parts of a Body to Reflect the Beams of Light Inward or Outward. But that as White Bodies reflect the most Light of any, so there Superficial Particles are, in the Sense newly Deliver'd, of a Specular Nature, I shall now further endeavour to shew both by the making of Specular bodies White, and the making of a White body Specular.



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10. In the Fifth place then, I will inform You, that (not to repeat what *Gassendus* observes concerning Water) I have for Curiosity sake Distill'd Quicksilver in a Cucurbit, fitted with a Capacious Glass-head, and observ'd that when the Operation was perform'd by the Degrees of Fire requisite for my purpose, there would stick to the Inside of the Alembick a multitude of Little round drops of *Mercury*. And as you know that *Mercury* is a Specular Body, so each of these Little drops was a small round Looking-glass, and a Multitude of them lying Thick and Near one another, they did both in my Judgment, and that of those I Invited to see it, make the Glass they were fastened to, appear manifestly a White Body. And yet as I said, this Whiteness depended upon the Minuteness and Nearness of the Little Mercurial *Globuli*, the Convexity of whose Surfaces fitted them to represent in a Narrow compass a Multitude of Little Lucid Images to differingly situated Beholders. And here let me observe a thing that seems much to countenance the Notion I have been recommending: namely, that whereas divers parts of the Sky, and especially the Milky-way, do to the naked Eye appear White, (as the name it self imports) yet the Galaxie look'd upon through the Telescope, does not shew White, but appears to be made up of a Vast multitude of Little Starrs; so that a Multitude of Lucid Bodies, if they be so Small that they cannot Singly or apart be discern'd by the Eye, and if they be sufficiently Thick set by one another, may by their confus'd beams appear to the Eye One White Body. And why it is not possible, that the like may be done, when a Multitude of Bright and Little Corpuscles being crowded together, are made to send together Vivid beams to the Eye, though they Shine but as the Planets by a Borrow'd Light?

11. But to return to our Experiments. We may take notice, That the White of an Egg, though in part Transparent, yet by its power of Reflecting some Incident Rays of Light, is in some measure a Natural *Speculum*, being long agitated with a Whisk or Spoon, loses its Transparency, and becomes very White, by being turn'd into Froth, that is into an Aggregate of Numerous small Bubbles, whose Convex Superficies fits them to Reflect the Light every way Outwards. And 'tis worth Noting, that when Water, for instance, is Agitated into Froth, if the Bubbles be Great and Few, the Whiteness will be but Faint, because the number of *Specula* within a Narrow compass is but Small, and they are not Thick set enough to Reflect so Many Little Images or Beams of the Lucid Body, as are requisite to produce a Vigorous sensation of Whiteness: And partly least it should be said, that the Whiteness of such Globulous Particles proceeds from the Air Included in the Froth; (which to make good, it should be prov'd that the Air it self is White) and partly to illustrate the better the Notion we have propos'd of Whiteness, I shall add, that I purposely made this Experiment,



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I took a quantity Fair water, & put to it in a clear Glass phial, a convenient quantity of Oyl or Spirit of Turpentine, because that Liquor will not incorporate with Water, and yet is almost as Clear and Colourless as it; these being Gently Shaken together, the Agitation breaks the Oyl (which as I said, is Indispos'd to Mix like Wine or Milk *per minima* with the Water) into a Multitude of Little Globes, which each of them Reflecting Outwards a Lucid Image, make the Imperfect Mixture of the two Liquors appear Whitish; but if by Vehemently Shaking the Glass for a competent time you make a further Comminution of the Oyl into far more Numerous and Smaller *Globuli*, and thereby confound it also better with the Water, the Mixture will appear of a Much greater Whiteness, and almost like Milk; whereas if the Glass be a while let alone, the Colour will by degrees Impair, as the Oily globes grow Fewer and Bigger, and at length will quite Vanish, leaving both the Liquors Distinct and Diaphanous as before. And such a Tryal hath not ill succeeded, when instead of the Colourless Oyl of Turpentine I took a Yellow Mixture made of a good Proportion of Crude Turpentine dissolv'd in that Liquor; and (if I mis-remember not) it also Succeeded better than one would expect, when I employ'd an Oyl brought by Filings of Copper infused in it, to a deep Green. And this (by the way) may be the Reason, why often times when the Oyls of some Spices and of Anniseeds &c. are Distilled in a Limbec with Water, the Water (as I have several times observ'd) comes over Whitish, and will perhaps continue so for a good while, because if the Fire be made too Strong, the subtile Chymical Oyl is thereby much Agitated and Broken, and Blended with the Water in such Numerous and Minute Globules, as cannot easily in a short time Emerge to the Top of the Water, and whilst they Remain in it, make it, for the Reason newly intimated, look Whitish; and perhaps upon the same Ground a cause may be rendred, why Hot water is observ'd to be usually more Opacous and Whitish, than the same Water Cold, the Agitation turning the more Spirituous or otherwise Conveniently Dispos'd Particles of the Water into Vapours, thereby Producing in the Body of the Liquor a Multitude of Small Bubbles, which interrupt the Free passage, that the Beams of Light would else have Every way, and from the Innermost parts of the Water Reflect many of them Outwards. These and the like Examples, *Pyrophilus*, have induc'd me to Suspect, that the Superficial Particles of White bodies, may for the Most part be as well Convex as Smooth; I content my self to say *Suspect* and *for the most part*, because it seems not Easie to prove, that when Diaphanous bodies, as we shall see by and by, are reduc'd into White Powders, each Corpuscle must needs be of a Convex Superficies, since perhaps it may Suffice that Specular Surfaces look severally ways. For (as we have seen) when a Diaphanous Body comes to be reduc'd



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to very Minute parts, it thereby requires a Multitude of Little Surfaces within a Narrow compass. And though each of these should not be of a Figure Convenient to Reflect a Round Image of the Sun, yet even from such an Inconveniently Figur'd body, there may be Reflected some (either Streight or Crooked) Physical Line of Light, which Line I call Physical, because it has some Breadth in it, and in which Line in many cases some Refraction of the Light falling upon the Body it depends on, may contribute to the Brightness, as if a Slender Wire, or Solid Cylinder of Glass be expos'd to the Light, you shall see in some part of it a vivid Line of Light, and if we were able to draw out and lay together a Multitude of these Little Wires or Thrids of Glass, so Slender, that the Eye could not discern a Distance betwixt the Luminous Lines, there is little doubt (as far as I can guess by a Tryal purposely made with very Slender, but far less Slender Thrids of Glass, whose Aggregate was Look'd upon one way White) but the whole Physical Superficies compos'd of them, would to the Eye appear White, and if so, it will not be always necessary that the Figure of those Corpuscles, that make a Body appear White, should be *Globulous*. And as for Snow it self, though the Learned *Gassendus* (as we have seen above) makes it to seem nothing else but a pure Frozen Froth, consisting of exceedingly Minute and Thickset Bubbles; yet I see no necessity of Admitting that, since not only by the Variously and Curiously Figur'd Snow, that I have divers times had the Opportunity with Pleasure to observe, but also by the Common Snow, it rather doth appear both to the Naked Eye, and in a *Microscope*, often, if not most commonly, to consist principally of Little Slender Icicles of several Shapes, which afford such Numerous Lines of Light, as we have been newly Speaking of.

12. Sixthly, If you take a Diaphanous Body, as for instance a Piece of Glass, and reduce it to Powder, the same Body, which when it was Entire, freely Transmitted the Beams of Light, acquiring by Contusion a multitude of Minute Surfaces, each of which is as it were a Little, but Imperfect *Speculum*, is qualify'd to Reflect in a Confus'd manner, so many either Beams, or Little and Singly Unobservable Images of the Lucid Body, that from a Diaphanous it Degenerates into a White Body. And I remember, I have for Trials sake taken Lumps of Rock Crystal, and Heating them Red hot in a Crucible, I found according to my Expectation, that being Quench'd in Fair water, even those that remain'd in seemingly entire Lumps exchang'd their Translucency for Whiteness, the Ignition and Extinction having as it were Crack'd each Lump into a multitude of Minute Bodies, and thereby given it a great multitude of new Surfaces. And ev'n with Diaphanous Bodies, that are Colour'd, there may be this way a Greater Degree of Whiteness produced, than one would lightly think; as I remember, I have by Contusion obtain'd Whitish Powders of *Granates*, Glass of *Antimony*, and *Emeralds* finely Beaten, and you may more easily make the Experiment, by taking Good Venereal *Vitriol* of a Deep Blew, and comparing with some of the Entire Crystals purposely reserv'd, some of the Subtile Powder of the same Salt, which will Comparatively exhibit a very considerable degree of Whitishness.



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13. Seventhly, And as by a Change of Position in the Parts, a Body that is not White, may be made White, so by a Slight change of the Texture of its Surface, a White Body may be Depriv'd of its Whiteness. For if, (as I have try'd in Gold-smiths Shops) you take a piece of Silver that has been freshly Boyl'd, as the Artificers call it, (which is done by, first Brushing, and then Decocting it with Salt and Tartar, and perhaps some other Ingredients) you shall find it to be of a Lovely White. But if you take a piece of Smooth Steel, and therewith Burnish a part of it, which may be presently done, you shall find that Part will Lose its Whiteness, and turn a *Speculum*, looking almost every where Dark, as other Looking-glasses do, which may not a little confirm our Doctrine. For by this we may guess, what it is chiefly that made the Body White before, by considering that all that was done to deprive it of that Whiteness, was only to Depress the Little Protuberances that were before on the Surface of the Silver into one Continu'd Superficies, and thereby effect this, that now the Image of the Lucid Body, and consequently a Kind of Whiteness shall appear to your Eye, but in some place of the greater Silver Looking-glass (whence the Beams reflected at an Angle Equal to that wherewith they fall on it, may reach your Eye) whilst the Asperity remain'd Undestroy'd, the Light falling on innumerable Little *Specula* Obverted some one way, and some another, did from all Sensibly Distinguishable parts of the Superficies reflect confus'd Beams or Representations of Light to the Beholders Eye, from whence soever he chance to Look upon it. And among the Experiments annex'd to this Discourse, you will find One, wherein by the Change of Texture in Bodies, Whiteness is in a Trice both Generated and Destroy'd.

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CHAP. II.

1. What we have Discours'd of Whiteness, may somewhat Assist us to form a Notion of Blackness, those two Qualities being Contrary enough to Illustrate each other. Yet among the Antient *Philosophers* I find less Assistance to form a Notion of Blackness than of Whiteness, only *Democritus* in the passage above Recited out of *Aristotle* has given a General Hint of the Cause of this Colour, by referring the Blackness of Bodies to their Asperity. But this I call but a General Hint, because those Bodies that are Green, and Purple, and Blew, seem to be so as well as Black ones, upon the Account of their Superficial Asperity. But among the *Moderns*, the formerly mention'd *Gassendus*, perhaps invited by this Hint of *Democritus*, has Incidentally in another Epistle given us, though a very Short, yet a somewhat Clearer account of the Nature of Blackness in these words: *Existimare par est corpora suapte Natura nigra constare ex particulis, quarum Superficieculae scabrae sint, nec facile lucem extrorsum reflectant.* I wish this Ingenious Man had enlarg'd



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himself upon this Subject; For indeed it seems, that as that which makes a Body White, is chiefly such a Disposition of its Parts, that it Reflects (I mean without much Interruption) more of the Light that falls on it, than Bodies of any other Colour do, so that which makes a Body Black is principally a Peculiar kind of Texture, chiefly of its Superficial Particle, whereby it does as it were Dead the Light that falls on it, so that very little is Reflected Outwards to the Eye.

2. And this Texture may be Explicated two, and perhaps more than two several ways, whereof the first is by Supposing in the Superficies of the Black Body a Particular kind of Asperity, whereby the Superficial Particles reflect but Few of the Incident Beams Outwards, and the rest Inwards towards the Body it self. As if for Instance, we should conceive the Surface of a Black Body to be Asperated by an almost Numberless throng of Little Cylinders, Pyramids, Cones, and other such Corpuscles, which by their being Thick Set and *Erected*, reflect the Beams of Light from one to another Inwards, and send them too and fro so often, that at length they are Lost before they can come to Rebound out again to the Eye. And this is the first of the two mention'd ways of Explicating Blackness. The other way is by Supposing the Texture of Black Bodies to be such, that either by their Yielding to the Beams of Light, or upon some other Account, they do as it were Dead the Beams of Light, and keep them from being Reflected in any Plenty, or with any Considerable Vigour of Motion, Outwards. According to this Notion it may be said, that the Corpuscles that make up the Beams of Light, whether they be Solary *Effluvioms*, or Minute Particles of some AETHERIAL Substance, Thrusting on one another from the Lucid Body, do, falling on Black Bodies, meet with such a Texture, that such Bodies receive Into themselves, and Retain almost all the Motion communicated to them by the Corpuscles that make up the Beams of Light, and consequently Reflect but Few of them, or those but Languidly, towards the Eye, it happening here almost in like manner as to a ball, which thrown against a Stone or Floor, would Rebound a great way Upwards, but Rebounds very Little or not at all, when it is thrown against Water, or Mud, or a Loose Net, because the Parts yield, and receive into themselves the Motion, on whose Account the Ball should be Reflected Outwards. But this Last way of Explicating Blackness, I shall content my Self to have Propos'd, without either Adopting it, or absolutely Rejecting it. For the Hardness of Touchstones, Black Marble and other Bodies, that being Black are Solid, seem to make it somewhat Improbable, that such Bodies should be of so Yielding a Texture, unless we should say, that some Bodies may be more Dispos'd to Yield to the Impulses of the Corpuscles of Light by reason of a Peculiar Texture, than other Bodies, that in other Tryals appear to be Softer than they. But though the Former of these two Explications of Blackness



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be that, by which we shall Endeavour to give an Account of it, yet as we said, we shall not Absolutely Reject this Latter, partly because they both Agree in this, that Black Bodies Reflect but Little of the Light that falls on them, and partly because it is not Impossible, that in some Cases both the Disposition of the Superficial particles, as to Figure and Position, and the Yielding of the Body, or some of its Parts, may joyntly, though not in an Equal measure concurr to the rendring of a Body Black. The Considerations that induc'd me to propose this Notion of Blackness, as I Explan'd it, are principally these:

3. First, That as I lately said, Whiteness and Blackness being generally reputed to be Contrary Qualities, Whiteness depending as I said upon the Disposition of the Parts of a Body to Reflect much Light, it seems likely, that Blackness may depend upon a Contrary Disposition of the Black Bodies Surface; But upon this I shall not Insist.

4. Next then we see, that if a Body of One and the same Colour be plac'd, part in the Sun-beams, and part in the Shade, that part which is not Shin'd on will appear more of Kin to Blackness than the other, from which more Light Rebounds to the Eye; And Dark Colours seem the Blacker, the less Light they are Look'd upon in, and we think all Things Black in the Dark, when they send no Beams to make Impressions on our Organs of Sight, so that Shadows and Darkness are near of Kin, and Shaddow we know is but a Privation of Light; and accordingly Blackness seems to proceed from the Paucity of Beams Reflected from the Black Body to the Eye, I say the Paucity of Beams, because those Bodies that we call Black, as Marble, Jeat, &c. are Short of being perfectly so, else we should not See them at all. But though the Beams that fall on the Sides of those Erected Particles that we have been mentioning, do Few of them return Outwards, yet those that fall upon the Points of those Cylinders, Cones, or Pyramids, may thence Rebound to the Eye, though they make there but a Faint Impression, because they Arrive not there, but Mingl'd with a great Proportion of Little Shades. This may be Confirm'd by my having procur'd a Large piece of Black Marble well Polish'd, and brought to the Form of a Large Sphaerical and Concave *Speculum*; For on the Inside this Marble being well Polish'd, was a kind of Dark Looking-glass, wherein I could plainly see a Little Image of the Sun, when that Shin'd upon it. But this Image was very far from Offending and Dazling my Eyes, as it would have done from another *Speculum*; Nor, though the *Speculum* were Large, could I in a Long time, or in a Hot Sun set a piece of Wood on Fire, though a far less *Speculum* of the same Form, and of a more Reflecting Matter, would have made it Flame in a Trice.



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5. And on this Occasion we may as well in Reference to something formerly deliver'd concerning Whiteness, as in Reference to what has been newly said, Subjoyn what we further observ'd touching the Differing Reflections of Light from White and Black Marble, namely, that having taking a pretty Large Mortar of White Marble, New and Polish'd in the Inside, and Expos'd it to the Sun, we found that it Reflected a great deal of Glaring Light, but so Dispers'd, that we could not make the Reflected Beams concurr in any such Conspicuous *Focus*, as that newly taken notice of in the Black Marble, though perhaps there may enough of them be made to meet near the Bottom, to make some Kind of *Focus*, especially since by holding in the Night-time a Candle at a convenient Distance, we were able to procure a Concourse of some, though not many of the Reflected Beams, at about two Inches distant from the Bottom of the Mortar: But we found the Heat even of the Sunbeams so Dispersedly Reflected to be very Languid, even in Comparison of the Black Marbles *Focus*. And the Little Picture of the Sun, that appear'd upon the White Marble as a *Speculum*, was but very Faint and exceeding ill Defin'd. Secondly, That taking two pieces of Plain and Polish'd Surfaces, and casting on them Successively the Beams of the Same Candle, In such manner, as that the Neighbouring Superficies being Shaded by an Opacous and Perforated Body, the Incident Beams were permitted to pass but through a Round Hole of about Half an Inch Diameter, the Circle of Light that appear'd on the White Marble was in Comparison very Bright, but very ill Defin'd; whereas that on the Black Marble was far less Luminous, but much more precisely Defin'd.

6. Thirdly, When you Look upon a piece of Linnen that has Small Holes in it, those Holes appear very Black, and Men are often deceiv'd in taking Holes for Spots of Ink; And Painters to represent Holes, make use of Black, the Reason of which seems to be, that the Beams that fall on those Holes, fall into them So Deep, that none of them is Reflected back to the Eye. And in narrow Wells part of the Mouth seems Black, because the Incident Beams are Reflected Downwards from one side to another, till they can no more Rebound to the Eye.

We may consider too, that if Differing parts of the same piece of Black Velvet be stroak'd Opposite ways, the piece of Velvet will appear of two Distinct kinds of Blackness, the one far Darker than the other, of which Disparity the Reason Seems to be, that in the Less obscure part of the Velvet, the Little Silken Piles whereof 'tis made up, being Inclin'd, there is a Greater part of each of them Obverted to the Eye, whereas in the other part the Piles of Silk being more Erected, there are far Fewer Beams Reflected Outwards from the Lateral parts of each Pile, So that most of those that Rebound to the Eye, come from the Tops of the Piles, which make but a small part of the whole Superficies, that may be cover'd by



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the piece of Velvet. Which Explication I propose, not that I think the Blackness of the Velvet proceeds from the Cause assign'd, since each Single Pile of Silk is Black by reason of its Texture, in what Position soever you Look upon it; But that the Greater Blackness of one of these Tuffts seems to proceed from the Greater Paucity of Beams Reflected from it, and that from the Fewness of those Parts of a Surface that Reflect Beams, and the Multitude of those Shaded Parts that Reflect none. And I remember, that I have oftentimes observ'd, that the Position of Particular Bodies far greater than Piles of Silk in reference to the Eye, may notwithstanding their having each of them a Colour of its own, make one part of their Aggregate appear far Darker than the other; For I have near Great Towns often taken notice, that a Cart-load of Carrots pack'd up, appear'd of a much Darker Colour when Look'd upon, where the Points of the Carrots were Obverted to the Eye, than where the Sides of them were so.

7. Fourthly, In a Darkned Room, I purposely observ'd, that if the Sun-beams, which came in at the Hole were receiv'd upon White or any other Colour, and directed to a Convenient place of the Room, they would Manifestly, though not all Equally, Encrease the Light of that Part; whereas if we Substituted, either a piece of Black Cloth or Black Velvet, it would so Dead the Incident Beams, that the place (newly mention'd) whereto I Obverted the Black Body, would be Less Enlightned than it was before, when it received its Light but from the Weak and Oblique Reflections of the Floor and Walls of a pretty Large Room, through which the Beams that came in at the Hole were Confusedly and Brokenly Dispers'd.

8. Fifthly, And to shew that the Beams that fall on Black Bodies, as they do not Rebound Outwards to the Eye, so they are Reflected towards the Body it self, as the Nature of those Erected Particles to which we have imputed Blackness, requires, we will add an Experiment that will also confirm our Doctrine touching Whiteness; Namely, that we took a Broad and Large Tile, and having Whitened over one half of the Superficies of it, and Black'd the other, we expos'd it to the Summer Sun; And having let it lye there a convenient time (for the Difference is more Apparent, if it have not lain there too long) we found, as we expected, that whilst the Whited part of the Tile remained Cool enough, the Black'd part of the same Tile was grown not only Sensible, but very Hot, (sometimes to a strong Degree.) And to satisfie some of our Friends the more, we have sometimes left upon the Surface of the Tile, besides the White and Black parts thereof, a part that Retain'd the native Red of the Tile it self, and Exposing them to the Sun, we observ'd this Last mention'd to have Contracted a Heat in comparison of the White, but a Heat Inferiour to that of the Black, of which the Reason seems to be, that the Superficial Particles of Black Bodies, being, as we said, more Erected,



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than those of White or Red ones, the Corpuscles of Light falling on their sides, being for the most part Reflected Inwards from one Particle to another, and thereby engag'd as it were and kept from Rebounding Upwards, they communicate their brisk Motion, wherewith they were impell'd against the Black Body, (upon whose account had they fallen upon a White Body, they would have been Reflected Outwards) to the Small parts of the Black Body, and thereby Produce in those Small parts such an Agitation, as (when we feel it) we are wont to call Heat. I have been lately inform'd, that an Observation near of Kin to Ours, has been made by some Learned Men in *France* and *Italy*, by long Exposing to a very Hot Sun, two pieces of Marble, the one White, the other Black; But though the Observation be worthy of them, and may confirm the same Truth with Our Experiment, yet besides that our Tryal needs not the Summer, nor any Great Heat to succeed, It seems to have this Advantage above the other, that whereas Bodies more Solid, and of a Closer Texture, though they use to be more Slowly Heated, are wont to receive a Greater Degree of Heat from the Sun or Fire, than (*Caeteris paribus*) Bodies of a Slightest Texture; I have found by the Information of Stone-cutters, and by other ways of Enquiry, that Black Marble is much Solider and Harder than White, so that possibly the Difference betwixt the Degrees of Heat they receive from the Sunbeams will by many be ascrib'd to the Difference of their Texture, rather than to that of their Colour, though I think our Experiment will make it Probable enough that the greater part of that Difference may well be ascrib'd to that Disposition of Parts, which makes the one Reflect the Sunbeams Inward; and the other Outwards. And with this Doctrine accords very well, that Rooms hung with Black, are not only Darker than else they would be, but are wont to be Warmer too; Insomuch that I have known a great Lady, whose Constitution was somewhat Tender, complain that she was wont to catch Cold, when she went out into the Air, after having made any long Visits to Persons, whose Rooms were hung with Black. And this is not the only Lady I have heard complain of the Warmth of such Rooms, which though perhaps it may be partly imputed to the *Effluvia* of those Materials wherewith the hangings were Dy'd, yet probably the Warmth of such Rooms depends chiefly upon the same Cause that the Darkness does; As (not to repeat what I formerly Noted touching my Gloves,) to satisfie some Curious Persons of that Sex, I have convinc'd them, by Tryall, that of two Pieces of Silken Stuff given me by themselves, and expos'd in their Presence, to the same Window, Shin'd on by that Sun, the White was *considerably* Heated, when the Black was not so much as *Sensibly* so.



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9. Sixthly, I remember, that Acquainting one Day a *Virtuoso* of Unsuspected Credit, that had Visited Hot Countries, with part of what I have here Deliver'd concerning Blackness, he Related to me by way of Confirmation of it, a very notable Experiment, which he had both others make, and Made himself in a Warm Climate, namely, that having carefully Black'd over Eggs, and Expos'd them to the Hot Sun, they were thereby in no very Long time well Roasted, to which Effect I conceive the Heat of the Climate must have Concurr'd with the Disposition of the Black Surface to Reflect the Sunbeams Inward, for I remember, that having made that among other Tryals in *England*, though in Summer-time, the Eggs I Expos'd, acquir'd indeed a considerable Degree of Heat, but yet not so Intense a One, as prov'd Sufficient to Roast them.

10. Seventhly, and Lastly, Our Conjectures at the Nature of Blackness may be somewhat Confirm'd by the (formerly mention'd) Observation of the Blind *Dutch-man*, that Discerns Colours with his Fingers; for he Says, that he Feels a greater Roughness upon the Surfaces of Black Bodies, than upon those of Red, or Yellow, or Green. And I remember, that the Diligent *Bartholinus* says,[9] that a Blind Earl of *Mansfield* could Distinguish White from Black only by the Touch, which would Sufficiently Argue a great Disparity in the Asperities, or other Superficial Textures of Bodies of those two Colours, if the Learn'd Relator had Affirm'd the Matter upon his own Knowledge.

[9] Hist. Anatom. Cent. 3. Hist. 44.

II. These, *Pyrophilus*, are the chief things that Occurr to me at present, about the Nature of Whiteness and Blackness, which it they have Rendred it so much as Probable, that in *Most*; or at least *Many* Cases, the Causes of these Qualities may be such as I have Adventur'd to Deliver, it is as much as I Pretend to; for till I have Opportunity to Examine the Matter by some further Tryals, I am not sure, but that in some White and Black Bodies, there may Concurr to the Colour some peculiar Texture or Disposition of the Body, whereby the Motion of the Small Corpuscles that make up the Incident Beams of Light, may be Differingly Modify'd, before they reach the Eye, especially in this, that White Bodies do not only Copiously Reflect those Incident Corpuscles Outwards, but Reflect them Briskly, and do not otherwise Alter them in the manner of their Motion. Nor shall I now stay to Enquire, whether some of those other ways, (as a Disposition to Alter the Velocity, the Rotation, or the Order and Manner of Appulse so the Eye of the Reflected Corpuscles that Compos'd the Incident Beams of Light) which we mention'd when we consider'd the Production of Colours in General, may not in some Cases be Applicable to those of White and Black Bodies: For I am yet so much a *Seeker* in this Matter, and so little Wedded to the Opinions I have propos'd, that what I am to add shall be but the Beginning of a Collection of Experiments and Observation towards the History of Whiteness and Blackness, without at present interposing my Explications of them, that so, I may assist your Enquires without much Fore-stalling or Biassing your Judgment.



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EXPERIMENT
IN
CONSORT,
Touching
Whiteness & Blackness.

* * * * *

EXPERIMENT I.

Having promis'd in the 114, and 115. Pages of the foregoing Discourse of Whiteness and Blackness, to shew, that those two Colours may by a change of Texture in bodies, each of them apart Diaphanous and Colourless, be at pleasure and in a trice as well Generated as Destroy'd, We shall begin with Experiments that may acquit us of that promise.

Take then what Quantity you please of Fair Water, and having Heated it, put into it as much good Common Sublimate, as it is able to Dissolve, and (to be sure of having it well glutted:) continue putting in the Sublimate, till some of it lye Untouch'd in the bottom of the Liquor, Filter this Solution through Cap-paper, to have it cleer and limpid, and into a spoonfull or two thereof, (put into a clean glass vessel,) shake about four or five drops (according as you took more or less of this Solution) of good limpid Spirits of Urine, and immediately the whole mixture will appear White like Milk, to which mixture if you presently add a convenient proportion of Rectifi'd *Aqua Fortis* (for the number of drops is hard to determine, because of the Differing Strength of the liquor, but easily found by tryal) the Whiteness will presently disappear, and the whole mixture become Transparent, which you may, if you please, again reduce to a good degree of Whiteness (though inferiour to the first) onely by a more copious affusion of fresh Spirit of Urine. *N.* First, That it is not so necessary to employ either *Aqua Fortis* or Spirit of Urine about this Experiment, but that we have made it with other liquors instead of these, of which perhaps more elsewhere. Secondly, That this Experiment, though not made with the same *Menstruums*, nor producing the same Colour is yet much of Kin to that other to be mentioned in this Tract among our other Experiments of Colours, about turning a Solution of Praecipitate into an Orange-colour, and the Chymical Reason being much alike in both, the annexing it to one of them may suffice FOR both.

EXPERIMENT II.

Make a strong Infusion of broken Galls in Fair Water, and having Filtred it into a clean Vial, add more of the same liquor to it, till you have made it somewhat Transparent, and sufficiently diluted the Colour, for the credit of the Experiment, lest otherwise the Darkness of the liquor might make it be objected, that 'twas already almost Ink; Into this



Infusion shake a convenient quantity of a Clear, but very strong Solution of Vitriol, and you shall immediately see the mixture turn Black almost like Ink, and such a way of producing Blackness is vulgar enough; but if presently after you doe upon this mixture drop a small quantity of good oyl of Vitriol, and, by shaking the Vial disperse it nimbly through the two other liquors, you shall (if you perform your



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part well, and have employ'd oyl of Vitriol Cleer and Strong enough) see the Darkness of the liquor presently begin to be discuss'd, and grow pretty Cleer and Transparent, losing its Inky Blackness, which you may again restore to it by the affusion of a small quantity of a very strong Solution of Salt of Tartar. And though neither of these Atramentous liquors will seem other than very Pale Ink, if you write with a clean Pen dipt in them, yet that is common to them with some sorts of Ink that prove very good when Dry, as I have also found, that when I made these carefully, what I wrote with either of them, especially with the Former, would when thoroughly Dry grow Black enough not to appear bad Ink. This Experiment of taking away and restoring Blackness from and to the liquors, we have likewise tryed in Common Ink; but there it succeeds not so well, and but very slowly, by reason that the Gum wont to be employed in the making it, does by its Tenacity oppose the operations of the above mention'd Saline liquors. But to consider Gum no more, what some kind of Praecipitation may have to do in the producing and destroying of Inks without it, I have elsewhere given you some occasion and assistance to enquire; But I must not now stay to do so my self, only I shall take notice to you, that though it be taken for granted that bodies will not be Praecipitated by Alcalizat Salts, that have not first been dissolved in some Acid *Menstruums*, yet I have found upon tryals, which my conjectures lead me to make on purpose, That divers Vegetables *barely infus'd*, or, *but slightly decocted in common water*, would, upon the affusion of a Strong and Cleer *Lixivium* of Potashes, and much more of some other Praecipitating liquors that I sometimes employ, afford good store of a Crudled matter, such as I have had in the Praecipitations of Vegetable substances, by the intervention of Acid things, and that this matter was easily separable from the rest of the liquor, being left behind by it in the Filtre; and in making the first Ink mention'd in this Experiment, I found that I could by Filtration separate pretty store of a very Black pulverable substance, that remain'd in the Filtre, and when the Ink was made Cleer again by the Oyl of Vitriol, the affusion of dissolv'd *Sal Tartari* seem'd but to Praecipitate, and thereby to Unite and render Conspicuous the particles of the Black mixture that had before been dispers'd into very Minute and singly Invisible particles by the Incisive and resolving power of the highly Corrosive Oyl of Vitriol.

And to manifest, *Pyrophilus*, that Galls are not so requisite as many suppose to the making Atramentous Liquors, we have sometimes made the following Experiment, We took dried Rose leaves and Decocted them for a while in Fair Water, into two or three spoonfulls of this Decoction we shook a few drops of a strong and well filtrated Solution of Vitriol (which perhaps had it been Green would have done as well) and immediately

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the mixture did turn Black, and when into this mixture presently after it was made, we shook a just Proportion of *Aqua Fortis*, we turn'd it from a Black Ink to a deep Red one, which by the affusion of a little Spirit of Urine may be reduc'd immediately to an Opacous and Blackish Colour. And in regard, *Pyrophilus*, that in the former Experiments, both the Infusion of Galls, and the Decoction of Roses, and the Solution of Copperis employ'd about them, are endow'd each of them with its own Colour, there may be a more noble Experiment of the sudden production of Blackness made by the way mention'd in the Second Section of the Second Part of our Essays, for though upon the Confusion of the two Liquors there mention'd, there do immediately emerge a very Black mixture, yet both the Infusion of *Orpiment* and the Solution of *Minium* were before their being joyn'd together, Limpid and Colourless.

EXPERIMENT III.

If pieces of White Harts-horn be with a competent degree of Fire distill'd in a Glass-retort, they will, after the avolation of the Flegm, Spirit, Volatile Salt, and the looser and lighter parts of the Oleagenous substance, remain behind of a Cole-black colour. And even Ivory it self being skilfully Burnt (how I am wont to do it, I have elsewhere set down) affords Painters one of the best and deepest Blacks they have, and yet in the Instance of distill'd Harts-horn, the operation being made in Glass-vessels carefully clos'd, it appears there is no Extraneous Black substance that Insinuates it self into White Harts-horn, and thereby makes it turn Black; but that the Whiteness is destroy'd, and the Blackness generated, only by a Change of Texture, made in the burnt Body, by the Recess of some parts and the Transposition of others. And though I remember not that in many Distillations of Harts-horn I ever sound the *Cap. Mort.* to pass from Black to a true Whiteness, whilst it continu'd in Clos'd vessels, yet having taken out the Cole-black fragments, and Calcin'd them in Open vessels, I could in few hours quite destroy that Blackness, & without sensibly changing their Bulk or Figure, reduce them to great Whiteness. So much do these two Colours depend upon the Disposition of the little parts, that the Bodies wherein they are to be met with do consist of. And we find, that if Whitewine Tartar, or even the white Crystals of such Tartar be burnt without being truly Calcin'd, the *Cap. Mortuum* (as the Chymists call the more Fixt part) will be Black. But if you further continue the Calcination till you have perfectly Incinerated the Tartar, & kept it long enough in a Strong fire, the remaining *Calx* will be White. And so we see that not only other Vegetable substances, but even White woods, as the Hazel, will yield a Black Charcoal, and afterwards Whitish ashes; And so Animal substances naturally White, as Bones and Eggshels, will grow Black upon the being Burnt, and White again when they are perfectly Calcin'd.

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EXPERIMENT IV.

But yet I much Question whether that Rule delivered by divers, as well Philosophers as Chymists, *adusta nigra, sed perusta alba*, will hold as Universally as is presum'd, since I have several Examples to allege against it: For I have found that by burning Alabaster, so as both to make it appear to boyl almost like Milk, and to reduce it to a very fine Powder, it would not at all grow Black, but retain its Pure and Native Whiteness, and though by keeping it longer than is usual in the fire, I produced but a faint Yellow, even in that part of the Powder that lay nearest the top of the Crucible, yet having purposely enquired of an Experienced Stone-cutter, who is Curious enough in tryng Conclusions in his own Trade, he told me he had found that if Alabaster or Plaster of Paris be very long kept in a Strong fire, the whole heap of burnt Powder would exchange its Whiteness for a much deeper Colour than the Yellow I observ'd. Lead being Calcin'd with a Strong fire turns (after having purhaps run thorough divers other Colour) into *Minium*, whose Colour we know is a deep red; and if you urge this *Minium*, as I have purposely done with a Strong fire, you may much easier find a Glassie and Brittle Body darker than *Minium*, than any white *Calx* or Glass. 'Tis known among Chymists, that the white *Calx* of Antimony, by the further and more vehement operation of the fire, may be melted into Glass, which we have obtain'd of a Red Colour, which is far deeper than that of the *Calx* of Burnt Antimony, and though common Glafs of Antimony being usually Adulterated with *Borax*, have its Colour thereby diluted, oftentimes to a very pale Yellow; yet not onely ours made more sincerely, was, as we said, of a Colour less remote from Black, than was the *Calx*; but we observ'd, that by Melting it once or twice more, and so exposing it to the further operation of the Fire, we had, as we expected, the Colour heightned. To which we shall add but this one Instance, (which is worth the taking notice of in Reference to Colours:) That, if you take Blew, but Unsophisticated, Vitriol, and burn it very slowly, and with a Gentle degree of Heat, you may observe, that when it has Burnt but a Little, and yet so far as that you may rub it to Powder betwixt your fingers, it will be of a White or Whitish Colour; But if you Prosecute the Calcination, this Body which by a light Adustion was made White, will pass through other Colours, as Gray, Yellowish, and Red; and if you further burn it with a Long and Vehement fire, by that time it comes to be *Perustum*, it will be of a dark purple, nearer to Black, not only than the first *Calx*, but than the Vitriol before it at all felt the fire. I might add that *Crocus Martis* (*per se* as they call it) made by the Lasting violence of the Reverberated flames is not so near a Kin to White, as the Iron or Steel that afforded it was before its Calcinations; but that

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I suppose, these Instances may Suffice to satisfie you, that Minerals are to be excepted out of the forementioned Rule, which perhaps, though it seldome fail in substances belonging to the Vegetable or Animal Kingdome, may yet be Question'd even in some of these, if that be true, which the Judicious Traveller *Bellonius* affirms, that Charcoales made out of the Wood of *Oxycaeder* are White; And I could not find that though in Retorts Hartshorn and other White Bodies will be Denigrated by Heat, yet Camphire would not at all lose its Whiteness, though I have purposely kept it in such a heat, as made it melt and boyl.

EXPERIMENT V.

And now I speak of Camphire, it puts me in mind of adding this Experiment, That, though as I said in Clos'd Glasses, I could not Denigrate it by Heat, but it would Sublime to the sides and top of the Glass, as it was before, yet not only it will, being set on fire in the Free Air, send forth a Copious smoak, but having purposely upon some of it that was Flaming, clapt a Large Glass, almost in the form of a Hive, (but more Slender only) with a Hole at the top, (which I caus'd to be made to trye Experiments of Fire and Flame in) it continued so long burning that it Lin'd all the Inside of the Glass with a Soot as Black as Ink, and so Copious, that the Closeness of the Vessel consider'd, almost all that part of the White Camphire that did take Fire, seem'd to have been chang'd into that deep Black Substance.

EXPERIMENT VI

And this also brings into my mind another Experiment that I made about the production of Blackness, whereof, for Reasons too long to be here deduced, I expected and found a good Success, an it was this: I took Rectifi'd Oyl of Vitriol (that I might have the Liquor Clean as well as Strong) and by degrees mixt with it a convenient proportion of the Essential Oyl, as Chymists call it, of Wormwood, drawn over with store of Water in a Limbec, and warily Distilling the mixture in a Retort, there remain'd a scarce credible quantity of dry Matter, Black as a Coal. And because the Oyl of Wormwood, though a Chymical Oyl drawn by a *Virtuoso*, seem'd to have somewhat in it of the Colour of the Plant, I Substituted in its Room, the Pure and Subtile Essential Oyl of Winter-Savory, and mixing little by little this Liquor, with (if I mis-remember not) an Equal weight of the formerly mention'd Rectifi'd Oyl of Vitriol, and Distilling them as before in a Retort, besides what there pass'd over into the Receiver, even these two clear Liquors left me a Considerable Proportion, (though not so great as the two former) of a Substance Black as Pitch, which I yet Keep by me as a Rarity.

EXPERIMENT VII.



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A way of Whiting Wax Cheaply and in Great Quantity may be a thing of good Oeconomical Use, and we have elsewhere set down the Practice of Trades-men that Blanch it; But here Treating of Whiteness only in Order to the Philosophy of Colours, I shall not Examine which of the Slow wayes may be best Employ'd, to free Wax from the Yellow Melleous parts, but shall rather set down a Quick way of making it White, though but in very Small Quantities. Take then a little Yellow Wax, scraped or thinly sliced, and putting it into a Bolts-head or some other Convenient Glass, pour to it a pretty deal of Spirit of Wine, and placing the Vessel in Warm Sand, Encrease the Heat by degrees, till the Spirit of Wine begin to Simper or to Boyl a little; and continuing that degree of Fire, if you have put Liquor enough, you will quickly have the Wax dissolv'd, then taking it off the fire, you may either suffer it to Cool as hastily as with Safety to the Glass you can, or Pour it whilst 'tis yet Hot into a Filtre of Paper, and either in the Glass where it Cools, or in the Filtre, you will soon find the Wax and *Menstruum* together reduc'd into a White Substance, almost like Butter, which by letting the Spirit Exhale will shrink into a much Lesser Bulk, but still retaining its Whiteness. And that which is pretty in the working of this Magistry of Wax, is, that the Yellowness vanishes, neither appearing in the Spirit of Wine that passes Limpid through the Filtre, nor in the Butter of Wax, if I may so call it, that, as I said, is White.

EXPERIMENT VIII.

There is an Experiment, *Pyrophilus*, which though I do not so exactly remember, and though it be somewhat Nice to make, yet I am willing to Acquaint You with, because the thing Produc'd, though it be but a Curiosity, is wont not a little to please the Beholders, and it is a way of turning by the help of a Dry Substance, an almost Golden-Colour'd Concrete, into a White one, the Several Tryals are not at present so fresh in my Memory to enable me to tell you Certainly, whether an Equal onely or a Double weight of Common Sublimate must be taken in reference to the Tinglass, but if I mistake not, there was in the Experiment that succeeded best, Two parts of the Former taken to One of the Latter. These Ingredients being finely Powdred and Exactly mix'd, we Sublim'd together by degrees of fire (the due Gradation of which is in this Experiment a thing of main Importance) there ascended a matter of a very peculiar Texture, for it was for the most part made up of very Thin, Smooth, Soft and Slippery Plates, almost like the finest sort of the Scales of Fishes, but of so Lovely a White Inclining to Pearl-Colour, and of so Curious and Shining a Gloss, that they appear'd in some respect little Inferiour to Orient Pearls, and in other Regards, they seem'd to Surpass them, and were Applauded for a sort of the Prettiest Trifles that we had ever prepar'd to Amuse the Eye. I will not undertake that though you'l hardly miss changing the Colour of your shining Tinglass, yet you will the first or perhaps the second time hit Right upon the way of making the Glistring Sublimate I have been mentioning.

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EXPERIMENT IX.

When we Dissolve in *Aqua Fortis* a mixture of Gold and Silver melted into one Lump, it usually happens that the Powder of Gold that falls to the bottom, as not being Dissoluble by that *Menstruum*, will not have its own Yellow, but appear of a Black Colour, though neither the Gold, nor the Silver, nor the *Aqua Fortis* did before manifest any Blackness. And divers Alchymists, when they make Solutions of Minerals they would Examine, are very Glad, if they see a Black Powder Praecipitated to the Bottom, taking it for a Hopefull Sign, that those Particles are of a Golden Nature, which appear in a Colour so ordinary to Gold parted from other Metalls by *Aqua Fortis*, that it is a trouble to the Refiner to Reduce the Praecipitated *Calx* to its Native Colour. For though, (as we have try'd,) that may be Quickly enough done by Fire, which will make this Gold look very Gloriously (as indeed 'tis at least one of the Best wayes that is Practis'd for the Refining of Gold,) yet it requires both Watchfulness and Skill, to give it such a Degree of Fire as will serve to Restore it to its Lustre, without giving it such a One, as may bring it to Fusion, to which the Minuteness of the *Corpuseles* it consists of makes the Powder very apt. And this brings into my Mind, that having taken a Flat and Bright piece of Gold, that was Refin'd by a Curious and Skilfull Person on purpose to Trye to what height of Purity Gold could be brought by Art, I found that this very piece, as Glorious as it look'd, being rubb'd a little upon a piece of fine clean Linnen, did sully it with a kind of Black; and the like I have observ'd in Refin'd Silver, which I therefore mention, because I formerly suspected that the Impurity of the Metall might have been the only Cause of what I have divers times obferv'd in wearing Silver-hilted Swords, Namely, that where they rubb'd upon my Clothes, if they were of a Light-Colour'd Cloath, the Affriction would quickly Black them; and Congruously hereunto I have found Pens Blackt almost all over, when I had a while carri'd them about me in a Silver Ink-case. To which I shall only add, that whereas in these several Instances of Denigration, the Metalls are worn off, or otherwise Reduc'd into very Minute Parts, that Circumstance may prove not Unworthy your Notice.

EXPERIMENT X.

That a Solution of Silver does Dye Hair of a Black Colour, is a Known Experiment, which some persons more Curious than Dextrous, have so Unluckily made upon themselves as to make their Friends very Merry. And I remember that the other day, I made my self some Sport by an Improvement of this Observation, for having dissolv'd some Pure Silver in *Aqua Fortis*, and Evaporated the *Menstruum ad siccitatem*, as they speak, I caus'd a Quantity of fair Water to be pour'd upon the *Calx* two or three several times, and to be at each Evaporated, till the *Calx* was very Drye, and all the Greenish



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Blewness that is wont to appear in Common Crystals of Silver, was quite carry'd away. Then I made those I meant to Deceive, Moisten some part of their Skin with their own Spittle, and slightly Rub the moistned parts with a little of this Prepar'd Silver, Whereupon they Admir'd to see, that a Snow-white Body laid upon the White Skin should presently produce a deep Blackness, as if the stains had been made with Ink, especially considering that this Blackness could not, like that produc'd by ordinary Ink, be readily Wash'd off, but requir'd many Hours, and part of it some dayes to its Obliteration. And with the same White *Calx* and a little Fair Water we likewise Stain'd the White Hafts of Knives, with a lasting Black in those parts where the *Calx* was Plentifully enough laid on, for where it was laid on but very Thinly, the Stain was not quite of so Deep a Colour.

EXPERIMENT XI

The Cause of the Blackness of those many Nations, which by one common Name we are wont to call *Negroes*, has been long since Disputed of by Learned Men, who possibly had not done amiss, if they had also taken into Consideration, why some whole races of other Animals besides Men, as Foxes and Hares, are Distinguish'd by a Blackness not familiar to the Generality of Animals of the same Species; The General Opinion (to be mention'd a little lower) has been rejected even by some of the Antient Geographers, and among our Moderns *Ortelius* and divers other Learned Men have Question'd it. But this is no place to mention what thoughts I have had to and fro about these Matters: Only as I shall freely Acknowledge, that to me the inquiry seems more Abstruse than it does to many others, and that because consulting with Authors, and with Books of Voyages, and with Travellers, to satisfie my self in matters of Fact, I have met with some things among them, which seem not to agree very well with the Notions of the most Classick Authors concerning these things; for it being my Present Work to deliver rather matters Historical than Theorys, I shall Annex Some few of my Collections, instead of a Solemn Disputation. It is commonly presum'd that the Heat of the Climate wherein they live, is the reason, why so many Inhabitants of the Scorching Regions of *Africa* are Black; and there is this familiar Observation to Countenance this Conjecture, That we plainly see that Mowers, Reapers, and other Countrey-people, who spend the most part of the Hot Summer dayes expos'd to the Sun, have the skin of their Hands and Faces, which are the parts immediately Expos'd to the Sun and Air, made of a Darker Colour than before, and consequently tending to Blackness; And Contrarywise we observe that the *Danes* and some other people that Inhabit Cold Climates, and even the *English* who feel not so Rigorous a Cold, have usually Whiter faces than the *Spaniards*, *Portugalls* and other European Inhabitants of Hotter Climates. But this Argument I take to be far more Specious than



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Convincing; for though the Heat of the Sun may Darken the Colour of the Skin, by that Operation, which we in *English* call Sun-burning, yet Experience doth not Evince, that I remember, That that Heat alone can produce a Discolouring that shall amount to a true Blackness, like that of *Negroes*, and we shall see by and by that even the Children of some *Negroes* not yet 10. dayes Old (perhaps not so much by three quarters of that time) will notwithstanding their Infancy be of the same Hue with their Parents. Besides, there is this strong Argument to be alleg'd against the Vulgar Opinion, that in divers places in *Asia* under the same Parallel, or even of the same Degree of Latitude with the *African* Regions Inhabited by Blacks, the People are at most but Tawny;^[10] And in *Africa* it self divers Nations in the Empire of *Ethiopia* are not *Negroes*, though Situated in the Torrid Zone, and as neer the AEquinocstial, as other Nations that are so (as the Black Inhabitants of *Zeylan* and *Malabar* are not in our Globes plac'd so near the Line as *Amara* the Famousest place in *Ethiopia*.) Moreover, (that which is of no small Moment in our present Disquisition) I find not by the best Navigators and Travellers to the *West-Indies*, whose Books or themselves I have consulted on this Subject, that excepting perhaps one place or two of small extent, there are any Blacks Originally Natives of any part of *America* (for the Blacks now there have been by the *Europeans* long Transplanted thither) though the New World contain in it so great a Variety of Climates, and particularly reach quite Cross the Torri'd Zone from one Tropic to another. And enough it be true that the *Danes* be a Whiter People than the *Spaniards*, yet that may proceed rather from other causes (not here to be enquired into) than from the Coldness of the Climate, since not onely the *Swedes* and other Inhabitants of those Cold Countreys, are not usually so White as the *Danes*, nor Whiter than other Nations in proportion to their Vicinity to the Pole. [And since the Writing of the former part of this Essay, having an opportunity on a Solemn occasion to take Notice of the Numerous Train of Some Extraordinary Embassadours sent from the *Russian* Emperour to a great Monarch, observ'd, that (though it were then Winter) the Colour of their Hair and Skin was far less Whitish than the *Danes* who Inhabit a milder Region is wont to be, but rather for the most part of a Darkish Brown; And the Physician to the Embassadour with whom those *Russes* came, being ask'd by me whether in *Muscovy* it self the Generality of the People were more inclin'd to have Dark-colour'd Hair than Flaxen, he answer'd Affirmatively; but seem'd to suspect that the True and Antient *Russians*, a Sept of whom he told me he had met with in one of the Provinces of that vast Empire, were rather White like the *Danes*,



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than any thing near so Brown as the present *Muscovites* whom he guesses to be descended of the *Tartars*, and to have inherited their Colour from them.] But to Prosecute our former Discourse, I shall add for further Proof of the Conjecture I was countenancing that good Authors inform us that there are *Negroes* in *Africa* not far from the *Cape of good Hope*, and consequently beyond the Southern Tropick, and without the Torrid Zone, much about the same Northern Latitude (or very little more) wherein there are divers *American* Nations that are not *Negroes*, and wherein the Inhabitants of *Candia*, some parts of *Sicily*, and even of *Spain* are not so much as Tawny-Mores. But (which is a fresh and strong Argument against the common Opinion,) I find by our recent Relations of *Greenland* (our Accounts whereof we owe to the Curiosity of that Royal *Virtuoso* the present King of *Denmark*;) that the Inhabitants are Olive-colour'd, or rather of a Darker Hiew. But if the Case were the same with Men, and those other kinds of Animals I formerly nam'd, I should offer something as a considerable proof, That, Cold may do much towards the making Men White or Black, and however I shall let down the Observation as I have met with it, as worthy to come into the History of Whiteness and Blackness, and it is, that in some parts of *Russia* and of *Livonia* it is affirm'd by *Olaus Magnus* and others, that Hares and Foxes (some add Partridges) which before were Black, or Red, or Gray, do in the depth of Winter become White by reason of the great Cold; (for that it should be, as some conceive, by Looking upon the Snow, seems improbable upon divers accounts) And I remember that having purposely enquir'd of a *Virtuoso* who lately Travell'd through *Livonia* to *Mosco* concerning the Truth of this Tradition, he both told me, he believ'd it, and added, that he saw divers of those lately nam'd Animals either in *Russia* or *Livonia*, (for I do not very well remember whether of the two) which, though White when he saw them in Winter, they assur'd him had been Black, or of other Colours before the Winter began, and would be so again when it was over. But for further satisfaction, I also consulted one that had for some years been an Eminent Physician in *Russia*, who though he rejected some other Traditions that are generally enough believ'd concerning that Countrey, told me nevertheless, that he saw no cause to doubt of this Tradition of *Olaus Magnus* as to Foxes and Hares, not onely because 'tis the common and uncontroul'd Assertion of the Natives, but also because he himself in the Winter could never that he remember'd see Foxes and Hares of any other Colour than White; And I my self having seen a small White Fox brought out of *Russia* into *England* towards the latter end of Winter, foretold those that shew'd him me, that he would change Colour in Summer, and accordingly



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coming to look upon him again in *July*, I found that the Back and Sides, together with the upper part of the Head and Tayl were already grown of a Dark Colour, the lower part of the Head and Belly containing as yet a Whiteness. Let me add, that were it not for some scruple I have, I should think more than what *Olaus* relates, confirm'd by the judicious *Olearius*, who was twice employ'd into those parts as a Publick Minister, who in his Account of *Moscovy* has this Passage: *The Hares there are Gray; but in some Provinces they grow white in the Winter.* And within some few Lines after: *It is not very Difficult to find the Cause of this Change, which certainly proceeds only from the Outward Cold, since I know that even in Summer, Hares will change Colour, if they be kept a competent time in a Cellar;* I say, were it not for Some Scruple, because I take notice, that in the same Page the Author Affirms, that the like change of Colour that happens to Hares in some Provinces of *Muscovy*, happens to them also in *Livonia*, and yet immediately subjoyns, that in *Curland* the Hares vary not their Colour in Winter, though these two last named Countries be contiguous, (that is) sever'd only by the River of *Dugna*; For it is scarce conceivable how Cold alone should have, in Countries so near, so strangely differing an operation, though no less strange a thing is confess'd by many, that ascribe the Complexion of *Negroes* to the Heat of the Sun, when they would have the River of *Cenega* so to bound the *Moors*, that though on the North-side they are but Tawny, on the other side they are Black.

[10] *Olearius Voyage de Mosco. et de Perse liv. 3.*

There is another Opinion concerning the Complexion of *Negroes*, that is not only embrac'd by many of the more Vulgar Writers, but likewise by that ingenious Traveller Mr. *Sandys*, and by a late most learned Critick, besides other men of Note, and these would have the Blackness of *Negroes* an effect of *Noah's* Curse ratify'd by God's, upon *Cham*; But though I think that even a Naturalist may without disparagement believe all the Miracles attested by the Holy Scriptures, yet in this case to flye to a Supernatural Cause, will, I fear, look like Shifting off the Difficulty, instead of Resolving it; for we enquire not the First and Universal, but the Proper, Immediate, and Physical Cause of the Jetty Colour of *Negroes*; And not only we do not find expressed in the Scripture, that the Curse meant by *Noah* to *Cham*, was the Blackness of his Posterity, but we do find plainly enough there that the Curse was quite another thing, namely that he should be a Servant of Servants, that is by an Ebraism, a very Abject Servant to his Brethren, which accordingly did in part come to pass, when the *Israelites* of the posterity of *Sem*, subdued the *Canaanites*, that descended from *Cham*,

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and kept them in great Subjection. Nor is it evident that Blackness is a Curse, for Navigators tell us of Black Nations, who think so much otherwise of their own condition, that they paint the Devil White. Nor is Blackness inconsistent with Beauty, which even to our European Eyes consists not so much in Colour, as an Advantageous Stature, a Comely Symmetry of the parts of the Body, and Good Features in the Face. So that I see not why Blackness should be thought such a Curse to the *Negroes*, unless perhaps it be, that being wont to go Naked in those Hot Climates, the Colour of their Skin does probably, according to the Doctrine above deliver'd, make the Sun-beams more Scorching to them, than they would prove to a people of a White Complexion.

Greater probability there is, That the Principal Cause (for I would not exclude all concurrent ones) of the Blackness of *Negroes* is some Peculiar and Seminal Impression, for not onely we see that *Blackmore* boyes brought over into these Colder Climates lose not their Colour; But good Authors inform us, That the Off-spring of *Negroes* Transplanted out of *Africa*, above a hundred years ago, retain still the Complexion of their Progenitors, though possibly in Tract of time it will decay; As on the other side, the White people removing into very Hot Climates, have their Skins by the Heat of the Sun scorch'd into Dark Colours; yet neither they, nor their Children have been observ'd, even in the Countreys of *Negroes*, to descend to a Colour amounting to that of the Natives; whereas I remember I have Read in *Pisos*[11] excellent account of *Brasile*, that betwixt the *Americans* and *Negroes* are generated a distinct sort of Men, which they call *Cabocles*, and betwixt *Portugalls* and *AETHiopian* women, He tells us, he has sometimes seen Twins, whereof one had a White skin, the other a Black; not to mention here some other instances, he gives, that the productions of the mixtures of differing people, that is (indeed,) the effects of Seminal Impressions which they consequently argue to have been their Causes; and we shall not much scruple at this, if we consider, that even Organical parts may receive great Differences from such peculiar Impressions, upon what account soever they came to be settled in the first Individual persons, from whom they are Propogated to Posterity, as we see in the Blobber-Lips and Flat-Noses of most Nations of *Negroes*. And if we may Credit what Learned men deliver concerning the Little Feet of the *Chinesses*, the *Macrocephali* taken notice of by *Hippocrates*, will not be the only Instance we might apply to our present purpose. And on this occasion it will not perchance be Impertinent to add something of what I have observ'd in other Animals, as that there is a sort of Hens that want Rumps; And that (not to mention that in several places there is a sort of Crows or Daws that are not



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Cole-black as ours, but partly of a Whitish Colour) in spite of *Porphyries* examples of Inseparable Accidents, I have seen a perfectly White Raven, as to Bill as well as Feathers, which I attentively considered, for fear of being impos'd upon. And this recalls into my Memory, what a very Ingenious Physician has divers times related to me of a young Lady, to whom being call'd, he found that though she much complain'd of want of Health, yet there appear'd so little cause either in her Body, or her Condition to Guess that She did any more than fancy her self Sick, that scrupling to give her Physick, he perswaded her Friends rather to divert her Mind by little Journeys of Pleasure, in one of which going to Visit St. *Winifrids* Well, this Lady, who was a *Catholick*, and devout in her Religion, and a pretty while in the Water to perform some Devotions, and had occasion to fix her Eyes very attentively upon the Red pimple-stones, which in a scatter'd order made up a good part of those that appear'd through the water, and a while after growing Bigg, she was deliver'd of a Child, whose White Skin was Copiously speckl'd with spots of the Colour and Bignesss of those Stones, and though now this Child have already liv'd several years, yet she still retains them. I have but two things to add concerning the Blackness of *Negroes*, the one is, that the Seat of that Colour seems to be but the thin *Epidermes*, or outward Skin, for I knew a young *Negroe*, who having been lightly Sick of the Small Pox or Measles, (for it was doubted which of the two was his Disease) I found by enquiry of a person that was concern'd for him, that in those places where the little Tumors had broke their passage through the Skin, when they were gone, they left Within specks behind them; And the lately commended *Piso* assures us, that having the opportunity in *Brasil* to Dissect many *Negroes*, he clearly found that their Blackness went no deeper than the very outward Skin, which *Cuticula* or *Epidermis* being remov'd, the undermost Skin or *Cutis* appear'd just as White as that of *Europaean* Bodies. And the like has been affirmed to me by a Physician of our own, whom, hearing he had Dissectcd a *Negroe* here in *England*, I consulted about this particular. The other thing to be here taken notice of concerning *Negroes* is, That having enquir'd of an Intelligent acquaintance of mine (who keeps in the *Indies* about 300. of them as well Women as Men to work in his Plantations,) whether their Children come Black into the world; he answer'd, That they did not, but were brought forth of almost the like Reddish Colour with our *European* Children; and having further enquir'd, how long it was before these Infants appear'd Black, be reply'd, that 'twas not wont to be many daies. And agreeable to this account I find that, given us in a freshly publish'd French Book written by a *Jesuit*, that had good opportunity of Knowing



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the Truth of what he Delivers, for being one of the Missionaries of his Order into the Southern *America* upon the Laudable Design of Converting Infidels to Christianity, he Baptiz'd several Infants, which when newly Born, were much of the same Colour with *European* Babes, but within about a Week began to appear of the Hue of their Parents. But more Pregnant is the Testimony of our Country-man *Andrew Battel*, who being sent Prisoner by the *Portugalls* to *Angola*, liv'd there, and in the adjoining Regions, partly as a Prisoner, partly as a Pilot, and partly as a Souldier, near 18. years, and he mentioning the *African* Kingdom of *Longo*, peopl'd with Blacks, has this passage:[12] *The Children in this Country are Born White, and change their Colour in two dayes to a Perfect Black. As for Example, The Portugalls which dwell in the Kingdome of Longo have sometimes Children by the Negroe_-women, and many times the Fathers are deceived, thinking, when the Child is Born, that it is theirs, and within two dayes it proves the Son or Daughter of a_ Negroe,_ which the_ Portugalls greatly grieve at; And the same person has elsewhere a Relation, which, if he have made no use at all of the liberty of a Traveller, is very well worth our Notice, since this, together with that we have formerly mention'd of Seminal Impressions, shews a possibility, that a Race of Negroes might be begun, though none of the Sons of Adam, for many Precedent Generations were of that Complexion. For I see not why it should not be at least as possible, that White Parents may sometimes have Black Children, as that African Negroes should sometimes have lastingly White ones, especially since concurrent causes may easily more befriend the Productions of the Former kind, than under the scorching Heat of Africa those of the Latter. And I remember on the occasion of what he delivers, that of the White Raven formerly mention'd, the Possessor affirm'd to me, that in the Nest out of which he was taken White, they found with him but one other Young one, and that he was of as Jetty a Black as any common Raven. But let us hear our Author himself[13]; Here are (sayes he, speaking of the formerly mention'd Regions) *Born in this Country White Children, which is very rare among them, for their Parents are Negroes; And when any of them are Born, they are presented to the King, and are call'd Dondos; these are as White as any White Men. These are the Kings Witches, and are brought up in Witchcraft, and alwayes wait on the King: There is no man that dare meddle with these Dondos, if they go to the Market they may take what they lift, for all Men stand in awe of them. The King of Longo hath four of them. And yet this Country in our Globes is plac'd almost in the midst of the Torrid Zone (four or five Degrees Southward of the Line.) And our Author elsewhere tells**



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us of the Inhabitants, that they are so fond of their Blackness, that they will not suffer any that is not of that Colour (as the *Portugalls* that come to Trade thither) to be so much as Buri'd in their Land, of which he annexes a particular example,[14] that may be seen in his Voyage preserv'd by our Industrious Countreyman Mr. *Purchas*. But it is high time for me to dismiss Observations, and go on with Experiments.

[11] *Piso Nat. & Med. Hist. Brasil. lib 1. in fine.*

[12] *Purchas Pilgrim. Second part, Seventh Book 3. Chap. Sect 5.*

[13] *Purchas. Ibid.*

[14] *Purchas Ibid. in fin*

EXPERIMENT XII.

The way, *Pyrophilus*, of producing Whiteness by Chymical Praecipitations is very well worth our observing, for thereby Bodyes of very Differing Colours as well as Natures, though dissolv'd in Several Liquors, are all brought into *Calces* or Powders that are White. Thus we find that not only Crabs-eyes, that are of themselves White, and Pearls that are almost so, but *Coral* and *Minium* that are Red, being dissolv'd in Spirit of Vinegar, may be uniformly Praecipitated by Oyl of *Tartar* into White Powders. Thus Silver and Tin separately dissolv'd in *Aqua Fortis*, will the one Praecipitate it self, and the other be Praecipitated by common Salt-water into a White *Calx*, and so will Crude Lead and Quicksilver first dissolv'd likewise in *Aqua Fortis*. The like *Calx* will be afforded as I have try'd by a Solution of that shining Mineral Tinglass dissolv'd in *Aqua Fortis*, and Praecipitated out of it; and divers of these *Calces* may be made at least as Fair and White, if not better Colour'd, if instead of Oyl of *Tartar* they were Praecipitated with Oyl of *Vitriol*, or with another Liquor I could Name. Nay, that Black Mineral *Antimony* it self, being reduc'd by and with the Salts that concurr to the Composition of common Sublimate, into that Cleer though Unctuous Liquor that Chymists commonly call Rectifi'd Butter of *Antimony*, will by the bare affusion of store of Fair Water be struck down into that Snow-white Powder, which when the adhering Saltness is well wash'd off, Chymists are pleas'd to call *Mercurius Vitae*, though the like Powder may be made of *Antimony*, without the addition of any *Mercury* at all. And this Lactescence if I may so call it, does also commonly ensue when Spirit of Wine, being Impregnated with those parts of Gums or other Vegetable Concretions, that are suppos'd to abound with Sulphureous Corpuscles, fair Water is suddenly pour'd upon the Tincture or Solution. And I remember that very lately I did, for Tryal sake, on a Tincture of *Benjamin* drawn with Spirit of Wine, and brought to be as Red as Blood, pour some fair Water, which presently mingling with the Liquor, immediately turn'd the whole Mixture White. But if such Seeming

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Milks be suffer'd to stand unstirr'd for a convenient while, they are wont to let fall to the bottome a Resinous Substance, which the Spirit of Wine Diluted and Weakned by the Water pour'd into it was unable to support any longer. And something of Kin to this change of Colour in Vegetables is that, which Chymists are wont to observe upon the pouring of Acid Spirits upon the Red Solution of *Sulphur*, dissolv'd in an Infusion of Pot-ashes, or in some other sharp *Lixivium*, the Praecipitated *Sulphur* before it subsides, immediately turning the Red Liquor into a White one. And other Examples might be added of this way of producing Whiteness in Bodyes by Praecipitating them out of the Liquors wherein they have been Dissolv'd; but I think it may be more usefull to admonish you, *Pyrophilus*, that this observation admits of Restrictions, and is not so Universal, as by this time perhaps you have begun to think it; For though most Praecipitated Bodyes are White, yet I know some that are not; For Gold Dissolv'd in *Aqua Regis*, whether you Praecipitate it with Oyl of *Tartar*, or with Spirit of *Sal Armoniack*, will not afford a White but a Yellow *Calx*. *Mercury* also though reduc'd into Sublimate, and Praecipitated with Liquors abounding with Volatile Salts, as the Spirits drawn from Urine, Harts-horn, and other Animal substances, yet will afford, as we Noted in our first Experiment about Whiteness and Blackness, a White Praecipitate, yet with some Solutions hereafter to be mentioned, it will let fall an Orange-Tawny Powder. And so will Crude *Antimony*, if, being dissolv'd in a strong Lye, you pour (as farr as I remember) any Acid Liquor upon the Solution newly Filtrated, whilst it is yet Warm. And if upon the Filtrated Solution of *Vitriol*, you pour a Solution of one of these fix'd Salts, there will subside a Copious substance, very farr from having any Whiteness, which the Chymists are pleas'd to call, how properly I have elsewhere examin'd, the *Sulphur of Vitriol*. So that most part of Dissolv'd Bodyes being by Praecipitation brought to White Powders, and yet some affording Praecipitates of other Colours, the reason of both the Phaenomena may deserve to be enquir'd into.

EXPERIMENT XIII.

Some Learned Modern Writers^[15] are of Opinion, that the Account upon which Whiteness and Blackness ought to be call'd, as they commonly are, the two Extreme Colours, is, That Blackness (by which I presume is meant the Bodyes endow'd with it) receives no other Colours; but Whiteness very easily receives them all; whence some of them compare Whiteness to the *Aristotelian Materia prima*, that being capable of any sort of Forms, as they suppose White Bodyes to be of every kind of Colour. But not to Dispute about Names or Expressions, the thing it self that is affirm'd as Matter of Fact, seems to be True enough in most Cases, not in all, or so, as to hold Universally. For though it be a common



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observation among Dyers, That Clothes, which have once been throughly imbu'd with Black, cannot so well afterwards be Dy'd into Lighter Colours, the praeexistent Dark Colour infecting the Ingredients, that carry the Lighter Colour to be introduc'd, and making it degenerate into Some more Sad one; Yet the Experiments lately mention'd may shew us, that where the change of Colour in Black Bodies is attempted, not by mingling Bodyes of Lighter Colours with them, but by Addition of such things as are proper to alter the Texture of those Corpuscles that contain the Black Colour, 'tis no such difficult matter, as the lately mention'd Learned Men imagine, to alter the Colour of Black Bodyes. For we saw that Inks of several Kinds might in a trice be depriv'd of all their Blackness; and those made with Logwood and Red-Roses might also be chang'd, the one into a Red, the other into a Reddish Liquor; and with Oyl of *Vitriol* I have sometimes turn'd Black pieces of Silk into a kind of Yellow, and though the Taffaty were thereby made Rotten, yet the spoyling of that does no way prejudice the Experiment, the change of Black Silk into Yellow, being never the less True, because the Yellow Silk is the less good. And as for Whiteness, I think the general affirmation of its being so easily Destroy'd or Transmuted by any other Colour, ought not to be receiv'd without some Cautions and Restrictions. For whereas, according to what I formerly Noted, Lead is by Calcination turned into that Red Powder we call *Minium*; And Tin by Calcination reduc'd to a White *Calx*, the common Putty that is sold and us'd so much in Shops, instead of being, as it is pretended and ought to be, only the *Calx* of Tin, is, by the Artificers that make it, to save the charge of Tin, made, (as some, of themselves have confess'd, and as I long suspected by the Cheap rate it may be bought for) but of half Tin and half Lead, if not far more Lead than Tin, and yet the Putty in spite of so much Lead is a very White Powder, without disclosing any mixture of *Minium*. And so if you take two parts of Copper, which is a High-colour'd Metall, to but one of Tin, you may by Fusion bring them into one Mass, wherein the Whiteness of the Tin is much more Conspicuous and Predominant than the Reddishness of the Copper. And on this occasion it may not be Impertinent to mention an Experiment, which I relate upon the Credit of a very Honest man, whom I purposely enquir'd of about it, being my self not very fond of making Tryals with *Arsenick*, the Experiment is this, That if you Colliquate *Arsenick* and Copper in a due proportion, the *Arsenick* will Blanch the Copper both within and without, which is an Experiment well enough Known; but when I enquir'd, whether or no this White mixture being skilfully kept a while upon the Cupel would not let go its *Arsenick*, which made Whiteness its praedominant Colour, and return to the Reddishness of Copper, I was assur'd



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of the Affirmative; so that among Mineral Bodies, some of those that are White, may be far more capable, than those I am reasoning with seem to have known, of Eclipsing others, and of making their Colour Praedominant in Mixtures. In further Confirmation of which may be added, that I remember that I also took a lump of Silver and Gold melted together, wherein by the AEstimate of a very Experienced Refiner, there might be about a fourth or third part of Gold, and yet the Yellow Colour of the Gold was so hid by the White of the Silver, that the whole Mass appear'd to be but Silver, and when it was rubb'd upon the Touchstone, an ordinary beholder could scarce have distinguish'd it from the Touch of common Silver; though if I put a little *Aqua Fortis* upon any part of the White Surface it had given the Touchstone, the Silver in the moistned part being immediately taken up and conceal'd by the Liquor, the Golden Particles would presently disclose that native Yellow, and look rather as if Gold, than if the above mention'd mixture, had been rubb'd upon the Stone.

[15] See *Scaliger* Exercit. 325. Sect. 9.

EXPERIMENT XIV.

I took a piece of Black-horn, (polish'd as being part of a Comb) this with a piece of broken glass I scrap'd into many thin and curdled flakes, some shorter and some longer, and having laid a pretty Quantity of these scrapings together, I found, as I look'd for, that the heap they compos'd was White, and though, if I laid it upon a clean piece of White Paper, its Colour seem'd somewhat Eclips'd by the greater Whiteness of the Body it was compar'd with, looking somewhat like Linnen that had been sulli'd by a little wearing, yet if I laid it upon a very Black Body, as upon a Beaver Hatt, it then appear'd to be of a good White, which Experiment, that you may in a trice make when you please, seems very much to Disfavour both their Doctrine that would have Colours to flow from the Substantial Forms of Bodyes, and that of the Chymists also, who ascribe them to one or other of their three Hypostatical Principles; for though in our Case there was so great a Change made, that the same Body without being substantially either Increas'd or Lessened, passes immediately from one extreme Colour to another (and that too from Black to White) yet this so great and sudden change is effected by a slight Mechanical Transposition of parts, there being no Salt or *Sulphur* or *Mercury* that can be pretended to be Added or Taken away, nor yet any substantial Form that can reasonably be suppos'd to be Generated and Destroy'd, the Effect proceeding only from a Local Motion of the parts which so vary'd their Position as to multiply their distinct Surfaces, and to Qualifie them to Reflect far more Light to the Eye, than they could before they were scrap'd off from the entire piece of Black horn.

EXPERIMENT XV.



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And now, *Pyrophilus*, it will not be improper for us to take some notice of an Opinion touching the cause of Blackness, which I judged it not so seasonable to Question, till I had set down some of the Experiments, that might justifie my dissent from it. You know that of late divers Learned Men, having adopted the three Hypostatical Principles, besides other Notions of the Chymists, are very inclinable to reduce all Qualities of Bodies to one or other of those three Principles, and Particularly assign for the cause of Blackness the Sootie steam of *adust* or *torrifi'd Sulphur*. But I hope that what we have deliver'd above to countenance the Opinion we have propos'd about the Cause of Blackness, will so easily supply you with several Particulars that may be made use of against this Opinion, that I shall now represent to You but two things concerning it.

And First it seems that the favourers of the Chymicall Theories might have pitcht upon some more proper term, to express the Efficient of Blackness than *Sulphur adust*; for we know that *common Sulphur*, not only when Melted, but even when Sublim'd, does not grow Black by suffering the Action of the fire, but continues and ascends Yellow, and rather more than less White, than it was before its being expos'd to the fire. And if it be set on fire, as when we make that acid Liquor, that Chymists call *Oleum Sulphuris per campanam*, it affords very little Soot, and indeed the flame yeelds so little, that it will scarce in any degree Black a sheet of White Paper, held a pretty while over the flame and smoak of it, which is observed rather to Whiten than Infect linnen, and which does plainly make Red Roses grow very Pale, but not at all Black, as far as the Smoak is permitted to reach the leaves. And I can shew you of a sort of fixt Sulphur made by an Industrious Laborant of your acquaintance, who assur'd me that he was wont to keep it for divers weeks together night and day in a naked and Violent fire, almost like that of the Glass-house, and when, to satisfie my Curiosity, I made him take out a lump of it, though it were glowing hot (and yet not melted,) it did not, when I had suffered it to cool, appear Black, the true Colour of it being a true Red. I know it may be said, that *Chymists* in the Opinion above recited mean the *Principle of Sulphur*, and not *common Sulphur* which receives its name, not from its being *all* perfectly of a Sulphureous Nature, but for that *plenty* and *Predominancy* of the Sulphureous Principle in it. But allowing this, 'tis easie to reply, that still according to this very Reason, *torrifi'd Sulphur* should afford more Blackness, than most other concretes, wherein that Principle is confess'd to be far less copious. Also when I have expos'd Camphire to the fire in Close Vessels, as Inflammable, and consequently (according to the Chymists) as Sulphureous a Body as it is, I could not by such a degree of Heat, as brought it

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to Fusion, and made it Boyl in the glass, impress any thing of Blackness, or of any other Colour, than its own pure White, upon this Vegetable concrete. But what shall we say to Spirit of Wine, which being made by a Chymical Analysis of the Liquor that affords it, and being totally Inflammable, seems to have a full right to the title they give it of *Sulphur Vegetabile*, & yet this fluid Sulphur not only contracts not any degree of Blackness by being often so heated, as to be made to Boyl, but when it burns away with an Actual flame, I have not found that it would discolour a piece of White Paper held over it, with any discernable soot. Tin also, that wants not, according to the Chymists, a *Sulphur Joviale*, when thoroughly burned by the fire into a *Calx*, is not Black, but eminently White. And I lately noted to you out of *Bellonius*, that the Charcoals of Oxy-cedar are not of the former of these two Colours, but of the latter. And the Smoak of our Tinby coals here in *England*, has been usually observ'd, rather to Blanch linnen than to Black it. To all which, other Particulars of the like nature might be added, but I rather choose to put you in mind of the third Experiment, about making Black Liquors, or Inks, of Bodies that were non of them Black before. For how can it be said, that when those Liquors are put together actually Cold, and continue so after their mixture, there intervenes any new *Adustion of Sulphur* to produce the emergent Blackness? (and the same question will be applicable to the Blackness produc'd upon the blade of a Knife, that has cut Lemmons and some kind of Sowr apples, if the juyce (though both Actually and Potentially Cold) be not quickly wip'd of) And when by the instilling either of a few drops of Oyl of Vitriol as in the second Experiment, or of a little of the Liquor mention'd in the Passage pointed at in the fourth Experiment, (where I teach at once to Destroy one black Ink, and make another) the Blackness produc'd by those Experiments is presently destroy'd; if the Colour proceeded only from the Plenty of Sulphurous parts, torrify'd in the Black Bodies, I demand, what becomes of them, when the Colour so suddenly disappears? For it cannot Reasonably be said, that all those that suffic'd to make so great a quantity of Black Matter, should resort to so very small a proportion of the Clarifying Liquor, (if I may so call it) as to be deluted by it, with out at all Denigrating it. And if it be said that the Instill'd Liquor dispers'd those Black Corpuscles, I demand, how that Dispersion comes to destroy their Blackness, but by making such a Local Motion of their parts, as destroys their former Texture? which may be a Matter of such moment in cases like ours, that I remember that I have in few houres, without addition, from Soot it self, attain'd pretty store of Crystalline Salt, and good store of Transparent Liquor, and (which I have on another occasion noted as remarkable) this so Black Substance had its Colour so alter'd, by the change of Texture it receiv'd from the fire, wherewith it was distill'd, that it did for a great while afford such plenty of very white Exhalations, that the Receiver, though large, seem'd to be almost fill'd with Milk.



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Secondly, But were it granted, as it is in some cases not Improbable, that divers Bodies may receive a Blackness from a Sootie Exhalation, occasion'd by the Adustion of their Sulphur, which (for the Reasons lately mention'd I should rather call their Oonly parts;) yet still this account is applicable but to some Particular Bodies, and will afford us no General Theory of Blackness. For if, for example, White Harts-horn, being, in Vessels well luted to each other, expos'd to the fire, be said to turn Black by the Infection of its own Smoak, I think I may justly demand, what it is that makes the Smoak or Soot it self Black, since no Such Colour, but its contrary, appear'd before in the Harts-horn? And with the same Reason, when we are told, that torrify'd Sulphur makes bodies Black, I desire to be told also, why Torrefaction makes Sulphur it self Black? nor will there be any Satisfactory Reason assign'd of these Quaeries, without taking in those Fertile as well as intelligible Mechanical Principles of the Position and Texture of the Minute parts of the body in reference to the Light and the Eye; and these applicable Principles may Serve the turn in many cases, where the Adustion of Sulphur cannot be pretended; as in the appearing Blackness of an Open window, lookt upon at a somewhat remote distance from the house, as also in the Blackness Men think they see in the Holes that happen to be in White linnen, or Paper of the like Colour; and in the Increasing Blackness immediatly Produc'd barely by so rubbing Velvet, whose Piles were Inclind before, as to reduce them to a more Erected posture, in which and in many other cases formerly alleg'd, there appears nothing requisite to the Production of *the* Blackness, but the hindering of the incident Beams of Light from rebounding plentifully enough to the Eye. To be short, those I reason with, do concerning Blackness, what the Chymists are wont also to do concerning other Qualities, namely to content themselves to tell us, in what Ingredient of a Mixt Body, the Quality enquir'd after, does reside, instead of explicating the Nature of it, which (to borrow a comparison from their own Laboratories) is much as if in an enquiry after the cause of Salivation, they should think it enough to tell us, that the several Kinds of Praecipitates of Gold and *Mercury* as likewise of Quick-silver and Silver (for I know that make and use of such Praecipitates also) do Salivate upon the account of the *Mercury*, which though Disguis'd abounds in them, whereas the Difficulty is as much to know upon what account *Mercury* it self, rather than other Bodies, has that power of working by Salivation. Which I say not, as though it were not *something* (and too often the most we can arrive at) to discover in which of the Ingredients of a Compounded Body, the Quality, whose Nature is sought, resides, but because, though this Discovery it self may pass for *something*, and is oftentimes more than what is taught us about the same subjects in the Schools, yet we ought not to think it *enough*, when more Clear and Particular accounts are to be had.



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* * * * *

THE
Experimental History
OF
COLOURS
Begun.

* * * * *

The Third PART.

* * * * *

Containing
Promiscuous Experiments
About
COLOURS.

* * * * *

EXPERIMENT I.

Because that, according to the Conjectures I have above propos'd, one of the most General Causes of the Diversity of Colours in Opacous Bodies, is, that some reflect the Light mingl'd with more, others with less of Shade (either as to Quantity, or as to Interruption) I hold it not unfit to mention in the first place, the Experiments that I thought upon to examine this Conjecture. And though coming to transcribe them out of some Physiological *Adversaria* I had written in loose Papers, I cannot find one of the chief Records I had of my Tryals of this Nature, yet the Papers that scap'd miscarrying, will, I presume, suffice to manifest the main thing for which I now allege them; I find then Among my *Adversaria*, the following Narrative.

October the 11. About ten in the Morning in Sun-shiny Weather, (but not without fleeting Clouds) we took several sorts of Paper Stain'd, some of one Colour, and some of another; and in a Darken'd Room whose Window look'd Southward, we cast the Beams that came in at a hole about three Inches and a half in Diameter, upon a White wall that was plac'd on one side, about five foot distance from them.

The White gave much the Brightest Reflection.

The Green, Red, and Blew being Compar'd together, the Red gave much the strongest Reflection, and manifestly enough also threw its *Colour* upon the Wall; The Green and Blew were scarce Discernable by their Colours, and seem'd to reflect an almost Equal Light.



The Yellow Compar'd with the two last nam'd, Reflected somewhat more Light.

The Red and Purple being Compar'd together, the former manifestly Reflected a good deal more Light.

The Blew and Purple Compar'd together, the former seem'd to Reflect a little more Light, though the Purple Colour were more manifestly seen.

A Sheet of very well fleck'd Marbl'd Paper being Apply'd as the others, did not cast any or its Distinct Colours upon the Wall; nor throw its Light upon it with an Equal Diffusion, but threw the Beams Unstain'd and Bright to this and that part of the Wall, as if it's Polish had given it the Nature of a specular Body. But comparing it with a sheet of White Paper, we found the Reflection of the latter to be much Stronger, it diffusing almost as much Light to a *good Extent* as the Marble Paper did to *one part* of the Wall.

The Green and Purple left us somewhat in suspence which Reflected the most Light; only the Purple seem'd to have some little Advantage over the Green, which was Dark in its kind.



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Thus much I find in our above mention'd *Collections*, among which there are also some Notes concerning the Production of *Compounded Colours*, by *Reflection* from Bodies differinglly Colour'd. And these Notes we intended should supply us with what we should mention as our second Experiment: but having lost the Paper that contain'd the Particulars, and remembring onely in General, that if the Objects which Reflected the Light were not Strongly Colour'd and somewhat Glossy, the Reflected Beams would not manifestly make a Compounded Colour upon the Wall, and even then but very Faintly, we shall now say no more of that Matter, only reserving our selves to mention hereafter the Composition of a Green, which we still retain in Memory.

EXPERIMENT II.

We may add, *Pyrophilus*, on this Occasion, that though a Darken'd Room be Generally thought requisite to make the Colour of a Body appear by Reflection from another Body, that is not one of those that are commonly agreed upon to be Specular (as Polish'd Metall, Quick silver, Glass, Water, &c.) Yet I have often observ'd that when I wore Doublets Lin'd with some silken Stuff that was very Glossy and Vividly Colour'd, especially Red, I could in an Inlightned Room plainly enough Discern the Colour, upon the Pure White Linnen that came out at my Sleeve and reach'd to my Cufs; as if that Fine White Body were more Specular, than Colour'd and Unpolish'd Bodies are thought Capable of being.

EXPERIMENT III.

Whilst we were making the newly mention'd Experiments, we thought fit to try also what Composition of Colours might be made by Altering the Light in its Passage to the Eye by the Interposition not of Perfectly Diaphanous Bodies, (that having been already try'd by others as well as by us (as we shall soon have occasion to take notice) but of Semi-opacous Bodies, and those such as look'd upon in an ordinary Light, and not held betwixt it and the Eye, are not wont to be Discriminated from the rest of Opacous Bodies; of this Tryal, our mention'd *Adversaria* present us the following Account.

Holding these Sheets, sometimes one sometimes the other of them, before the Hole betwixt the Sun and the Eye, with the Colour'd sides obverted to the Sun; we found them *single* to be somewhat Transparent, and appear of the same Colour as before, onely a little alter'd by the great Light they were plac'd in; but laying *two* of them one over another and applying them so to the Hole, the Colours were compounded as follows.

The Blew and Yellow scarce exhibited any thing but a Darker Yellow, which we ascrib'd to the Coarseness of the Blew Papers, and its Darkness in its Kind. For applying the Blew parts of the Marbl'd Paper with the Yellow Paper after the same manner, they exhibited a good Green.

The Yellow and Red look'd upon together gave us but a Dark Red, somewhat (and but a little,) inclining to an Orange Colour.

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The Purple and Red look'd on together appear'd more Scarlet.

The Purple and Yellow made an Orange.

The Green and Red made a Dark Orange Tawny.

The Green and Purple made the Purple appear more Dirty.

The Blew and Purple made the Purple more Lovely, and far more Deep.

The Red parts of the Marbl'd Paper look'd upon with the Yellow appear'd of a Red far more like Scarlet than without it.

[Page 191] But the Fineness or Coarseness of the Papers, their being carefully or slightly Colour'd, and divers other Circumstances, may so vary the Events of such Experiments as these, that if, *Pyrophilus*, you would Build much on them, you must carefully Repeat them.

EXPERIMENT IV.

The Triangular Prismatical Glass being the Instrument upon whose Effects we may the most Commodiously speculate the Nature of Emphatical Colours, (and perhaps that of Others too;) we thought it might be usefull to observe the several Reflections and Refractions which the Incident Beams of Light suffer in Rebouncing from it, and Passing through it. And this we thought might be Best done, not (as is usual,) in an ordinary Inlightn'd Room, where (by reason of the Difficulty of doing otherwise) ev'n the Curious have left Particulars Unheeded, which may in a convenient place be easily taken notice of; but in a Darken'd Room, where by placing the Glass in a convenient Posture, the Various Reflections and Refractions may be Distinctly observ'd; and where it may appear *what* Beams are Unting'd; and *which* they are, that upon the Bodyes that terminate them, do Paint either the Primary or Secondary Iris. In pursuance of this we did in the above mention'd Darken'd Room, make observation of no less than four Reflections, and three Refractions that were afforded us by the same Prism, and thought that notwithstanding what was taught us by the Rules of Catoptricks and Dioptricks, it would not be amiss to find also, by hiding sometimes one part of the Prism, and sometimes another, and observing where the Light or Colour Vanish'd thereupon, by which Reflection and by which Refraction each of the several places whereon the Light rebounding from, or passing through, the Prism appear'd either Sincere or Tinted, was produc'd. But because it would be Tedious and not so Intelligible to deliver this in Words, I have thought fit to Referr You to the Annexed Scheme where the Newly mention'd particulars may be at one View taken Notice of.

EXPERIMENT V.

[Illustration: *The Explication of the Scheme.*]



PPP. An Aequilaterotriangular Crystalline Prism, one of whose edges P . is placed directly towards the Sun.

AB & $[\alpha]$ $[\beta]$ Two rays from the Sun falling on the Prism at B $[\beta]$. and thence partly reflected towards C & $[\gamma]$. and partly refracted towards D & $[\delta]$.

BC & $[\beta]$ $[\gamma]$. Those reflected Rays.



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B D & [beta] [delta]. Those refracted Rays which are partly refracted towards *E* & [epsilon]. and there paint an Iris 1 2 3 4 5. denoting the five consecutions of colours Red, Yellow, Green, Blew, and Purple; and are partly reflected towards *F* & [zeta].

D F & [delta] [zeta]. Those Reflected Rays which are partly refracted towards *G* & [eta]. colourless, and partly reflected, towards *H* & [theta].

F H & [zeta] [theta]. Those reflected Rays which are refracted towards *I* & [iota]. and there paint an other fainter Iris, the colours of which are contrary to the former 5 4 3 2 1. signifying Purple, Blew, Green, Yellow, Red, so that the Prism in this posture exhibits four Rainbows.

I know not whether you will think it Inconsiderable to annex to this Experiment, That we observ'd in a Room not Darken'd, that the Prismatical Iris (if I may so call it) might be Reflected without losing any of its several *Colours* (for we now consider not their *Order*) not onely from a plain Looking-glass and from the calm Surface of Fair Water, but also from a Concave Looking-glass; and that Refraction did as little Destroy those Colours as Reflection. For by the help of a large (double Convex) Burning-glass through which we Refracted the Suns Beams, we found that one part of the Iris might be made to appear either beyond, or on this side of the other Parts of the same Iris; but yet the same Vivid Colours would appear in the Displac'd part (if I may so term it) as in the other. To which I shall add, that having, by hiding the side of the Prism, obverted to the Sun with an Opacous Body, wherein only one small hole was left for the Light to pass through, reduc'd the Prismatical Iris (cast upon White Paper) into a very narrow compass, and look'd upon it through a Microscope; the Colours appear'd the same as to kind that they did to the naked Eye.

EXPERIMENT VI.

It may afford matter of Speculation to the Inquisitive, such as you, *Prophilus*, that as the Colours of outward Objects brought into a Darken'd Room, do so much depend for their Visibility upon the Dimness of the Light they are there beheld by; that the ordinary Light of the day being freely let in upon them, they immediately disappear: so our Tryals have inform'd us, that as to the Prismatical Iris painted on the Floor by the beams of the Sun Trajected through a Triangular-glass; though the Colours of it appear very Vivid ev'n at Noon-day, and in Sun shiny Weather, yet by a more Powerfull Light they may be made to disappear. For having sometimes, (in prosecution of some Conjectures of mine not now to be Insisted on,) taken a large Metalline Concave *Speculum*, and with it cast the converging Beams of the Sun upon a Prismatical Iris which I had caus'd to be projected upon the Floor, I found that the over-powerfull Light made the Colours of the Iris disappear. And if I so Reflected the Light as that it cross'd but the middle of the Iris, in that part only the Colours vanish'd or were made Invisible; those parts of the Iris that were on the right and left hand of the Reflected Light (which seem'd to divide them, and

cut the Iris asunder) continuing to exhibit the same Colours as before. But upon this we must not now stay to Speculate.



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EXPERIMENT VII.

I have sometimes thought it worth while to take notice, whether or no the Colours of Opacous Bodies might not appear to the Eye somewhat Diversify'd, not only by the Disposition of the Superficial parts of the Bodies themselves and by the Position of the Eye in Reference to the Object and the Light, (for these things are Notorious enough;) but according also to the Nature of the Lucid Body that shines upon them. And I remember that in Prosecution of this Curiosity, I observ'd a manifest Difference in some Kinds of Colour'd Bodies look'd on by Day-light, and afterwards by the light of the Moon; either directly falling on them or Reflected upon them from a Concave Looking-glass. But not finding at present in my Collections about Colours any thing set down of this Kind, I shall, till I have opportunity to repeat them, content my self to add what I find Register'd concerning Colours look'd on by Candle-light, in regard that not only the Experiment is more easie to be repeated, but the Objects being the Same Sorts of Colour'd Paper lastly mention'd, the Collation of the two Experiments may help to make the Conjectures they will suggest somewhat the less uncertain.

Within a few dayes of the time above mention'd, divers Sheets of Colour'd Paper that had been look'd upon before in the Sunshine were look'd upon at night by the light of a pretty big Candle, (snuff'd) and the Changes that were observ'd were these.

The Yellow seem'd much fainter than in the Day, and inclinable to a pale Straw Colour.

The Red seem'd little Chang'd; but seem'd to Reflect Light more strongly than any other Colour (for White was none of them.)

A fair Deep Green look'd upon by it self seem'd to be a Dark Blew: But being look'd upon together with a Dark Blew, appear'd Greenish; and beheld together with a Yellow appear'd more Blew than at first.

The Blew look'd more like a Deep Purple or Murray than it had done in the Daylight.

The Purple seem'd very little alter'd.

The Red look'd upon with the Yellow made the Yellow look almost like Brown Cap-paper.

N. The Caution Subjoyned to the third Experiments is also Applicable to this.

EXPERIMENT VIII.

But here I must not omit to subjoyn, that to satisfie our Selves, whether or no the Light of a Candle were not made unsincere, and as it were Ting'd with a Yellow Colour by the Admixture of the Corpuscles it assumes from its Fuel; we did not content our selves with what appears to the Naked Eye, but taking a pretty thick Rod or Cylinder (for thin



Pieces would not serve the turn) of deep Blew Glass, and looking upon the Candles flame at a Convenient distance through it, we perceiv'd as we expected, the Flame to look Green; which as we often note, is the Colour wont to emerge from the Composition of Opacous Bodies, which were apart one of them Blew, and the other Yellow.



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And this perchance may be the main Reason of that which some observe, that a sheet of very White Paper being look'd upon by Candle light, 'tis not easie at first to discern it from a light Yellow or Lemon Colour; White Bodyes (as we have elsewhere observ'd) having more than those that are otherwise Colour'd, of a Specular Nature; in regard that though they exhibit not, (unless they be Polish'd,) the shape of the Luminary that shines on them, yet they Reflect its Light more Sincere and Untroubl'd, by either Shades or Refractions, than Bodyes of other Colours (as Blew, or Green, or Yellow or the like.)

EXPERIMENT IX.

We took a Leaf of Such Foliated Gold as Apothecaries are wont to Gild their Pills with; and with the Edge of a Knife, (lightly moysten'd by drawing it over the Surface of the Tongue, and afterwards) laid upon the edge of the Gold Leaf; we so fasten'd it to the Knife, that being held against the light, it continu'd extended like a little Flagg. This Leaf being held very near the Eye, and obverted to the Light, appear'd so full of Pores, that it seem'd to have such a kind of Transparency as that of a Sive, or a piece of Cyprus, or a Love-Hood; but the Light that pass'd by these Pores was in its Passages So Temper'd with Shadow, and Modify'd, that the Eye discern'd no more a Golden Colour, but a Greenish Blew. And for other's satisfaction, we did in the Night look upon a Candle through such a Leaf of Gold; and by trying the Effect of Several Proportions of Distance betwixt the Leaf, the Eye and the Light, we quickly hit upon such a Position for the Leaf of Gold, as that the flame, look'd on through it, appear'd of a Greenish Blew, as we have seen in the Day time. The like Experiment try'd with a Leaf of Silver succeeded not well.

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EXPERIMENT X.

We have sometimes found in the Shops of our Druggists, a certain Wood, which is there called *Lignum Nephriticum*, because the Inhabitants of the Country where it grows, are wont to use the Infusion of it made in fair Water against the Stone of the Kidneys, and indeed an Eminent Physician of our Acquaintance, who has very Particularly enquir'd into that Disease, assures me, that he has found such an Infusion one of the most effectual Remedyes, which he has ever tried against that formidable Disease. The ancientest Account I have met with of this Simple, is given us by the Experienc'd *Monardes* in these Words. *Nobis*, says he, [16] *Nova Hispania mittit quoddam ligni genus crassum & enode, cujus usus jam diu receptus fuit in his Regionibus ad Renum vitia & urinae difficultates ac arenulas pellendas. Fit autem hac ratione, Lignum assulatim & minutim concisum in limpidissima aqua fontana maceratur, inque ea relinquitur, donec aqua a bibentibus absumpta sit, dimidia hora post injectum lignum*

aqua caeruleum colorem contrahit, qui sensim intenditur pro temporis diuturnitate, tametsi



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lignum candidum fit. This Wood, *Pyrophilus*, may afford us an Experiment, which besides the singularity of it, may give no small assistance to an attentive Considerer towards the detection of the Nature of Colours. The Experiment as we made it is this. Take *Lignum Nephriticum*, and with a Knife cut it into thin Slices, put about a handfull of these Slices into two three or four pound of the purest Spring-water, let them infuse there a night, but if you be in hast, a much shorter time may suffice; *decant* this Impregnated Water into a clear Glass Vial, and if you hold it directly between the Light and your Eye, you shall see it wholly Tincted (excepting the very top of the Liquor, wherein you will some times discern a Sky-colour'd Circle) with an almost Golden Colour, unless your Infusion have been made too Strong of the Wood, for in that case it will against the Light appear somewhat Dark and Reddish, and requires to be diluted by the addition of a convenient quantity of fair Water. But if you hold this Vial from the Light, so that your Eye be plac'd betwixt the Window and the Vial, the Liquor will appear of a deep and lovely Caeruleous Colour, of which also the drops, if any be lying on the outside of the Glass, will seem to be very perfectly; And thus far we have try'd the Experiment, and found it to Succeed even by the Light of Candles of the larger size. If you so hold the Vial over against your Eyes, that it may have a Window on one side of it, and a Dark part of the Room both before it and on the other side, you shall see the Liquor partly of a Blewish and partly of a Golden Colour. If turning your back to the Window, you powr out some of the Liquor towards the Light and towards your Eyes, it will seem at the coming out of the Glass to be perfectly Caeruleous, but when it is fallen down a little way, the drops may seem Particolour'd, according as the Beams of Light do more or less fully Penetrate and Illustrate them. If you take a Bason about half full of Water, and having plac'd it so in the Sun-beams Shining into a Room, that one part of the Water may be freely illustrated by the Beams of Light, and the other part of it Darkned by the shadow of the Brim of the Bason, if then I say you drop of our Tincture, made somewhat strong, both into the Shaded and Illuminated parts of the Water, you may by looking upon it from several places, and by a little Agitation of the water, observe divers pleasing Phaenomena which were tedious to particularize. If you powr a little of this Tincture upon a sheet of White Paper, so as the Liquor may remain of some depth upon it, you may perceive the Neighbouring drops to be partly of one Colour, and partly of the other, according to the position of your Eye in reference to the Light when it looks upon them, but if you powr off all the Liquor, the Paper will seem Dy'd of an almost Yellow Colour. And if a sheet of Paper with some of this Liquor in it be plac'd in a window where the Sunbeams may shine freely on



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it, then if you turn your back to the Sun and take a Pen or some such slender Body, and hold it over-thwart betwixt the Sun and the Liquor, you may perceive that the Shadow projected by the Pen upon the Liquor, will not all of it be a vulgar and Dark, but in part a curiously Colour'd shadow, that edge of it, which is next the Body that makes it, being almost of a lively Golden Colour, and the remoter verge of a Caeruleous one.

[16] *Nicolaus Monardes lib simplic. ex India allatis, cap. 27.*

These and other Phaenomena, which I have observ'd in this delightfull Experiment, divers of my friends have look'd upon not without some wonder, and I remember an excellent Oculist finding by accident in a friends Chamber a fine Vial full of this Liquor, which I had given that friend, and having never heard any thing of the Experiment, nor having any Body near him that could tell him what this strange Liquor might be, was a great while apprehensive, as he presently after told me, that some strange new distemper was invading his Eyes. And I confess that the unusualness of the Phaenomena made me very sollicitous to find out the Cause of this Experiment, and though I am far from pretending to have found it, yet my enquiries have, I suppose, enabled me to give such hints, as may lead your greater sagacity to the discovery of the Cause of this wonder. And first finding that this Tincture, if it were too copious in the water, Kept the Colours from being so lively, and their Change from being so discernable, and finding also that the Impregnating Virtue of this Wood did by its being frequently Infus'd in New Water by degrees Decay, I Conjectur'd that the Tincture afforded by the Wood must proceed from some Subtiler parts of it drawn forth by the Water, which swimming too and fro in it did so Modify the Light, as to exhibit such and such Colours; and because these Subtile parts were so easily Soluble even in Cold water, I concluded that they must abound with Salts, and perhaps contain much of the Essential Salt, as the *Chymists* call it, of the Wood. And to try whether these Subtile parts were Volatile enough to be Distill'd, without the Dissolution of their Texture, I carefully Distill'd some of the Tincted Liquor in very low Vessels, and the gentle heat of a Lamp Furnace; but found all that came over to be as Limpid and Colourless as Rock-water, and the Liquor remaining in the Vessel to be so deeply Caeruleous, that it requir'd to be oppos'd to a very strong Light to appear of any other Colour. I took likewise a Vial with Spirit of Wine, and a little Salt of Harts-horn, and found that there was a certain proportion to be met with betwixt the Liquor and the Salt, which made the Mixture fit to exhibit some little Variety of Colours not Observable in ordinary Liquors, as it was variously directed in reference to the Light and the Eye, but this Change of Colour was very far short from that which we had admir'd in our Tincture. But



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however, I suspected that the Tinging Particles did abound with such Salts, whose Texture, and the Colour springing from it, would probably be alter'd by peircing Acid Salts, which would in likelihood either make some Dissipation of their Parts, or Associate themselves to the like Bodies, and either way alter the Colour exhibited by them; whereupon Pouring into a small Vial full of Impregnated Water, a very little Spirit of Vinegar, I found that according to my Expectation, the Caeruleous Colour immediately vanish'd, but was deceiv'd in the Expectation I had, that the Golden Colour would do so too; for, which way soever I turned the Vial, either to or from the Light, I found the Liquor to appear always of a Yellowish Colour and no other: Upon this I imagin'd that the Acid Salts of the Vinegar having been able to deprive the Liquor of its Caeruleous Colour, a Sulphureous Salt being of a contrary Nature, would be able to Mortifie the Saline Particles of Vinegar, and Destroy their Effects; And accordingly having plac'd my Self betwixt the Window, and the Vial, and into the Same Liquor dropt a few drops of Oyl of Tartar *per Deliquium*, (as *Chymists* call it) I observ'd with pleasure, that immediately upon the Diffusion of this Liquor, the Impregnated Water was restor'd to its former Caeruleous Colour; And this Liquor of *Tartar* being very Ponderous, and falling at first to the Bottom of the Vial, it was easie to observe that for a little while the Lower part of the Liquor appear'd deeply Caeruleous; whilst all the Upper part retain'd its former Yellowness, which it immediately lost as soon as either Agitation or Time had made a competent Diffusion of the Liquor of *Tartar* through the Body of the former Tincture; and this restored Liquor did, as it was Look'd upon against or from the Light, exhibit the Same *Phaenomena* as the Tincted Water did, before either of the Adventitious Liquors was pour'd into it.

Having made, *Pyrophilus*, divers Tryals upon this Nephritick Wood, we found mention made of it by the Industrious Jesuit *Kircherus*, who having received a Cup Turned of it from the *Mexican* Procurator of his Society, has probably receiv'd also from him the Information he gives us concerning that *Exotick* Plant, and therefore partly for that Reason, and partly because what he Writes concerning it, does not perfectly agree with what we have deliver'd, we shall not Scruple to acquaint you in his own Words, with as much of what he writes concerning our Wood, as is requisite to our present purpose. *Hoc loco* (says he)[17] *neutiquam omittendum duximus quoddam ligni candidi Mexicani genus, quod Indigenae Coalle & Tlapazatli vocant, quod etsi experientia hucusque non nisi Caeruleo aquam colore tingere docuerit, nos tamen continua experientia invenimus id aquam in omne Colorum genus transformare, quod merito cuipiam Paradoxum videri posset; Ligni frutex grandis, ut aiunt, non raro in molem arboris excrescit, truncus illius est*



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crassus, enodis, instar piri arboris, folia ciceris foliis, aut rutae haud absimilia, flores exigui, oblongi, lutei & spicatim digesti; est frigida & humida planta, licet parum recedat a medio temperamento. Hujus itaque descriptae arboris lignum in poculum efformatum, aquam eidem infusam primo in aquam intense Caeruleam, colore floris Buglossae; tingit, & quo diutius in eo steterit, tanto intensiorem colorem acquirit. Hanc igitur aquam si Vitreae Sphaerae infuderis, lucique exposueris, ne ullum quidem Caerulei coloris vestigium apparebit, sed instar aquae purae putae fontanae limpidam claramque aspicientibus se praebebit. Porro si hanc phialam vitream versus locum magis umbrosum direxeris, totus humor gratissimum virorem referet; si adhuc umbrosioribus locis, subrubrum, & sic pro rerum objectarum conditione, mirum dictu, colorem mutabit; in tenebris vero vel in vase opaco posita, Caeruleum colorem suum resumet.

[17] Kircher. Art. Mag. lucis & umbrae, lib. 1. part. 3.

In this passage we may take notice of the following Particulars. And first, he calls it a White Mexican Wood, whereas (not to mention that *Mornardes* informs us that it is brought out of *Nova Hispania*) the Wood that we have met with in several places, and employ'd as *Lignum Nephriticum*, was not White, but for the most part of a much Darker Colour, not unlike that of the Sadder Colour'd Wood of Juniper. 'Tis true, that *Monardes* himself also says, that the Wood is White; and it is affirm'd, that the Wood which is of a Sadder Colour is Adulterated by being Imbu'd with the Tincture of a Vegetable, in whose Decoction it is steep'd. But having purposely enquir'd of the Eminentest of our *English* Druggists, he peremptorily deny'd it. And indeed, having consider'd some of the fairest Round pieces of this Wood that I could meet with in these Parts, I had Opportunity to take notice that in one or two of them it was the External part of the Wood that was White, and the more Inward part that was of the other Colour, the contrary of which would probably have appear'd, if the Wood had been Adulterated after the afore-mention'd manner. And I have at present by me a piece of such Wood, which for about an Inch next the Bark is White, and then as it were abruptly passes to the above-mention'd Colour, and yet this Wood by the Tincture, it afforded us in Water, appears to have its Colour'd part Genuine enough; for as for the White part, it appears upon tryal of both at once, much less enrich'd with the tingent Property.

Next, whereas our Author tells us, that the Infusion of this Wood expos'd in a Vial to the Light, looks like Spring-water, in which he afterwards adds, that there is no Tincture to be seen in it, our Observation and his agree not, for the Liquor, which opposed to the Darker part of a Room exhibits a Sky-colour, did constantly, when held against the Light, appear Yellowish or Reddish, according as its Tincture was more Dilute



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or Deep; and then, whereas it has been already said, that the Caeruleous Colour was by Acid Salts abolished, this Yellowish one surviv'd without any considerable Alteration, so that unless our Author's Words be taken in a very Limited Sense, we must conclude, that either his Memory mis-inform'd him, or that his *White Nephritick* Wood, and the Sadder Colour'd one which we employ'd, were not altogether of the same Nature: What he mentions of the Cup made of *Lignum Nephriticum*, we have not had Opportunity to try, not having been able to procure pieces of that Wood great enough, and otherwise fit to be turned into Cups; but as for what he says in the Title of his Experiment, that this Wood tinges the Water with all Sorts of Colours, that is much more than any of those pieces of Nephritick Wood that we have hitherto employ'd, was able to make good; The change of Colours discernable in a Vial full of Water, Impregnated by any of them, as it is directed towards a place more Lightsome or Obscure, being far from affording a Variety answerable to so promising a Title. And as for what he tells us, that in the Dark the Infusion of our Wood will resume a Caeruleous Colour, I wish he had Inform'd us how he Try'd it.

But this brings into my mind, that having sometimes for Curiosity sake, brought a round Vial with a long Neck fill'd with the Tincture of *Lignum Nephriticum* into the Darken'd Room already often mention'd, and holding it sometimes in, sometimes near the Sunbeams that enter'd at the hole, and sometimes partly in them, and partly out of them, the Glass being held in several postures, and look'd upon from several Neighbouring parts of the Room, disclos'd a much greater Variety of Colours than in ordinary inlightn'd Rooms it is wont to do; exhibiting, besides the usual Colours, a Red in some parts, and a Green in others, besides Intermediate Colours produc'd by the differing Degrees, and odd mixtures of Light and Shade.

By all this You may see, *Pyrophilus*, the reasonableness of what we elsewhere had occasion to mention, when we have divers times told you, that it is usefull to have New Experiments try'd over again, though they were, at first, made by Knowing and Candid Men, such Reiterations of Experiments commonly exhibiting some New Phaenomena, detecting some Mistake or hinting some Truth, in reference to them, that was not formerly taken notice of. And some of our friends have been pleas'd to think, that we have made no unusefull addition to this Experiment, by shewing a way, how in a moment our Liquor may be depriv'd of its Blewness, and restor'd to it again by the affusion of a very few drops of Liquors, which have neither of them any Colour at all of their own. And that which deserves some particular wonder, is, that the Caeruleous Tincture of our Wood is subject by the former Method to be Destroy'd or Restor'd, the Yellowish or Reddish Tincture continuing what it was. And that you may see, that Salts are of

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a considerable use in the striking of Colours, let me add to the many Experiments which may be afforded us to this purpose by the Dyers Trade, this Observation; That as far as we have hitherto try'd, those Liquors in general that are strong of Acid Salts have the Power of Destroying the Blewness of the Infusion of our Wood, and those Liquors indiscriminately that abound with Sulphureous Salts, (under which I comprehend the Urinous and Volatile Salts of Animal Substances, and the Alcalisate or fixed Salts that are made by Incineration) have the vertue of Restoring it.

A Corollary of the Tenth Experiment.

That this Experiment, *Pyrophilus*, may be as well Usefull as Delightfull to You, I must mind You, *Pyrophilus*, that in the newly mention'd Observation, I have hinted to You a New and Easie way of Discovering in many Liquors (for I dare not say in all) whether it be an Acid or Sulphureous Salt, that is Predominant; and that such a Discovery is oftentimes of great Difficulty, and may frequently be of great Use, he that is not a Stranger to the various Properties and Effects of Salts, and of how great moment it is to be able to distinguish their Tribes, may readily conceive. But to proceed to the way of trying other Liquors by an Infusion of our Wood, take it briefly thus. Suppose I have a mind to try whether I conjecture aright, when I imagine that Allom, though it be plainly a Mixt Body, does abound rather with Acid than Sulphureous Salt. To satisfie my self herein, I turn my back to the Light, and holding a small Vial full of the Tincture of *Lignum Nephriticum*, which look'd upon in that Position, appears Caeruleous, I drop into it a little of a strong Solution of Allom made in Fair Water, and finding upon the Affusion and shaking of this New liquor, that the Blewness formerly conspicuous in our Tincture does presently vanish, I am thereby incited to suppose, that the Salt Praedominant in Allom belongs to the Family of Sour Salts; but if on the other side I have a mind to examine whether or no I rightly conceive that Salt of Urine, or of Harts-horn is rather of a Saline Sulphureous (if I may so speak) than of an Acid Nature, I drop a little of the Saline Spirit of either into the Nephritick Tincture, and finding that the Caeruleous Colour is rather thereby Deepned than Destroy'd, I collect that the Salts, which constitute these Spirits, are rather Sulphureous than Acid. And to satisfie my self yet farther in this particular, I take a small Vial of fresh Tincture, and placing both it and my self in reference to the Light as formerly, I drop into the Infusion just as much Distill'd Vinegar, or other Acid liquor as will serve to Deprive it of its Blewness (which a few drops, if the Sour Liquor be strong, and the Vial small will suffice to do) then without changing my Posture, I drop and shake into the same Vial a small proportion of Spirit of Hartshorn or Urine, and finding that upon this affusion, the Tincture immediately

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recovers its Caeruleous Colour, I am thereby confirm'd firm'd in my former Opinion, of the Sulphureous Nature of these Salts. And so, whereas it is much doubted by Some Modern Chymists to what sort of Salt, that which is Praedominant in Quick-lime belongs, we have been perswaded to referr it rather to Lixivate than Acid Salts, by having observ'd, that though an Evaporated Infusion of it will scarce yield such a Salt, as Ashes and other Alcalizate Bodyes are wont to do, yet if we deprive our Nephritick Tincture of its Blewness by just so much Distill'd Vinegar as is requisite to make that Colour Vanish, the *Lixivium* of Quick-lime will immediately upon its Affusion recall the Banished Colour; but not so Powerfully as either of the Sulphureous Liquors formerly mention'd. And therefore I allow my self to guess at the *Strength* of the Liquors examin'd by this Experiment, by the *Quantity* of them which is sufficient to Destroy or Restore the Caeruleous Colour of our Tincture. But whether concerning Liquors, wherein neither Acid nor Alcalisate Salts are Eminently Praedominant, our Tincture will enable us to conjecture any thing more than that such Salts are not Praedominant in them, I take not upon me to determine here, but leave to further Tryal; For I find not that Spirit of Wine, Spirit of Tartar freed from Acidity, or Chymical Oyl of Turpentine, (although Liquors which must be conceiv'd very Saline, if Chymists have, which is here no place to Dispute, rightly ascrib'd tastes to the Saline Principle of Bodyes,) have any Remarkable Power either to deprive our Tincture of its Caeruleous Colour, or restore it, when upon the Affusion of Spirit of Vinegar it has disappear'd.

EXPERIMENT XI.

And here I must not omit, *Pyrophilus*, to inform You, that we can shew You even in a Mineral Body something that may seem very near of Kin to the Changeable Quality of the Tincture of *Lignum Nephriticum*, for we have several flat pieces of Glass, of the thickness of ordinary Panes for Windows one of which being interposed betwixt the Eye and a clear Light, appears of a Golden Colour, not much unlike that of the moderate Tincture of our Wood, but being so look'd upon as that the Beams of light are not so much Trajected thorough it as Reflected from it to the Eye, that Yellow seems to degenerate into a pale Blew, somewhat like that of a Turquoise. And what which may also appear strange, is this, that if in a certain posture you hold one of these Plates Perpendicular to the Horizon, so that the Sun-beams shine upon half of it, the other half being Shaded, You may see that the part Shin'd upon will be of a much Diluter Yellow than the Shaded part which will appear much more Richly Colour'd; and if You alter the Posture of the Glass, so that it be not held Perpendicular, but Parallel in reference to the Horizon, You may see, (which perhaps you will admire) the Shaded part look of a Golden Colour, but the other that the Sun shines freely on, will appear



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considerably Blew, and as you remove any part of the Glass thus held Horizontally into the Sun-beams or Shade, it will in the twinkling of an Eye seem to pass from one of the above mention'd Colours to the other, the Sun-beams Trajected through it upon a sheet of White Paper held near it, do colour it with a Yellow, somewhat bordering upon a Red, but yet the Glass may be so oppos'd to the Sun, that it may upon Paper project a mix'd Colour here and there more inclin'd to Yellow, and here and there more to Blew. The other Phaenomena of this odd Glass, I fear it would be scarce worth while to Record, and therefore I shall rather advertise You, *First* that in the trying of these Experiments with it, you must take notice that one of the sides has either alone, or at least principally its Superficial parts dispos'd to the Reflection of the Blew Colour above nam'd, and that therefore you must have a care to keep that side nearest to the Eye. And next, that we have our selves made Glasses not unfit to exhibit an Experiment not unlike that I have been speaking of, by laying upon pieces of Glass some very finely foliated Silver, and giving it by degrees a much stronger Fire than is requisite or usual for the Tinging of Glasses of other Colours. And this Experiment, not to mention that it was made without a Furnace in which Artificers that Paint Glass are wont to be very Curious, is the more considerable, because, that though a Skilfull Painter could not deny to me that 'twas with Silver he Colour'd his Glasses Yellow; yet he told me, that when to Burn them (as they speak) he layes on the plates of Glass nothing but a *Calx* of Silver Calcin'd without Corrosive Liquors, and Temper'd with Fair Water, the Plates are Ting'd of a fine Yellow that looks of a Golden Colour, which part soever of it you turn to or from the Light; whereas (whether it be what an Artificer would call Over-doing, or Burning, or else the imploying the Silver Crude that makes the Difference,) we have found more than once, that some Pieces of Glass prepar'd as we have related, though held against the Light they appear'd of a Transparent Yellow, yet look'd on with ones back turn'd to the Light they exhibited an Untransparent Blew.

EXPERIMENT XII.

If you will allow me, *Pyrophilus*, for the avoiding of Ambiguity, to imploy the Word Pigments, to signifie such prepared materials (as Cochinele, Vermilion, Orpiment,) as Painters, Dyers and other Artificers make use of to impart or imitate particular Colours, I shall be the better understood in divers passages of the following papers, and particularly when I tell you, That the mixing of Pigments being no inconsiderable part of the Painters Art, it may seem an Incroachment in me to meddle with it. But I think I may easily be excus'd (though I do not altogether pass it by) if I restrain my self to the making of a Transient mention of some few of their Practices about this matter; and that only so far forth, as may warrant



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me to observe to you, that there are but few Simple and Primary Colours (if I may so call them) from whose Various Compositions all the rest do as it were Result. For though Painters can imitate the Hues (though not always the Splendor) of those almost Numberless differing Colours that are to be met with in the Works of Nature, and of Art, I have not yet found, that to exhibit this strange Variety they need employ any more than *White*, and *Black*, and *Red*, and *Blew*, and *Yellow*; these *five*, *Variouly Compounded*, and (if I may so speak) *Decompounded*, being sufficient to exhibit a Variety and Number of Colours, such, as those that are altogether Strangers to the Painters Pallets, can hardly imagine.

Thus (for Instance) Black and White differingly mix'd, make a Vast company of Lighter and Darker Grays.

Blew and Yellow make a huge Variety of Greens.

Red and Yellow make Orange Tawny.

Red with a little White makes a Carnation.

Red with an Eye of Blew, makes a Purple; and by these simple Compositions again Compounded among themselves, the Skilfull Painter can produce what kind of Colour he pleases, and a great many more than we have yet Names for. But, as I intimated above, 'tis not my Design to prosecute this Subject, though I thought it not unfit to take some Notice of it, because we may hereafter have occasion to make use of what has been now deliver'd, to illustrate the Generation of Intermediate Colours; concerning which we must yet subjoyn this Caution, that to make the Rules about the Emergency of Colours, fit to be Relied upon, the Corpuscles whereof the Pigments consist must be such as do not Destroy one anothers Texture, for in case they do, the produced Colour may be very Different from that which would Result from the Mixture of other harmless Pigments of the same Colours, as I shall have Occasion to shew ere long.

EXPERIMENT XIII.

It may also give much light to an Enquirer into the Nature of Colours, to know that not only in Green, but in many (if not all) other Colours, the Light of the Sun passing through Diaphanous Bodies of differing Hues may be tinged of the same Compound Colour, as if it came from some Painters Colours of the same Denomination, though this later be exhibited by Reflection, and be (as the former Experiment declares) manifestly Compounded of material Pigments. Wherefore to try the Composition of Colours by Trajection, we provided several Plates of Tinged Glass, which being laid two at a time one on the top of another, the Object look'd upon through them both, appear'd of a Compounded Colour, which agrees well with what we have observ'd in the second



Experiment, of Looking against the Light through differinglly Colour'd Papers. But we thought the Experiment would be more Satisfactory, if we procur'd the Sun-beams to be so Ting'd in their passage through Plates of Glass, as to exhibit



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the Compounded Colour upon a Sheet of White Paper. And though by reason of the Thickness of the Glasses, the Effect was but Faint, even when the Sun was High and Shin'd forth clear, yet, we easily remedied that by Contracting the Beams we cast on them by means of a Convex Burning-glass, which where it made the Beams much converge Inceas'd the Light enough to make the Compounded Colour very manifest upon the Paper. By this means we observ'd, that the Beams trajected through Blew and Yellow compos'd a Green, that an intense and moderate Red did with Yellow make differing degrees of Saffron, and Orange Tawny Colours, that Green and Blew made a Colour partaking of both, such as that which some Latin Writers call *Pavonaceus*, that Red and Blew made a Purple, to which we might add other Colours, that we produc'd by the Combinations of Glasses differingly Ting'd, but that I want proper Words to express them in our Language, and had not when we made the Tryals, the Opportunity of consulting with a Painter, who perchance might have Suppli'd me with some of the terms I wanted.

I know not whether it will be requisite to subjoyn on this Occasion, what I tried concerning Reflections from Colour'd Glasses, and other Transparent Bodies, namely, that having expos'd four or five sorts of them to the Sun, and cast the Reflected Beams upon White Paper held near at hand, the Light appear'd not manifestly Ting'd, but as if it had been Reflected from the Impervious parts of a Colourless Glass, only that Reflected from the Yellow was here and there stain'd with the same Colour, as if those Beams were not all Reflected from the Superficial, but some from the Internal parts of the Glass; upon which Occasion you may take notice, that a Skilfull Tradesman, who makes such Colour'd Glass told me, that where as the Red Pigment was but Superficial, the Yellow penetrated to the very midst of the Plate. But for further Satisfaction, not having the Opportunity to Foliate those Plates, and so turn them into Looking-glasses, we Foliated a Plate of *Muscovy* Glass, and then laying on it a little Transparent Varnish of a Gold Colour, we expos'd it to the Sun-beams, so as to cast them upon a Body fit to receive them, on which the Reflected Light, appearing, as we expected, Yellow, manifested that Rebouncing from the Specular part of the *Selenitis*, it was Ting'd in its return with the Colour of the Transparent Varnish through which it pass'd.

EXPERIMENT XIV.

After what we have said of the Composition of Colours, it will now be seasonable to annex some Experiments that we made in favour of those Colours, that are taught in the Schools not to be Real, but only Apparent and Phantastical; For we found by Tryals, that these Colours might be Compounded, both with True and Stable Colours, and with one another, as well as unquestionably Genuine and Lasting Colours, and that the Colours resulting from such Compositions, would respectively deserve the same Denominations.



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For first, having by the Trajection of the Sun-beams through a Glass-prism thrown an Iris on the Floor, I found that by placing a Blew Glass at a convenient distance betwixt the Prism and the Iris, that part of the Iris that was before Yellow, might be made to appear Green, though not of a Grass Green, but of one more Dilute and Yellowish. And it seems not improbable, that the narrow Greenish List (if I may so call it) that is wont to be seen between the Yellow and Blew parts of the Iris, is made by the Confusion of those two Bordering Colours.

Next, I found, that though the want of a sufficient Liveliness in either of the Compounding Colours, or a light Error in the manner of making the following Tryals, was enough to render some of them Unsuccessfull, yet when all necessary Circumstances were duely observ'd, the Event was answerable to our Expectation and Desire.

And (as I formerly Noted) that Red and Blew compound a Purple, so I could produce this last nam'd Colour, by casting at some Distance from the Glass the Blew part of the Prismatical Iris (as I think it may be call'd for Distinction sake) upon a Lively Red, (for else the Experiment succeeds not so well.) And I remember, that sometimes when I try'd this upon a piece of Red Cloath, *that* part of the Iris which would have been Blew, (as I try'd by covering that part of the Cloath with a piece of White Paper) and Compounded with the Red, wherewith the Cloath was Imbued before, appear'd of a fair Purple, did, when I came to View it near at hand, look very Odly, as if there were some strange Reflection or Refraction or both made in the Hairs of which that Cloath was composed.

Calling likewise the Prismatical Iris upon a very Vivid Blew, I found that part of it, which would else have been the Yellow, appear Green. (Another somewhat differing Tryal, and yet fit to confirm this, you will find in the fifteenth Experiment.)

But it may seem somewhat more strange, that though the Prismatical Iris being made by the Refraction of Light through a Body that has no Colour at all, must according to the Doctrine of the Schools consist of as purely Emphatical Colours, as may be, yet even these may be Compounded with one another, as well as Real Colours in the Grossest Pigments. For I took at once two Triangular Glasses, and one of them being kept fixt in the same Posture, that the Iris it projected on the Floor might not Waver, I cast on the same Floor another Iris with the other Prism, and Moving it too and fro to bring what part of the second Iris I pleas'd, to fall upon what part of the first I thought fit, we did sometimes (for a small Errour suffices to hinder the Success) obtain by this means a Green Colour in that part of the more Stable Iris, that before was Yellow, or Blew, and frequently by casting those Beams that in one of the Iris's made the Blew upon the Red parts of the other Iris, we were able to produce a lovely Purple, which we can Destroy or Recompose at pleasure, by Severing and Reapproaching the Edges of the two Iris's.



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EXPERIMENT XV.

On this occasion, *Pyrophilus*, I shall add, that finding the Glass-prism to be the usefulest Instrument Men have yet employ'd about the Contemplation of Colours, and considering that Prisms hitherto in use are made of Glass, Transparent and Colourless, I thought it would not be amiss to try, what change the Superinduction of a Colour, without the Destruction of the Diaphaneity, would produce in the Colours exhibited by the Prism. But being unable to procure one to be made of Colour'd Glass, and fearing also that if it were not carefully made, the Thickness of it would render it too Opacous, I endeavoured to substitute one made of Clarify'd Rosin, or of Turpentine brought (as I elsewhere teach) to the consistence of a Transparent Gum. But though these Endeavours were not wholly lost, yet we found it so difficult to give these Materials their true Shape, that we chose rather to Varnish over an ordinary Prism with some of these few Pigments that are to be had Transparent; as accordingly we did first with Yellow, and then with Red, or rather Crimson, made with Lake temper'd with a convenient Oyl, and the Event was, That for want of good Transparent Colours, (of which you know there are but very few) both the Yellow and the Red made the Glass so Opacous, (though the Pigment were laid on but upon two Sides of the Glass, no more being absolutely necessary) that unless I look'd upon an Inlightned Window, or the Flame of a Candle, or some other Luminous or very Vivid object, I could scarce discern any Colours at all, especially when the Glass was cover'd with Red. But when I did look on such Objects, it appear'd (as I expected) that the Colour of the Pigment had Vitiated or Drown'd some of those which the Prism would according to its wont have exhibited, and mingling with others, Alter'd them: as I remember, that both to my Eyes, and others to whom I show'd it, when the Prism was cover'd with Yellow, it made those Parts of bright Objects, where the Blew would else have been Conspicuous, appear of a light Green. But, *Pyrophilus*, both the Nature of the Colours, and the Degree of Transparency, or of Darkness in the Pigment, besides divers other Circumstances, did so vary the *Phaenomena* of these Tryals, that till I can procure small Colour'd Prisms, or Hollow ones that may be filled with Tincted Liquor, or obtain Some better Pigments than those I was reduc'd to employ, I shall forbear to Build any thing upon what has been delivered, and shall make no other use of it, than to invite you to prosecute the Inquiry further.

EXPERIMENT XVI.



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And here, *Pyrophilus*, since we are treating of Emphatical Colours, we shall add what we think not unworthy your Observation, and not unfit to afford some Exercise to the Speculative. For there are some Liquors, which though Colourless themselves, when they come to be Elevated, and Dispers'd into Exhalations, exhibit a conspicuous Colour, which they lose again, when they come to be Reconjoyn'd into a Liquor, as good Spirit of *Nitre*; or upon its account strong *Aqua-fortis*, though devoid of all appearance of Redness whilst they continue in the form of a Liquor, if a little Heat chance to turn the Minute parts of them into Vapour, the Steam will appear of a Reddish or deep Yellow Colour, which will Vanish when those Exhalations come to resume the form of Liquor.

And not only if you look upon a Glass half full of *Aqua-fortis*, or Spirit of *Nitre*, and half full of *Nitrous* steams proceeding from it, you will see the Upper part of the Glass of the Colour freshly mention'd, if through it you look upon the Light. But which is much more considerable, I have tried, that putting *Aqua-fortis* in a long clear Glass, and adding a little Copper or some such open Metall to it, to excite Heat and Fumes, the Light trajected through those Fumes, and cast upon a sheet of White Paper, did upon that appear of the Colour that the Fumes did, when directly Look'd upon, as if the Light were as well Ting'd in its passage through these Fumes, as it would have been by passing through some Glass or Liquor in which the same Colour was Inherent.

To which I shall further add, that having sometimes had the Curiosity to observe whether the Beams of the Sun near the Horizon trajected through a very Red Sky, would not (though such rednesses are taken to be but Emphatical Colours) exhibit the like Colour, I found that the Beams falling within a Room upon a very White Object, plac'd directly opposite to the Sun, disclos'd a manifest Redness, as if they had pass'd through a Colour'd *Medium*.

EXPERIMENT XVII.

The emergency, *Pyrophilus*, of Colours upon the Coalition of the Particles of such Bodies as were neither of them of the Colour of that Mixture whereof they are the Ingredients, is very well worth our attentive Observation, as being of good use both Speculative and Practical; For much of the Mechanical use of Colours among Painters and Dyers, doth depend upon the Knowledge of what Colours may be produc'd by the Mixtures of Pigments so and so Colour'd. And (as we lately intimated) 'tis of advantage to the contemplative Naturalist, to know how many and which Colours are Primitive (if I may so call them) and Simple, because it both eases his Labour by confining his most sollicitous Enquiry to a small Number of Colours upon which the rest depend, and assists him to judge of the nature of particular compounded Colours, by shewing him from the Mixture of what more Simple ones,



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and of what Proportions of them to one another, the particular Colour to be consider'd does result. But because to insist on the Proportions, the Manner and the Effects of such Mixtures would oblige me to consider a greater part of the Painters Art and Dyers Trade, than I am well acquainted with, I confin'd my self to make Trial of *several ways to produce Green*, by the composition of Blew and Yellow. And shall in this place both Recapitulate most of the things I have Dispersedly deliver'd already concerning that Subject, and Recruit them.

And first, whereas Painters (as I noted above) are wont to make Green by tempering Blew and Yellow, both of them made into a soft Consistence, with either Water or Oyl, or some Liquor of Kin to one of those two, according as the Picture is to be Drawn with those they call *water Colours*, or those they term *Oyl Colours*, I found that by choosing fit Ingredients, and mixing them in the form of Dry Powders, I could do, what I could not if the Ingredients were temper'd up with a Liquor; But the Blew and Yellow Powders must not only be finely Ground, but such as that the Corpuscles of the one may not be too unequal to those of the other, lest by their Disproportionate Minuteness the Smaller cover and hide the Greater. We us'd with good success a slight Mixture of the fine Powder of Bise, with that of Orpiment, or that of good Yellow Oker, I say a *slight* Mixture, because we found that an *exquisite* Mixture did not do so well, but by lightly mingling the two Pigments in several little Parcels, those of them in which the Proportion and Manner of Mixture was more Lucky, afforded us a good Green.

2. We also learn'd in the Dye-houses, that Cloth being Dy'd Blew with Woad, is afterwards by the Yellow Decoction of *Luteola* or Woud-wax or Wood-wax Dy'd into a Green Colour.
3. You may also remember what we above Related, where we intimated, that having in a Darkn'd Room taken two Bodies, a Blew and a Yellow, and cast the Light Reflected from the one upon the other, we likewise obtain'd a Green.
4. And you may remember, that we observ'd a Green to be produc'd, when in the same Darkn'd Room we look'd at the Hole at which alone the Light enter'd, through the Green and Yellow parts of a sheet of Marbl'd Paper laid over one another.
5. We found too, that the Beams of the Sun being trajected through two pieces of Glass, the one Blew and the other Yellow, laid over one another, did upon a sheet of White paper on which they were made to fall, exhibit a lovely Green.
6. I hope also, that you have not already forgot, what was so lately deliver'd, concerning the composition of a Green, with a Blew and Yellow; of which most Authors would call the one a *Real*, and the other an *Emphatical*.



7. And I presume, you may have yet fresh in your memory, what the fourteenth Experiment informs you, concerning the exhibiting of a Green, by the help of a Blew and Yellow, that were both of them Emphatical.



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8. Wherefore we will proceed to take notice, that we also devis'd a way of trying whether or no Metalline Solutions though one of them at least had its Colour Adventitious, by the mixture of the *Menstruum* employ'd to dissolve it, might not be made to compound a Green after the manner of other Bodies. And though this seem'd not easie to be perform'd by reason of the Difficulty of finding Metalline Solutions of the Colour requisite, that would mix without Praecipitating each other; yet after a while having consider'd the matter, the first Tryal afforded me the following Experiment. I took a High Yellow Solution of good Gold in *Aqua-Regis*, (made of *Aqua-fortis*, and as I remember half its weight of Spirit of Salt) To this I put a due Proportion of a deep and lovely Blew Solution of Crude Copper, (which I have elsewhere taught to be readily Dissoluble in strong Spirit of Urine) and these two Liquors though at first they seem'd a little to Curdle one another, yet being thoroughly mingl'd by Shaking, they presently, as had been Conjectur'd, united into a Transparent Green Liquor, which continu'd so for divers days that I kept it in a small Glass wherein 'twas made, only letting fall a little Blackish Powder to the Bottom. The other *Phaenomena* of this Experiment belong not to this place, where it may suffice to take notice of the Production of a Green, and that the Experiment was more than once repeated with Success.

9. And lastly, to try whether this way of compounding Colours would hold ev'n in Ingredients actually melted by the Violence of the Fire, provided their Texture were capable of safely induring Fusion, we caus'd some Blew and Yellow Ammel to be long and well wrought together in the Flame of a Lamp, which being Strongly and Incessantly blown on them kept them in some degree of Fusion, and at length (for the Experiment requires some Patience as well as Skil) we obtain'd the expected Ammel of a Green Colour.

I know not, *Pyrophilus*, whether it be worth while to acquaint you with the ways that came into my Thoughts, whereby in some measure to explicate the first of the mention'd ways of making a Green; for I have sometimes Conjectur'd, that the mixture of the Bise and the Orpiment produc'd a Green by so altering the Superficial Asperity, which each of those Ingredients had apart, that the Light Incident on the mixture was Reflected with differing Shades, as to Quantity, or Order, or both, from those of either of the Ingredients, and such as the Light is wont to be Modify'd with, when it Reflects from Grass, or Leaves, or some of those other Bodies that we are wont to call Green. And sometimes too I have doubted, whether the produced Green might not be partly at least deriv'd from this, That the Beams that Rebound from the Corpuscles of the Orpiment, giving one kind of stroak upon the *Retina*, whose Perception we call Yellow, and the Beams Reflected from the Corpuscles of the Bise, giving another stroak upon the same *Retina*,



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like to Objects that are Blew, the Contiguity and Minuteness of these Corpuscles may make the Appulse of the Reflected Light fall upon the *Retina* within so narrow a Compass, that the part they Beat upon being but as it were a Physical point, they may give a Compounded stroak, which may consequently exhibit a Compounded and new Kind of Sensation, as we see that two Strings of a Musical Instrument being struck together, making two Noises that arrive at the Ear at the same time as to Sense, yield a Sound differing from either of them, and as it were Compounded of both; Insomuch that if they be Discordantly ton'd, though each of them struck apart would yield a Pleasing Sound, yet being struck together they make but a Harsh and troublesome Noise. But this not being so fit a place to prosecute Speculations, I shall not insist, neither upon these Conjectures nor any others, which the Experiment we have been mentioning may have suggested to me. And I shall leave it to you, *Pyrophilus*, to derive what Instruction you can from comparing together the Various ways whereby a Yellow and a Blew can be made to Compound a Green. That which I now pretend to, being only to shew that the first of those mention'd ways, (not to take at present notice of the rest) does far better agree with our Conjectures about Colours, than either with the Doctrine of the Schools, or with that of the *Chymists*, both which seem to be very much Disfavour'd by it.

For first, since in the Mixture of the two mention'd Powders I could by the help of a very excellent *Microscope* (for ordinary ones will scarce serve the turn) discover that which seem'd to the naked Eye a Green Body, to be but a heap of Distinct, though very small Grains of Yellow Orpiment and Blew Bise confusedly enough Blended together, it appears that the Colour'd Corpuscles of either kind did each retain its own Nature and Colour; By which it may be guess'd, what meer Transposition and Juxtaposition of Minute and Singly unchang'd Particles of Matter can do to produce a new Colour; For that this Local Motion and new Disposition of the small parts of the Orpiment did Intervene is much more manifest than it is easie to Explicate how they should produce this new Green otherwise than by the new Manner of their being put together, and consequently by their new Disposition to Modify the Incident Light by Reflecting it otherwise than they did before they were Mingl'd together.

Secondly, The Green thus made being (if I may so speak) Mechanically produc'd, there is no pretence to derive it from I know not what incomprehensible Substantial Form, from which yet many would have us believe that Colours must flow; Nor does this Green, though a Real and Permanent, not a Phantastical and Vanid Colour, seem to be such an Inherent Quality as they would have it, since not only each part of the Mixture remains unalter'd in Colour, and consequently of a differing Colour from the Heap they Compose, but if the Eye be assisted by a *Microscope* to discern things better and more distinctly than before it could, it sees not a Green Body, but a Heap of Blew and Yellow Corpuscles.

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And in the third place, I demand what either Sulphur, or Salt, or Mercury has to do in the Production of this Green; For neither the Bise nor the Orpiment were indu'd with that Colour before, and the bare Juxtaposition of the Corpuscles of the two Powders that work not upon each other, but might if we had convenient Instruments be separated, unalter'd, cannot with any probability be imagin'd either to Increase or Diminish any of the three Hypostatical Principles, (to which of them soever the *Chymists* are pleas'd to ascribe Colours) nor does there here Intervene so much as Heat to afford them any colour to pretend, that at least there is made an Extraversion (as the *Helmontians* speak) of the Sulphur or of any of the two other supposed Principles; But upon this Experiment we have already Reflected enough, if not more than enough for once.

EXPERIMENT XVIII.

But here, *Pyrophilus*, I must advertise you, that 'tis not every Yellow and every Blew that being mingl'd will afford a Green; For in case one of the Ingredients do not Act only as endow'd with such a Colour, but as having a power to alter the Texture of the Corpuscles of the other, so as to Indispose them to Reflect the Light, as Corpuscles that exhibit a Blew or a Yellow are wont to Reflect it, the emergent Colour may be not Green, but such as the change of Texture in the Corpuscles of one or both of the Ingredients qualifies them to shew forth; as for instance, if you let fall a few Drops of Syrrup of Violets upon a piece of White Paper, though the Syrrup being spread will appear Blew, yet mingling with it two or three Drops of the lately mention'd Solution of Gold, I obtain'd not a Green but a Reddish mixture, which I expected from the remaining Power of the Acid Salts abounding in the Solution, such Salts or Saline Spirits being wont, as we shall see anon, though weakn'd, so to work upon that Syrrup as to change it into a Red or Reddish Colour. And to confirm that for which I allege the former Experiment, I shall add this other, that having made a very strong and high-colour'd Solution of Filings of Copper with Spirit of Urine, though the *Menstruum* seem'd Glutted with the Metall, because I put in so much Filings that many of them remain'd for divers days Undissolv'd at the Bottom, yet having put three or four Drops of Syrrup of Violets upon White Paper, I found that the deep Blew Solution proportionably mingl'd with this other Blew Liquor did not make a Blew mixture, but, as I expected, a fair Green, upon the account of the Urinous Salt that was in the *Menstruum*.

EXPERIMENT XIX.



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To shew the *Chymists*, that Colours may be made to Appear or Vanish, where there intervenes no Accession or Change either of the Sulphureous, or the Saline, or the Mercurial principle (as they speak) of Bodies: I shall not make use of the Iris afforded by the Glass-prism, nor of the Colours to be seen in a fair Morning in those drops of Dew that do in a convenient manner Reflect and Refract the Beams of Light to the Eye; But I will rather mind them of what they may observe in their own Laboratories, namely, that divers, if not all, Chymical Essential Oyls, as also good Spirit of Wine, being shaken till they have good store of Bubbles, those Bubbles will (if attentively consider'd) appear adorn'd with various and lovely Colours, which all immediately Vanish, upon the relapsing of the Liquor that affords those Bubbles their Skins, into the rest of the Oyl, or Spirit of Wine, so that a Colourless Liquor may be made in a trice to exhibit variety of Colours, and may lose them in a moment without the Accession or Diminution of any of its Hypostatical Principles. And, by the way, 'tis not unworthy our notice, that some Bodies, as well Colourless, as Colour'd, by being brought to a great Thinness of parts, acquire Colours though they had none before, or Colours differing from them they were before endued with: For, not to insist on the Variety of Colours, that Water, made somewhat Glutinous by Sope, acquires, when 'tis blown into such Sphaerical Bubbles as Boys are wont to make and play with; Turpentine (though it have a Colour deep enough of its own) may (by being blown into after a certain manner) be brought to afford Bubbles adorn'd with variety of Orient Colours, which though they Vanish after some while upon the breaking of the Bubbles, yet they would in likelihood always exhibit Colours upon their *Superfices*, (though not always the same in the same Parts of them, but Vary'd according to the Incidence of the Sight, and the Position of the Eye) if their Texture were durable enough: For I have seen one that was Skill'd at fashioning Glasses by the help of a Lamp, blowing some of them so strongly as to burst them, whereupon it was found, that the Tenacity of the Metall was such, that before it broke it suffer'd it self to be reduc'd into Films so extremely thin, that being kept clean they constantly shew'd on their Surfaces (but after the manner newly mention'd) the varying Colours of the Rain-bow, which were exceedingly Vivid, as I had often opportunity to observe in some, that I caus'd purposely to be made, to keep by me.

But lest it should be objected, that the above mentioned Instances are drawn from Transparent Liquors, it may possibly appear, not impertinent to add, what I have sometimes thought upon, and several times tried, when I was considering the Opinions of the *Chymists* about Colours, I took then a Feather of a convenient Bigness and Shape, and holding it at a fit distance betwixt my Eye and the Sun when he was near the Horizon,

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me thought there appear'd to me a Variety of little Rain-bows, with differing and very vivid Colours, of which none was constantly to be seen in the Feather; the like *Phaenomenon* I have at other times (though not with altogether so good success) produc'd, by interposing at a due distance a piece of Black Ribband betwixt the almost setting Sun and my Eye, not to mention the Trials I have made to the same purpose, with other Bodies.

EXPERIMENT XX.

Take good Syrrup of Violets, Impregnated with the Tincture of the flowers, drop a little of it upon a White Paper (for by that means the Change of Colour will be more conspicuous, and the Experiment may be practis'd in smaller Quantities) and on this Liquor let fall two or three drops of Spirit either of Salt or Vinegar, or almost any other eminently Acid Liquor, and upon the Mixture of these you shall find the Syrrup immediatly turn'd Red, and the way of Effecting such a Change has not been unknown to divers Persons who have produc'd the like, by Spirit of Vitriol, or juice of Limmons, but have Groundlessly ascrib'd the Effect to some Peculiar Quality of those two Liquors, whereas, (as we have already intimated) almost any Acid Salt will turn Syrrup of Violets Red. But to improve the Experiment, let me add what has not (that I know of) been hitherto observ'd, and has, when we first shew'd it them, appear'd something strange, even to those that have been inquisitive into the Nature of Colours; namely, that if instead of Spirit of Salt, or that of Vinegar, you drop upon the Syrrup of Violets a little Oyl of Tartar *per Deliquium*, or the like quantity of Solution of Potashes, and rubb them together with your finger, you shall find the Blew Colour of the Syrrup turn'd in a moment into a perfect Green, and the like may be perform'd by divers other Liquors, as we may have occasion elsewhere to Inform you.

Annotation upon the twentieth Experiment.

The use of what we lately deliver'd concerning the way of turning Syrrup of Violets, Red or Green, may be this; That, though it be a far more common and procurable Liquor than the Infusion of *Lignum Nephriticum*, it may yet be easily substituted in its Room, when we have a mind to examine, whether or no the Salt predominant in a Liquor or other Body, wherein 'tis Loose and Abundant, belong to the Tribe of *Acid* Salts or not. For if such a Body turn the Syrrup of a Red or Reddish Purple Colour, it does for the most part argue the Body (especially if it be a distill'd Liquor) to abound with Acid Salt. But if the Syrrup be made Green, that argues the Predominant Salt to be of a Nature repugnant to that of the Tribe of Acids. For, as I find that either Spirit of Salt, or Oyl of Vitriol, or *Aqua-fortis*, or Spirit of Vinegar, or Juice of Lemmons, or any of the Acid Liquors I have yet had occasion to try, will turn Syrrup of Violets, of a *Red*, (or at least, of a *Reddish*



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Colour, so I have found, that not only the Volatile Salts of all Animal Substances I have us'd, as Spirit of Harts-horn, of Urine, of Sal-Armoniack, of Blood, &c. but also all the Alcalizate Salts I have imploy'd, as the Solution of Salt of Tartar, of Pot-ashes, of common Wood-ashes, Lime-water, &c. will immediately change the Blew Syrrup, into a perfect Green. And by the same way (to hint that upon the by) I elsewhere show you, both the changes that Nature and Time produce, in the more Saline parts of some Bodies, may be discover'd, and also how ev'n such Chymically prepar'd Bodies, as belong not either to the Animal Kingdome, or to the Tribe of *Alcali's*, may have their new and superinduc'd Nature successfully Examin'd. In this place I shall only add, that not alone the Changing the Colour of the Syrrup, requires, that the Changing Body be more strong, of the Acid, or other sort of Salt that is Predominant in it, than is requisite for the working upon the Tincture of *Lignum Nephriticum*; but that in this is also, the Operation of the formerly mention'd Salts upon our Syrrup, differs from their Operation upon our Tinctures, that in this Liquor, if the Caeruleous Colour be *Destroy'd* by an Acid Salt, it may be *Restor'd* by one that is either Volatile, or Lixivate; whereas in Syrrup of Violets, though one of these contrary Salts will *destroy* the Action of the other, yet neither of them will *restore* the Syrrup to its native Blew; but each of them will Change it into the Colour which it self doth (if I may so speak) affect, as we shall have Occasion to show in the Notes on the twenty fifth Experiment.

EXPERIMENT XXI.

There is a Weed, more known to Plowmen than belov'd by them, whose Flowers from their Colour are commonly call'd *Blew-bottles*, and *Corn-weed* from their Growing among Corn[18]. These Flowers some Ladies do, upon the account of their Lovely Colour, think worth the being Candied, which when they are, they will long retain so fair a Colour, as makes them a very fine Sallad in the Winter. But I have try'd, that when they are freshly gather'd, they will afford a Juice, which when newly express'd, (for in some cases 'twill soon enough degenerate) affords a very deep and pleasant Blew. Now, (to draw this to our present Scope) by dropping on this fresh Juice, a little Spirit of Salt, (that being the Acid Spirit I had then at hand) it immediately turn'd (as I predicted) into a Red. And if instead of the Sowr Spirit I mingled with it a little strong Solution of an Alcalizate Salt, it did presently disclose a lovely Green; the same Changes being by those differing sorts of Saline Liquors, producible in this *Natural juice*, that we lately mention'd to have happen'd to that *factitious Mixture*, the Syrrup of Violets. And I remember, that finding this Blew Liquor, when freshly made, to be capable of serving in a Pen for an Ink of that Colour, I attempted by moistning one part of a piece



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of White Paper with the Spirit of Salt I have been mentioning, and another with some Alcalizate or Volatile Liquor, to draw a Line on the leisurely dry'd Paper, that should, e'vn before the Ink was dry, appear partly Blew, partly Red, and partly Green: But though the latter part of the Experiment succeeded not well, (whether because Volatile Salts are too Fugitive to be retain'd in the Paper, and Alcalizate ones are too Unctuous, or so apt to draw Moisture from the Air, that they keep the Paper from drying well) yet the former Part succeeded well enough; the Blew and Red being Conspicuous enough to afford a surprizing Spectacle to those, I acquaint not with (what I willingly allow you to call) the *Trick*.

[18] *Herbarists* are wont to call this Plant *Cyanus vulgaris minor*.

Annotation upon the one and twentieth Experiment.

But lest you should be tempted to think (*Pyrophilus*) that Volatile or Alcalizate Salts change Blews into Green, rather upon the score of the easie Transition of the former Colour into the latter, than upon the account of the Texture, wherein most Vegetables, that afford a Blew, seem, though otherwise differing, to be Allied, I will add, that when I purposely dissolv'd Blew Vitriol in fair Water, and thereby imbu'd sufficiently that Liquor with that Colour, a Lixivate Liquor, and a Urinous Salt being Copiously pour'd upon distinct Parcels of it, did each of them, though perhaps with some Difference, turn the Liquor not Green, but of a deep Yellowish Colour, almost like that of Yellow Oker, which Colour the Precipitated Corpuscles retain'd, when they had Leisurely subsided to the Bottom. What this Precipitated Substance is, it is not needfull now to Enquire in this place, and in another, I have shown you, that notwithstanding its Colour, and its being Obtainable from an Acid *Menstruum* by the help of Salt of Tartar, it is yet far enough from being the true Sulphur of Vitriol.

EXPERIMENT XXII.

Our next Experiment (*Pyrophilus*) will perhaps seem to be of a contrary Nature to the two former, made upon Syrrup of Violets, and Juice of Blew-bottles. For as in them by the Affusion of Oyl of Tartar, a Blewish Liquor is made Green, so in this, by the sole Mixture of the same Oyl, a Greenish Liquor becomes Blew. The hint of this Experiment was given us by the practice of some *Italian* Painters, who being wont to Counterfeit *Ultra-marine Azure* (as they call it) by Grinding Verdigrease with Sal-Armoniack, and some other Saline Ingredients, and letting them Rot (as they imagine) for a good while together in a Dunghill, we suppos'd, that the change of Colour wrought in the Verdigrease by this way of Preparation, must proceed from the Action of certain Volatile and Alcalizate Salts, abounding in some of the mingled Concretes, and brought to make a further Dissolution of the Copper abounding in the Verdigrease, and therefore

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we Conjectur'd, that if both the Verdigrease, and such Salts were dissolv'd in fair Water, the small Parts of both being therein more subdivided, and set at liberty, would have better access to each other, and thereby Incorporate much the more suddenly; And accordingly we found, that if upon a strong Solution of good French Verdigrease (for 'tis that we are wont to imploy, as the best) you pour a just quantity of Oyl of Tartar, and shake them well together, you shall immediately see a notable Change of Colour, and the Mixture will grow thick, and not transparent, but if you stay a while, till the Grosser part be Precipitated to, and settled in the Bottom, you may obtain a clear Liquor of a very lovely Colour, and exceeding delightfull to the Eye. But, you must have a care to drop in a competent Quantity of Oyl of Tartar, for else the Colour will not be so Deep, and Rich; and if instead of this Oyl you imploy a clear *Lixivium* of Pot-ashes, you may have an Azure somewhat Lighter or Paler than, and therefore differing from, the former. And if instead of either of these Liquors, you make use of Spirit of Urine, or of Harts-horn, you may according to the Quantity and Quality of the Spirit you pour in, obtain some further Variety (though scarce considerable) of Caeruleous Liquors. And yet lately by the help of this Urinous Spirit we made a Blew Liquor, which not a few Ingenious Persons, and among them, some, whose Profession makes them very Conversant with Colours, have looked upon with some wonder. But these Azure Colour'd Liquors should be freed from the Subsiding matter, which the Salts of Tartar or Urine precipitate out of them, rather by being Decanted, than by Filtration. For by the latter of these ways we have sometimes found, the Colour of them very much Impair'd, and little Superiour to that of the grosser Substance, that it left in the Filtre.

EXPERIMENT XXIII.

That Roses held over the Fume of Sulphur, may quickly by it be depriv'd of their Colour, and have as much of their Leaves, as the Fume works upon, burn'd pale, is an Experiment, that divers others have tried, as well as I. But (*Pyrophilus*) it may seem somewhat strange to one that has never consider'd the Compounded nature of Brimstone, That, whereas the Fume of Sulphur will, as we have said, Whiten the Leaves of Roses; That Liquor, which is commonly call'd Oyl of Sulphur *per Campanam*, because it is suppos'd to be made by the Condensation of these Fumes in Glasses shap't like Bells, into a Liquor, does powerfully heighten the Tincture of Red Roses, and make it more Red and Vivid, as we have easily tried by putting some Red-Rose Leaves, that had been long dried, (and so had lost much of their Colour) into a Vial of fair Water. For a while after the Affusion of a convenient Quantity of the Liquor we are speaking of, both the Leaves themselves, and the Water they were Steep'd in, discover'd a very fresh and lovely Colour.

EXPERIMENT XXIV.



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It may (*Pyrophilus*) somewhat serve to Illustrate, not only the Doctrine of *Pigments*, and of *Colours*, but divers other Parts of the *Corpuscular Philosophy*; as that explicates Odours, and many other things, not as the Schools by Aery Qualities, but by Real, though extremely Minute Bodies; to examine, how much of a Colourless Liquor, a very small Parcel of a Pigment may Imbue with a *discernable* Colour. And though there be scarce any thing of Preciseness to be expected from such Trials, yet I presum'd, that (at least) I should be able to show a much further Subdivision of the Parts of Matter into *Visible* Particles, than I have hitherto found taken notice of, and than most men would imagine; no Body, that I know of, having yet attempted to reduce this Matter to any Measure.

The Bodies, the most promising for such a purpose, might seem to be the Metals, especially Gold, because of the Multitude, and Minuteness of its Parts, which might be argu'd from the incomparable Closeness of its Texture: But though we tried a Solution of Gold made in *Aqua Regia* first, and then in fair Water; yet in regard we were to determine the Pigment we employ'd, not by *Bulk* but *Weight*, and because also, that the Yellow Colour of Gold is but a faint one in Comparison of the deep Colour of *Cochineel*, we rather chose this to make our Trials with. But among divers of these it will suffice to set down one, which was carefully made in Vessels conveniently Shap'd; (and that in the presence of a Witness, and an Assistant) the Sum whereof I find among my *Adversaria*, Registered in the following Words. To which I shall only premise, (to lessen the wonder of so strange a diffusion of the Pigment) That *Cochineel* will be better Dissolv'd, and have its Colour far more heightn'd by Spirit of Urine, than (I say not by common Water, but) by Rectify'd Spirit of Wine it self.

The Note I spoke off is this. [One Grain of *Cochineel* dissolv'd in a pretty Quantity of Spirit of Urine, and then dissolv'd further by degrees in fair Water, imparted a discernable, though but a very faint Colour, to about six Glass-fulls of Water, each of them containing about forty three Ounces and an half, which amounts to above a hundred twenty five thousand times its own Weight.]

EXPERIMENT XXV.

It may afford a considerable Hint (*Pyrophilus*) to him, that would improve the Art of Dying, to know what change of Colours may be produc'd by the three several sorts of Salts already often mention'd, (some or other of which may be procur'd in Quantity at reasonable Rates) in the Juices, Decoctions, Infusions, and (in a word) the more soluble parts of Vegetables. And, though the design of this Discourse be the Improvement of Knowledge, not of Trades: yet thus much I shall not scruple to intimate here, That the Blew Liquors, mention'd in the twentieth and one and twentieth Experiments, are far from being the only

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Vegetable Substances, upon which Acid, Urinous, and Alcalizate Salts have the like Operations to those recited in those two Experiments. For Ripe *Privet Berries* (for instance) being crush'd upon White Paper, though they stain it with a Purplish Colour, yet if we let fall on some part of it two or three drops of Spirit of Salt, and on the other part a little more of the Strong Solution of Pot-ashes, the former Liquor immediately turn'd that part of the Thick juice or Pulp, on which it fell, into a lovely Red, and the latter turn'd the other part of it into a delightfull Green. Though I will not undertake, that those Colours in that Substance shall not be much more Orient, than Lasting; and though (*Pyrophilus*) this Experiment may seem to be almost the same with those already deliver'd concerning Syrrup of Violets, and the Juice of Blew-bottles, yet I think it not amiss to take this Occasion to inform you, that this Experiment reaches much farther, than perhaps you yet imagine, and may be of good Use to those, whom it concerns to know, how Dying Stuffs may be wrought upon by Saline Liquors. For, I have found this Experiment to succeed in so many Various Berries, Flowers, Blossoms, and other finer Parts of Vegetables, that neither my Memory, nor my Leisure serves me to enumerate them. And it is somewhat surprizing to see, by how Differingly-colour'd Flowers, or Blossoms, (for example) the Paper being stain'd, will by an Acid Spirit be immediately turn'd Red, and by any *Alcaly* or any Urinous Spirit turn'd Green; insomuch that ev'n the crush'd Blossoms of *Meserion*, (which I gather'd in Winter and frosty Weather) and those of Pease, crush'd upon White Paper, how remote soever their Colours be from Green, would in a moment pass into a deep Degree of that Colour, upon the Touch of an Alcalizate Liquor. To which let us add, That either of those new Pigments (if I may so call them) may by the Affusion of enough of a contrary Liquor, be presently chang'd from Red into Green, and from Green into Red, which Observation will hold also in Syrrup of Violets, Juices of Blew-bottles, &c.

Annotation.

After what I have formerly deliver'd to evince, That there are many Instances, wherein new Colours are produc'd or acquir'd by Bodies, which *Chymists* are wont to think destitute of Salt, or to whose change of Colours no new Accession of Saline Particles does appear to contribute, I think we may safely enough acknowledge, that we have taken notice of so many Changes made by the Intervention of Salts in the Colours of Mix'd Bodies, that it has lessen'd our Wonder, That though *many Chymists* are wont to ascribe the Colours of Such Bodies to their Sulphureous, and *the rest* to their Mercurial Principle; yet *Paracelsus* himself directs us in the Indagation of Colours, to have an Eye principally upon Salts, as we find in that passage of his, wherein he takes upon him to Oblige his Readers



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much by Instructing them, of what things they are to expect the Knowledge from each of the three distinct Principles of Bodies. *Alias* (says he) *Colorum similis ratio est: De quibus brevem institutionem hanc attendite, quod scilicet colores omnes ex Sale prodeant. Sal enim dat colorem, dat Balsamum.*[19] And a little beneath. *Iam natura Ipsa colores protrahit ex sale, cuique speciei dans illum, qui ipsi competit, &c.* After which he concludes; *Itaque qui rerum omnium corpora cognoscere vult, huic opus est, ut ante omnia cognoscat Sulphur, Ab hoc, qui desiderat novisse Colores is scientiam istorum petat a Sale, Qui scire vult Virtutes, is scrutetur arcana Mercurii. Sic nimirum fundamentum hauserit Mysteriorum, in quolibet crescenti indagandorum, prout natura cuilibet speciei ea ingressit.* But though *Paracelsus* ascribes to each of his belov'd Hypostatical Principles, much more than I fear will be found to belong to it; yet if we please to consider Colours, not as *Philosophers*, but as *Dyers*, the concurrence of Salts to the striking and change of Colours, and their Efficacy, will, I suppose, appear so considerable, that we shall not need to quarrel much with *Paracelsus*, for ascribing in this place (for I dare not affirm that he uses to be still of one Mind) the Colours of Bodies to their Salts, if by Salts he here understood, not only Elementary Salts, but such also as are commonly taken for Salts, as Allom, Crystals of Tartar, Vitriol, &c. because the Saline principle does chiefly abound in them, though indeed they be, as we elsewhere declare, mix'd Bodies, and have most of them, besides what is Saline, both Sulphureous, Aqueous, and Gross or Earthy parts.

[19] *Paracelsus* de Mineral. tract. 1. pag. m. 243

But though (*Pyrophilus*) I have observ'd a Red and Green to be produc'd, the former, by Acid Salts, the later by Salts not Acid, in the express Juices of so many differing Vegetable Substances, that the Observation, if persued, may prove (as I said) of good Use: yet to show you how much e'vn these Effects depend upon the particular Texture of Bodies, I must subjoyn some cases wherein I (who am somewhat backwards to admit Observations for Universal) had the Curiosity to discover, that the Experiments would not Uniformly succeed, and of these Exceptions, the chief that I now remember, are reducible to the following three.

EXPERIMENT XXVI.

And, (first) I thought fit to try the Operation of Acid Salts upon Vegetable Substances, that are already and by their own Nature Red. And accordingly I made Trial upon Syrrup of Clove-july-flowers, the clear express'd Juice of the succulent Berries of *Spina Cervina*, or Buckthorn (which I had long kept by me for the sake of its deep Colour) upon Red Roses, Infusion of Brazil, and divers other Vegetable Substances, on some of which crush'd (as is often mention'd) upon White Paper, (which is



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also to be understood in most of these Experiments, if no Circumstance of them argue otherwise) Spirit of Salt either made no considerable Change, or alter'd the Colour but from a Darker to a Lighter Red. How it will succeed in many other Vegetable Juices, and Infusions of the same Colour, I have at present so few at hand, that I must leave you to find it out your self. But as for the Operation of the other sorts of Salts upon these Red Substances, I found it not very Uniform, some Red, or Reddish Infusions, as of Roses, being turn'd thereby into a dirty Colour, but yet inclining to Green. Nor was the Syrrup of Clove-july-flowers turn'd by the solution of Pot-ashes to a much better, though somewhat a Greener, Colour. Another sort of Red Infusions was by an *Alcaly* not turn'd into a Green, but advanc'd into a Crimson, as I shall have occasion to note ere long. But there were other sorts, as particularly the lovely Colour'd juice of Buckthorn Berries, that readily pass'd into a lovely Green.

EXPERIMENT XXVII.

Among other Vegetables, which we thought likely to afford Exceptions to the General Observation about the differing Changes of Colours produc'd by Acid and Sulphureous Salts, we thought fit to make Trial upon the Flowers of *Jasmin*, they being both White as to Colour, and esteem'd to be of a more Oily nature than other Flowers. Whereupon having taken the White parts only of the Flowers, and rubb'd them somewhat hard with my Finger upon a piece of clean Paper, it appear'd very little Discolour'd. Nor had Spirit of Salt, wherewith I moisten'd one part of it, any considerable Operation upon it. But Spirit of Urine, and somewhat more effectually a strong Alcalizate Solution, did immediately turn the almost Colourless Paper moisten'd by the Juice of the *Jasmin*, not as those Liquors are wont to do, when put upon the Juices of other Flowers, of a good Green, but of a Deep, though somewhat Greenish Yellow, which Experiment I did afterwards at several times repeat with the like success. But it seems not that a great degree of Unctuousness is necessary to the Production of the like Effects, for when we try'd the Experiment with the Leaves of those purely White Flowers that appear about the end of Winter, and are commonly call'd *Snow drops*, the event, was not much unlike that, which, we have been newly mentioning.

EXPERIMENT XXVIII.

Another sort of Instances to show, how much changes of Colour effected by Salts, depend upon the particular Texture of the Colour'd Bodies, has been afforded me by several *Yellow* Flowers, and other Vegetables, as Mary-gold Leaves, early Prim-roses, fresh Madder, &c. For being rubb'd upon White Paper, till they imbued it with their Colour, I found not, that by the addition of Alcalizate Liquors, nor yet by that of an Urinous Spirit, they would be turn'd either Green or Red: nor did so Acid a Spirit, as that of Salt, considerably alter their Colour,



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save that it seem'd a little to Dilute it. Only in some early Prim-roses it destroy'd the greatest part of the Colour, and made the Paper almost White agen. And Madder also afforded some thing peculiar, and very differing from what we have newly mention'd: For having gather'd Some Roots of it, and, (whilst they were recent) express'd upon White Paper the Yellow Juice, an Alcalizate Solution drop'd upon it did not turn it either Green or White, but Red. And the bruis'd Madder it self being drench'd with the like Alcalizate Solution, exchang'd also its Yellowishness for a Redness.

An admonition touching the four preceding Experiments.

Having thus (*Pyrophilus*) given you divers Instances, to countenance the General observation deliver'd in the twenty fifth Experiment, and divers Exceptions whereby it ought to be Limited; I must leave the further Inquiry into these Matters to your own Industry. For not remembring at present many of those other Trials, long since made to satisfie my self about Particulars, and not having now the Opportunity to repeat them, I must content my Self to have given you the Hint, and the ways of prosecuting the search your Self; and only declare to you in general, that, As I have made many Trials, unmention'd in this Treatise, whose Events were agreeable to those mention'd in the twenty fifth Experiment, so (to name now no other Instances) what I have try'd with Acid and Sulphureous Salts upon the Pulp of Juniper Berries, rubb'd upon White Paper, inclines me to think, That among that vast Multitude, and strange Variety of Plants that adorn the face of the Earth, perhaps many other Vegetables may be found, on which such *Menstruums* may not have such Operations, as upon the Juice of Violets, Pease-blossoms, &c. no nor upon any of those three other sorts of Vegetables, that I have taken notice of in the three fore-going Experiments. It sufficiently appearing ev'n by these, that the effects of a Salt upon the Juices of particular Vegetables do very much depend upon their particular Textures.

EXPERIMENT XXIX.

It may be of some Use towards the discovery of the nature of these Changes, which the Alimental Juice receives in some Vegetables, according to the differing degrees of their Maturity, and according to the differing kinds of Plants of the same Denomination, to observe what Operation Acid, Urinous, and Alcalizate Salts will have upon the Juices of the several sorts of the Vegetable substances I have been mentioning.

To declare my meaning by an Example, I took from the same Cluster, one Blackberry full Ripe, and another that had not yet gone beyond a Redness, and rubbing apiece of white Paper, with the former, I observ'd, that the Juice adhering to it was of adark Reddish Colour, full of little Black Specks; and that this Juice by a drop of a strong *Lixivium*, was immediatly turn'd into a Greenish Colour deep enough, by as much Urinous Spirit into a Colour much of Kin to



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the former, though somewhat differing, and fainter; and by a drop of Spirit of Salt into a fine and lightsome Red: where as the Red Berry being in like manner rubb'd upon Paper, left on it a Red Colour, which was very little alter'd by the Acid Spirit newly nam'd, and by the Urinous and Lixivate Salts receiv'd changes of Colour differing from those that had been just before produc'd in the dark Juice of the Ripe Blackberry.

I remember also, that though the Infusion of Damask-Roses would as well, though not so much, as that of Red, be heightned by Acid Spirits to an intense degree of Redness, and by Lixivate Salts be brought to a Darkish Green; yet having for Trials sake taken a Rose, whose Leaves, which were large and numerous, like those of a Province Rose, were perfectly Yellow, though in a Solution of Salt of Tartar, they afforded a Green Blewish Tincture, yet I did not by an Acid Liquor obtain a Red one; all that the Saline Spirit I employ'd, perform'd, being (if I much misremember not) to Dilute Somewhat the Yellowness of the Leaves. I would also have tried the Tincture of Yellow Violets, but could procure none. And if I were in those Islands of *Banda*, which are made Famous as well as Rich, by being the almost only places, where Cloves will prosper, I should think it worth my Curiosity to try, what Operation the three differing Kinds of Salts, I have so often mention'd, would have upon the Juice of this Spice, (express'd at the several Seasons of it) as it grows upon the Tree. Since good Authors inform us, (of what is remarkable) that these whether Fruits, or Rudiments of Fruits, are at first *White*, afterward *Green*, and then *Reddish*, before they be beaten off the Tree, after which being Dry'd before they are put up, they grow *Blackish* as we see them. And one of the recentest *Herbarists* informs us, that the Flower grows upon the top of the Clove it self, consisting of four small Leaves, like a Cherry Blossom, but of an excellent *Blew*. But (*Pyrophilus*) to return to our own Observations, I shall add, that I the rather choose, to mention to you an Example drawn from Roses, because that though I am apt to think, as I elsewhere advertise, that something may be guess'd at about some of the Qualities of the Juices of Vegetables, by the Resemblance or Disparity that we meet with in the Changes made of their Colours, by the Operation of the same kinds of Salts; yet that those Conjectures should be very warily made, may appear among other things, by the Instance I have chosen to give in Roses. For though, (as I formerly told you) the Dry'd Leaves, both of the Damask, and of Red ones, give a Red Tincture to Water sharpen'd with Acid Salts, yet the one sort of Leaves is known to have a Purgative faculty,[20] and the other are often, and divers ways, employ'd for Binding.

[20] See *Parkinson* Th. Boran. Trib. 9. cap. 26.



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And I also choose (*Pyrophilus*) to subjoyn this twenty ninth Experiment to those that precede it, about the change of the Colours of Vegetables by Salts, for these two reasons: The first, that you may not easily entertain Suspitions, if in the Trials of an Experiment of some of the Kinds formerly mention'd, you should meet with an Event somewhat differing from what my Relations may have made you expect. And the second, That you may hereby be invited to discern, that it may not be amiss to take notice of the particular Seasons wherein you gather the Vegetables which in Nicer Experiments you make use of. For, if I were not hindred both by haste and some justifiable Considerations, I could perhaps add considerable Instances, to those lately deliver'd, for the making out of this Observation; but for certain reasons I shall at present substitute a remarkable passage to be met with in that Laborious Herbarist Mr. *Parkinson*, where treating of the Virtues of the (already divers times mention'd) Buckthorn Berries, he subjoyns the following account of several Pigments that are made of them, not only according to the several ways of Handling them, but according to the differing Seasons of Maturity, at which they are Gather'd; *Of these Berries, (says he) are made three several sorts of Colours as they shall be gather'd, that is, being gather'd while they are Green, and kept Dry, are call'd Sapberries, which being steep'd into some Allom-water, or fresh bruis'd into Allom-water, they give a reasonable fair Yellow Colour which Painters use for their Work, and Book-binders to Colour the edges of Books, and Leather-dressers to Colour Leather, as they use also to make a Green Colour, call'd Sap-green, taken from the Berries when they are Black, being bruis'd and put into a Brass or Copper Kettle or Pan, and there suffer'd to abide three or four Days, or a little heated upon the Fire, and some beaten Allom put unto them, and afterwards press'd forth, the Juice or Liquor is usually put in great Bladders tied with strong thred at the Head and hung up untill it be Dry, which is dissolv'd in Water or Wine, but Sack (he affirms) is the best to preserve the Colour from Starving, (as they call it) that is, from Decaying, and make it hold fresh the longer. The third Colour (where of none (says he) that I can find have made mention but only Tragus_) is a Purplish Colour, which is made of the Berries suffer'd to grow upon the Bushes untill the middle or end of_ November, that they are ready to drop from the Trees.*

And, I remember (*Pyrophilus*) that I try'd, with a success that pleas'd me well enough, to make such a kind of Pigment, as Painters call Sap-green, by a way not unlike that, deliver'd here by our Author, but I cannot now find any thing relating to that matter among my loose Papers. And my Trials were made so many years ago, that I dare not trust my Memory for Circumstances, but will rather tell



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you, that in a noted Colour-shop, I brought them by Questions to confess to me, that they made their Sap-green much after the ways by our *Botanist* here mention'd. And on this occasion I shall add an Observation, which though it does not strictly belong to this place, may well enough be mention'd here, namely, that I find by an account given us by the Learned *Clusius*, of *Alaternus*, that ev'n the Grosser Parts of the same Plant, are some of them one Colour, and some another; For speaking of that Plant, he tells us, that the *Portugalls* use the Bark to Dye their Nets into a Red Colour, and with the Chips of the Wood, which are Whitish, they Dye a Blackish Blew.

EXPERIMENT XXX.

Among the Experiments that tend to shew that the change of Colours in Bodies may proceed from the Vary'd Texture of their Parts, and the consequent change of their Disposition to Reflect or Refract the Light, that sort of Experiments must not be left unmention'd, which is afforded us by Chymical Digestions. For, if *Chymists* will believe several famous Writers about what they call the Philosophers Stone, they must acknowledge that the same Matter, seald up Hermetically in a Philosophical Egg, will by the continuance of Digestion, or if they will have it so (for it is not Material in our case which of the two it be) of Decoction, run through a great Variety of differing Colours, before it come to that of the Noblest *Elixir*; whether that be Scarlet, or Purple, or what ever other Kind of Red. But without building any thing on so Obtruse and Questionable an Operation, (which yet may be pertinently represented to those that believe the thing) we may observe, that divers Bodies digested in carefully-clos'd Vessels, will in tract of time, change their Colour: As I have elsewhere mention'd my having observ'd ev'n in Rectify'd Spirit of Harts-horn, and as is evident in the Precipitations of Amalgams of Gold, and Mercury, without Addition, where by the continuance of a due Heat the Silver-Colour'd Amalgam is reduc'd into a shining Red Powder. Further Instances of this Kind you may find here and there in divers places of my other Essays. And indeed it has been a thing, that has much contributed to deceive many *Chymists*, that there are more Bodies than one, which by Digestion will be brought to exhibit that Variety and Succession of Colours, which they imagine to be Peculiar to what they call the *True matter of the Philosophers*. But concerning this, I shall referr you to what you may elsewhere find in the Discourse written touching the passive Deceptions of *Chymists*, and more about the Production of Colours by Digestion you will meet with presently. Wherefore I shall now make only this Observation from what has been deliver'd, That in these Operations there appears not any cause to attribute the new Colours emergent to the Action of a new Substantial form, nor to any Increase or Decrement of either the Salt, Sulphur, or Mercury



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of the Matter that acquires new Colours: For the Vessels are clos'd, and these Principles according to the *Chymists* are Ingenerable and Incorruptible; so that the Effect seems to proceed from hence, that the Heat agitating and shuffling the Corpuscles of the Body expos'd to it, does in process of time so change its Texture, as that the Transposed parts do Modify the incident Light otherwise, than they did when the Matter appear'd of another Colour.

EXPERIMENT XXXI.

Among the several changes of Colour, which Bodies acquire or disclose by Digestion, it is very remarkable, that *Chymists* find a Redness rather than any other Colour in most of the Tinctures they Draw, and ev'n in the more Gross Solutions they make of almost all Concretes, that abound either with Mineral or Vegetable Sulphur, though the *Menstruum* employ'd about these Solutions or Tinctures be never so Limpid or Colourless.

This we have observ'd in I know not how many Tinctures drawn with Spirit of Wine from *Jalap*, *Guaicum*, and several other Vegetables; and not only in the Solutions of *Amber*, *Benzoin*, and divers other Concretes made with the same *Menstruum*, but also in divers Mineral Tinctures. And, not to urge that familiar Instance of the Ruby of Sulphur, as *Chymists* upon the score of its Colour, call the Solution of Flowers of Brimstone, made with the Spirit of Turpentine, nor to take notice of other more known Examples of the aptness of Chymical Oyls, to produce a Red Colour with the Sulphur they extract, or dissolve; not to insist (I say) upon Instances of this nature, I shall further represent to you, as a thing remarkable, that, both Acid and Alcalizate Salts, though in most other cases of such contrary Operations, in reference to Colours, will with many Bodies that abound with Sulphureous, or with Oily parts, produce a Red; as is manifest partly in the more Vulgar Instances of the Tinctures, or Solutions of Sulphur made with *Lixiviums*, either of Calcin'd Tartar or Pot-ashes, and other Obvious examples, partly by this, that the true Glass of Antimony extracted with some Acid Spirits, with or without Wine, will yield a Red Tincture, and that I know an Acid Liquor, which in a moment will turn Oyl of Turpentine into a deep Red. But among the many Instances I could give you of the easie Production of Redness by the Operation of Saline Spirit, as well as of Spirit of Wine; I remember two or three of those I have tried, which seem remarkable enough to deserve to be mention'd to you apart.

EXPERIMENT XXXII.

But before we set them down, it will not perhaps appear impertinent to premise;

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That there seems to be a manifest Disparity betwixt Red Liquors, so that some of them may be said to have a Genuine Redness in comparison of others, that have a Yellowish Redness: For if you take (for example) a good Tincture of *Chochineel*, dilute it never so much with fair Water, you will not (as far as I can judge by what I have tried) be able to make it a Yellow Liquor. Insomuch that a Single drop of a rich Solution of *Cochineel* in Spirit of Urine, being Diluted with above an Ounce of fair Water, exhibited no Yellowishness at all, but a fair (though somewhat faint) Pinck or Carnation; and even when *Cochineel* was by degrees Diluted much beyond the newly mention'd Colour, by the way formerly related to you in the twenty fourth Experiment, I remember not, that there appear'd in the whole Trial any Yellow. But if you take Balsom of Sulphur (for Instance) though it may appear in a Glass, where it has a good Thickness, to be of a deep Red, yet if you shake the Glass, or pour a few drops on a sheet of White Paper, spreading them on it with your Finger, the Balsom that falls back along the sides of the Glass, and that which stains the Paper, will appear Yellow, not Red. And there are divers Tinctures, such as that of Amber made with Spirit of Wine, (to name now no more) that will appear either Yellow or Red, according as the Vessels that they fill, are Slender or Broad.

EXPERIMENT XXXIII.

But to proceed to the Experiments I was about to deliver; *First*; Oyl or Spirit of Turpentine, though clear as fair Water, being Digested upon the purely White Sugar of Lead, has, in a short time, afforded us a high Red Tincture, that some Artists are pleas'd to call the Balsom of *Saturn*, which they very much (and probably not altogether without cause) extoll as an excellent Medicine in divers Outward affections.

EXPERIMENT XXXIV.

Next, take of common Brimstone finely powdred five Ounces, of Sal-Armoniack likewise pulveriz'd an equal weight, of beaten Quick-lime six Ounces, mix these Powders exquisitely, and Distill them through a Retort plac'd in Sand by degrees of Fire, giving at length as intense a Heat as you well can in Sand, there will come over (if you have wrought well) a Volatile Tincture of Sulphur, which may probably prove an excellent Medicine, and should have been mention'd among the other Preparations of Sulphur, which we have elsewhere imparted to you, but that it is very pertinent to our present Subject, The change of Colours. For though none of the Ingredients be Red, the Distill'd Liquor will be so: and this Liquor if it be well Drawn, will upon a little Agitation of the Vial first unstop'd (especially if it be held in a Warmer hand) lend forth a copious Fume, not Red, like that of Nitre, but White; And sometimes this Liquor may be so Drawn, that I remember, not long since, I took pleasure to observe in a parcel of it, that Ingredients not Red, did not only yield by Distillation a Volatile Spirit that was Red, but though that Liquor did upon the bare opening of the Bottle it was kept in, drive us away with the plenty and sulphureous sent of a White steam which it sent forth, yet the Liquor it self being touch'd by our Fingers, did immediately Dye them Black.



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EXPERIMENT XXXV.

The third and *last* Experiment I shall now mention to shew, how prone Bodies abounding in Sulphureous parts are to afford a Red Colour, is one, wherein by the Operation of a Saline Spirit upon a White or Whitish Body, which according to the *Chymists* should be altogether Sulphureous, a Redness may be produc'd, not (as in the former Experiments) slowly, but in the twinkling of an Eye. We took then of the Essential Oyl of Anniseeds, which has this Peculiarity, that in Cold weather it loses its Fluidity and the greatest part of its Transparency, and looks like a White or Whitish Oyntment, and near at hand seems to consist of a Multitude of little soft Scales: Of this Coagulated Stuff we spread a little with a Knife upon a piece of White Paper, and letting fall on it, and mixing with it a drop or two of Oyl of Vitriol, immediately (as we fore-saw) there emerg'd together with some Heat and Smoak, a Blood-Red Colour, which therefore was in a trice produc'd by two Bodies, whereof the one had but a Whitish Colour, and the other (if carefully rectify'd) had no Colour at all.

EXPERIMENT XXXVI.

But on this Occasion (*Pyrophilus*) we must add once for all, that in many of the above-recited Experiments, though the changes of Colour happen'd as we have mention'd them: yet the emergent or produc'd Colour is oft times very subject to Degenerate, both quickly and much. Notwithstanding which, since the Changes, we have set down, do happen presently upon the Operation of the Bodies upon each other, or at the times by us specify'd; *that* is sufficient both to justifie our Veracity, and to shew what we Intend; it not being Essential to the Genuineness of a Colour to be Durable. For a fading Leaf, that is ready to Rot, and moulder into Dust, may have as true a Yellow, as a Wedge of Gold, which so obstinately resists both Time and Fire. And the reason, why I take occasion from the former Experiment to subjoyn this general Advertisement, is, that I have several times observ'd, that the Mixture resulting from the Oyls of Vitriol, and of Anniseeds, though it acquire a thicker consistence than either of the Ingredients had, has quickly lost its Colour, turning in a very short time into a dirty Gray, at least in the Superficial parts, where 'tis expos'd to the Air; which last Circumstance I therefore mention, because that, though it seem probable, that this Degeneration of Colours may oft times and in divers cases proceed from the further Action of the Saline Corpuscles, and the other Ingredients upon one another, yet in many cases much of the Quick change of Colours seems ascribeable to the Air, as may be made probable by several reasons: The first whereof may be fetcht from the newly recited Example of the two Oyls; The next may be, that we have sometimes observ'd long Window-Curtains of light Colours, to have that part of them, which was expos'd to the Air, when the Window was open, of one Colour,



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and the lower part, that was sheltred from the Air by the Wall, of another Colour: And the third Argument may be fetch'd from divers Observations, both of others, and our own; For of that Pigment so well known in Painters Shops, by the name of *Turnsol*, our Industrious *Parkinson*, in the particular account he gives of the Plant that bears it, tells us also, That *the Berries when they are at their full Maturity, have within them between the outer Skin and the inward Kirnel or Seed, a certain Juice or Moisture, which being rubb'd upon Paper or Cloath, at the first appears of a fresh and lovely Green Colour, but presently changeth into a kind of Blewish Purple, upon the Cloath or Paper, and the same Cloath afterwards wet in Water, and wrung forth, will Colour the Water into a Claret Wine Colour, and these (concludes he) are those Raggs of Cloath, which are usually call'd Turnsol in the Druggists or Grocers Shops*[21]. And to this Observation of our *Botanist* we will add an Experiment of our own, (made before we met with That) which, though in many Circumstances, very differing, serves to prove the same thing; for having taken of the deeply Red Juice of *Buckthorn* Berries, which I bought of the Man that uses to sell it to the Apothecaries, to make their Syrrup *de Spina Cervina*, I let some of it drop upon a piece of White Paper, and having left it there for many hours, till the Paper was grown dry again, I found what I was inclin'd to suspect, namely, That this Juice was degenerated from a deep Red to a dirty kind of Greyish Colour, which, in a great part of the stain'd Paper seem'd not to have so much as an Eye of Red: Though a little Spirit of Salt or dissolv'd *Alcaly* would turn this unpleasant Colour (as formerly I told you it would change the not yet alter'd Juice) into a Red or Green. And to satisfie my self, that this Degeneration of Colour did not proceed from the Paper, I drop'd some of the deep Red or Crimson Juice upon a White glaz'd Tile, and suffering it to dry on there, I found that ev'n in that Body, on which it could not Soak, and by which it could not be Wrought, it nevertheless lost its Colour. And these Instances (*Pyrophilus*) I am the more carefull to mention to you, that you may not be much Surpris'd or Discourag'd, if you should sometimes miss of performing punctually what I affirm my self to have done in point of changing Colours; since in these Experiments the over-sight or neglect of such little Circumstances, as in many others would not be perhaps considerable, may occasion the mis-carrying of a Trial. And I was willing also to take this occasion of Advertising you in the repeating of the Experiments mention'd in this Treatise, to make use of the Juices of Vegetables, and other things prepar'd for your Trials, as soon as ever they are ready, lest one or other of them grow less fit, if not quite unfit by delay; and to estimate the Event of the Trials by the Change,

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that is produc'd presently upon the due and sufficient Application of Actives to Passives, (as they speak) because in many cases the effects of such Mixtures may not be lasting, and the newly produc'd Colour may in a little time degenerate. But, (*Pyrophilus*) I forgot to add to the two former Observations lately made about Vegetables, a third of the same Import, made in Mineral substances, by telling you, That the better to satisfie a Friend or two in this particular, I sometimes made, according to some Conjectures of mine, this Experiment; That having dissolv'd good Silver in *Aqua-fortis*, and Precipitated it with Spirit of Salt, upon the first Decanting of the Liquor, the remaining Matter would be purely White; but after it had lain a while uncover'd, that part of it, that was Contiguous to the Air, would not only lose its Whiteness, but appear of a very Dark and almost Blackish Colour, I say that part that was Contiguous to the Air, because if that were gently taken off, the Subjacent part of the same Mass would appear very White, till that also, having continu'd a while expos'd to the Air, would likewise Degenerate. Now whether the Air perform these things by the means of a Subtile Salt, which we elsewhere show it not to be destitute of, or by a peircing Moisture, that is apt easily to insinuate it self into the Pores of some Bodies, and thereby change their Texture, and so their Colour; Or by solliciting the Avolation of certain parts of the Bodies, to which 'tis Contiguous; or by some other way, (which possibly I may elsewhere propose and consider) I have not now the leisure to discourse. And for the same reason, though I could add many other Instances, of what I formerly noted touching the emergency of Redness upon the Digestion of many Bodies, insomuch that I have often seen upon the Borders of *France* (and probably we may have the like in *England*) a sort of Pears, which digested for some time with a little Wine, in a Vessel exactly clos'd, will in not many hours appear throughout of a deep Red Colour, (as also that of the Juice, wherein they are Stew'd, becomes) but ev'n on pure and white Salt of Tartar, pure Spirit of Wine, as clear as Rock-water, will (as we elsewhere declare) by long Digestion acquire a Redness; Though I say such Instances might be Multiply'd, and though there be some other Obvious changes of Colours, which happen so frequently, that they cannot but be as well Considerable as Notorious; such as is the Blackness of almost all Bodies burn'd in the open Air: yet our haste invites us to resign you the Exercise of enquiring into the Causes of these Changes. And certainly, the reason both *why* the Soots of such differing Bodies are almost all of them all Black, *why* so much the greater part of Vegetables should be rather Green than of any other Colour, and particularly (which more directly concerns this place) *why* gentle Heats do so frequently in Chymical Operations produce rather a Redness than another Colour in digested *Menstruums*, not only Sulphureous, as Spirit of Wine, but Saline, as Spirit of Vinegar, may be very well worth a serious Inquiry; which I shall therefore recommend to *Pyrophilus* and his Ingenious Friends.



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[21] *Parkinson*, Thea. Bot. Trib. 4 cap. 12.

EXPERIMENT XXXVII.

It may seem somewhat strange, that if you take the Crimson Solution of *Cochineel*, or the Juice of Black Cherries, and of some other Vegetables that afford the like Colour, (which because many take but for a deep Red, we do with them sometimes call it so) and let some of it fall upon a piece of Paper, a drop or two of an Acid Spirit, such as Spirit of Salt, or *Aqua-fortis*, will immediately turn it into a fair Red. Whereas if you make an Infusion of Brazil in fair Water, and drop a little Spirit of Salt or *Aqua-fortis* into it, that will destroy its Redness, and leave the Liquor of a Yellow, (sometimes Pale) I might perhaps plausibly enough say on this occasion, that if we consider the case a little more attentively, we may take notice, that the action of the Acid Spirit seems in both cases, but to weaken the Colour of the Liquor on which it falls. And so though it destroy Redness in the Tincture of Brazil, as well as produce Red in the Tincture of *Chochineel*, its Operations may be Uniform enough, since as Crimson seems to be little else than a very deep Red, with (perhaps) an Eye of Blew, so some kinds of Red seem (as I have lately noted) to be little else than heightned Yellow. And consequently in such Bodies, the Yellow seems to be but a diluted Red. And accordingly Alcalizate Solutions and Urinous Spirits, which seem dispos'd to Deepen the Colours of the Juices and Liquors of most Vegetables, will not only restore the Solution of *Cochineel* and the Infusion of Brazil to the Crimson, whence the Spirit of Salt had chang'd them into a truer Red; but will also (as I lately told you) not only heighthen the Yellow Juice of Madder into Red, but advance the Red Infusion of Brazil to a Crimson. But I know not whether it will not be much safer to derive these Changes from vary'd Textures, than certain kinds of Bodies; and you will perhaps think it worth while, that I should add on this occasion, That it may deserve some Speculation, why, notwithstanding what we have been observing, though Blew and Purple seem to be deeper Colours than Red, and therefore the Juices of Plants of either of the two former Colours may (congruously enough to what has been just now noted) be turn'd Red by Spirit of Salt or *Aqua-fortis*, yet Blew Syrrup of Violets and some Purples should both by Oyl of Tartar and Spirit of Urine be chang'd into Green, which seems to be not a deeper but a more diluted Colour than Blew, if not also than Purple.

EXPERIMENT XXXVIII.



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It would much contribute to the History of Colours, if *Chymists* would in their Laboratories take a heedfull notice, and give us a faithfull account of the Colours observ'd in the Steams of Bodies either Sublim'd or Distill'd, and of the Colours of those Productions of the Fire, that are made up by the Coalition of those Steams. As (for Instance) we observe in the Distilling of pure Salt peter, that at a certain season of the Operation, the Body, though it seem either Crystalline, or White, affords very Red Fumes: whereas though Vitriol be Green or Blew, the Spirit of it is observ'd to come over in Whitish Fumes. The like Colour I have taken notice of in the Fumes of several other Concretes of differing Colours, and Natures, especially when Distill'd with strong Fires. And we elsewhere note, that ev'n Soot, as Black as it is, has fill'd our Receivers with such copious White Fumes, that they seem'd to have had their In-sides wash'd with Milk. And no less observable may be, the Distill'd Liquors, into which such Fumes convene, (for though we will not deny, that by skill and care a Reddish Liquor may be obtain'd from Nitre) yet the common Spirit of it, in the making ev'n of which store of these Red Fumes are wont to pass over into the Receiver, appears not to be at all Red. And besides, that neither the Spirit of Vitriol, nor that of Soot is any thing White; And, besides also, that as far as I have observ'd, most (for I say not all) of the Emyreumatical Oyls of Woods, and other Concretes, are either of a deep Red, or of a Colour between Red and Black; besides this, I say, 'tis very remarkable that notwithstanding that great Variety of Colours to be met with in the Herbs, Flowers, and other Bodies wont to be Distill'd in *Balneo*: yet (as far at least as our common Distillers Experience reacheth) all the Waters and Spirits that first come over by that way of Distillation, leave the Colours of their Concretes behind them, though indeed there be one or two Vegetables not commonly taken notice of, whose Distill'd Liquors I elsewhere observe to carry over the Tincture of the Concrete with them. And as in Distillations, so in Sublimations, it were worth while to take notice of what comes up, in reference to our present scope, by purposely performing them (as I have in some cafes done) in conveniently shap'd Glasses, that the Colour of the ascending Fumes may be discern'd; For it may afford a Naturalist good Information to observe the Congruities or the Differences betwixt the Colours of the ascending Fumes, and those of the *Flowers*, they compose by their Convention. For it is evident, that these *Flowers*, do many of them in point of Colour, much differ, not only from one another, but oft times from the Concretes that afforded them. Thus, (not here to repeat what I formerly noted of the Black Soots of very differinglly Colour'd Bodies) though Camphire and Brimstone afford *Flowers* much of their own Colour, save that those of Brimstone are wont to be a little Paler,



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than the Lumps that yielded them; yet ev'n of Red *Benzoin*, that sublim'd Substance, which *Chymists* call its *Flowers*, is wont to be White or Whitish. And to omit other Instances, ev'n one and the same Black Mineral, Antimony, may be made to afford *Flowers*, some of them Red, and some Grey, and, which is more strange, some of them purely White. And 'tis the Prescription of some Glass-men by exquisitely mingling a convenient proportion of Brimstone, Sal-Armoniack, and Quicksilver, and Subliming them, together, to make a Sublimate of an excellent Blew; and though having caus'd the Experiment to be made, we found the produc'd Sublimate to be far from being of a lovely Colour, (as was promis'd) that there and there, it seem'd Blewish, and at least was of a Colour differing enough from either of the Ingredients, which is sufficient for our present purpose. But a much finer Colour is promis'd by some of the Empiricks, that pretend to Secrets, who tell us, that Orpiment, being Sublim'd, will afford among the Parts of it that fly Upward, some little Masses, which, though the Mineral it self be of a good Yellow, will be Red enough to emulate Rubies, both in Colour and Translucency. And this Experiment may, for ought I know, sometimes succeed; for I remember, that having in a small Bolt-head purposely sublim'd some powder'd Orpiment, we could in the Lower part of the Sublimate discern here and there some Reddish Lines, though much of the Upper part of the Sublimate consisted of a matter, which was not alone purely Yellow, but transparent almost like a Powder. And we have also this way obtain'd a Sublimate, the Lower part whereof though it consisted not of Rubies, yet the small pieces of it, which were Numerous enough, were of a pleasant Reddish Colour, and Glitter'd very prettily. But to insist on such kind of Trials and Observations (where the ascending Fumes of Bodies differ in Colour from the Bodies themselves) though it might indeed Inrich the History of Colours, would Robb me of too much of the little time I have to dispatch what I have further to tell you concerning them.

EXPERIMENT XXXIX

Take the dry'd Buds (or Blossoms) of the Pomegranate Tree, (which are commonly call'd in the Shops *Balaustiums*) pull off the Reddish Leaves, and by a gentle Ebullition of them in fair Water, or by a competent Infusion of them in like Water well heated, extract a faint Reddish Tincture, which if the Liquor be turbid, you may Clarifie it by Filtrating it Into this, if you pour a little good Spirit of Urine, or some other Spirit abounding in the like sort of Volatile Salts, the Mixture will presently turn of a dark Greenish Colour, but if instead of the fore-mention'd Liquor, you drop into the simple Infusion a little rectify'd Spirit of Sea-Salt, the Pale and almost Colourless Liquor will immediately not only grow more Transparent, but acquire a high Redness, like that of Rich Claret Wine, which so suddenly acquir'd Colour, may as quickly be Destroy'd and turn'd into a dirty Blewish Green, by the affusion of a competent quantity of the above-mention'd Spirit of Urine.



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Annotation.

This Experiment may bring some Light to, and receive some from a couple of other Experiments, that I remember I have met with in the ingenious *Gassendus's* Animadversions upon *Epicurus's* Philosophy, whilst I was turning over the Leaves of those Learned Commentaries; (my Eyes being too weak to let me read such Voluminous Books quite thorough) And I the less scruple (notwithstanding my contrary Custom in this Treatise) to set down these Experiments of another, because I shall a little improve the latter of them, and because by comparing there with that which I have last recited, we may be assisted to Conjecture upon what account it is, that Oyl of Vitriol heightens the Tincture of Red-rose Leaves, since Spirit of Salt, which is a highly Acid *Menstruum*, but otherwise differing enough from Oyl of Vitriol, does the same thing. Our Authors Experiments then, as we made them, are these; We took about a Glass-full of luke-warm Water, and in it immerg'd a quantity of the Leaves of *Senna*, and presently upon the Immersion there did not appear any Redness in the Water, but dropping into it a little Oyl of Tartar, the Liquor soon discover'd a Redness to the watchfull Eye, whereas by a little of that Acid Liquor of Vitriol, which is like the former, undeservedly called Oyl, such a Colour would not be extracted from the infused *Senna*. On the other side we took some Red-rose Leaves dry'd, and having shaken them into a Glass of fair Water, they imparted to it no Redness, but upon the affusion of a little Oyl of Vitriol the Water was immediately turn'd Red, which it would not have been, if instead of Oyl of Vitriol, we had employed Oyl of Tartar to produce that Colour: That these were *Gassendus* his Experiments, I partly remember, and was assur'd by a Friend, who lately Transcribed them out of *Gassendus* his Book, which I therefore add, because I have not now that Book at hand. And the design of *Gassendus* in these Experiments our Friend affirms to be, to prove, that of things not Red a Redness may be made only by Mixture, and the Varied position of parts, wherein the Doctrine of that Subtil Philosopher doth not a little Authorize, what we have formerly delivered concerning the Emergency and Change of Colours. But the instances, that we have out of him set down, seem not to be the most Eminent, that may be produced of this truth: For our next Experiment will shew the production of several Colours out of Liquors, which have not any of them any such Colour, nor indeed any discernable one at all; and whereas though our Author tells us, that there was no Redness either in the Water, or the Leaves of *Senna*, or the Oyl of Tartar; And though it be true, that the Predominant Colour of the Leaves of *Senna* be another than Red, yet we have try'd, that by steeping that Plant a Night even in Cold water, it would afford a very deep Yellow or Reddish Tincture without the help of the



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Oyl of Tartar, which seems to do little more than assist the Water to extract more nimbly a plenty of that Red Tincture, wherewith the Leaves of *Senna* do of themselves abound, and having taken off the Tincture of *Senna*, made only with fair Water, before it grew to be Reddish, and Decanted it from the Leaves, we could not perceive, that by dropping some Oyl of Tartar into it, that Colour was considerable, though it were a little heightened into a Redness; which might have been expected, if the particles of the Oyl did eminently Co-operate, otherwise than we have expressed, to the production of this Redness.

And as for the Experiment with Red-rose Leaves, the same thing may be alleged, for we found that such Leaves by bare Infusion for a Night and Day in fair Water, did afford us a Tincture bordering at least upon Redness, and that Colour being conspicuous in the Leaves themselves, would not by some seem so much to be produc'd as to be extracted by the affusion of Oyl of Vitriol. And the Experiment try'd with the dry'd Leaves of Damask-roses succeeded but imperfectly, but that is indeed observable to our Authors purpose, that Oyl of Tartar will not perform in this Experiment what Oyl of Vitriol doth; but because this last named Liquor is not so easily to be had, give me leave to Advertise you, that the Experiment will succeed, if instead of it you imploy *Aqua-fortis*. And though some Trials of our own formerly made, and others easily deducible from what we have already deliver'd, about the different Families and Operations of Salt, might enable us to present you an Experiment upon Red-rose Leaves, more accommodated to our Authors purpose, than that which he hath given us; yet our Reverence to so Candid a Philosopher, invites us rather to improve his Experiment, than substitute another in its place. Take therefore of the Tincture of Red-rose Leaves, (for with Damask-rose Leaves the Experiment succeedeth not well) made as before hath been taught with a little Oyl of Vitriol, and a good quantity of fair Water, pour off this Liquor into a clear Vial, half fill'd with Limpid water; till the Water held against the Light have acquir'd a competent Redness, without losing its Transparency, into this Tincture drop leisurely a little good Spirit of Urine, and shaking the Vial, which you must still hold against the Light, you shall see the Red Liquor immediately turn'd into a fine Greenish Blew, which Colour was not to be found in any of the Bodies, upon whose Mixture it emerg'd, and this Change is the more observable, because in many Bodies the Degenerating of Blew into Red is usual enough, but the turning of Red into Blew is very unfrequent. If at every drop of Spirit of Urine you shake the Vial containing the Red Tincture, you may delightfully observe a pretty variety of Colours in the passage of that Tincture from a Red to a Blew, and sometimes we have this way hit upon such a Liquor, as being look't upon against and from the Light, did seem faintly

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to emulate the above-mention'd Tincture of *Lignum Nephriticum*. And if you make the Tincture of Red-roses very high, and without Diluting it with fair Water, pour on the Spirit of Urine, you may have a Blew so deep, as to make the Liquor Opacous, but being dropt upon White Paper the Colour will soon disclose it self. Also having made the Red, and consequently the Blew Tincture very Transparent, and suffer'd it to rest in a small open Vial for a Day or two, we found according to our Conjecture, that not only the Blew but the Red Colour also was Vanish'd; the clear Liquor being of a bright Amber Colour, at the bottom of which subsided a Light, but Copious feculency of almost the same Colour, which seems to be nothing but the Tincted parts of the Rose Leaves drawn out by the Acid Spirits of the Oyl of Vitriol, and Precipitated by the Volatile Salt of the Spirit of Urine, which makes it the more probable, that the Redness drawn by the Oyl of Vitriol, was at least as well an extraction of the Tinging parts of the Roses, as a production of Redness; and lastly, if you be destitute of Spirit of Urine, you may change the Colour of the Tincture of Roses with many other Sulphureous Salts, as a strong Solution of Pot-ashes, Oyl of Tartar, &c. which yet are seldome so free from Feculency, as the Spirituous parts of Urine becomes by repeated Distillation.

Annotation.

On this, occasion, I call to mind, that I found, a way of producing, though not the same kind of Blew, as I have been mentioning, yet a Colour near of Kin to it, namely, a fair Purple, by imploying a Liquor not made Red by Art, instead of the Tincture of Red-roses, made with an Acid Spirit; And my way was only to take Log-wood, (a Wood very well known to Dyers) having by Infusion the Powder of it a while in fair Water made that Liquor Red, I dropt into it a *Tantillum* of an Urinous Spirit, as that of Sal-Armoniack, (and I have done the same thing with an *Alcali*) by which the Colour was in a moment turn'd into a Rich, and lovely Purple. But care must be had, that you let not fall into a Spoonfull above two or three Drops, lest the Colour become so deep, as to make the Liquor too Opacous. And (to answer the other part of *Gassendus* his Experiment) if instead of fair Water, I infus'd the Log-wood in Water made somewhat sour by the Acid Spirit of Salt, I should obtain neither a Purple Liquor, nor a Red, but only a Yellow one.

EXPERIMENT XL.

The Experiment I am now to mention to you, *Pyrophilus*, is that which both you, and all the other *Virtuosi* that have seen it, have been pleas'd to think very strange; and indeed of all the Experiments of Colours, I have yet met with, it seems to be the fittest to recommend the Doctrine propos'd in this Treatise, and to shew that we need not suppose, that all Colours must necessarily be Inherent Qualities, flowing from the Substantial Forms of the Bodies they are said



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to belong to, since by a bare Mechanical change of Texture in the Minute parts of Bodies; two Colours may in a moment be Generated quite *De novo*, and utterly Destroy'd. For there is this difference betwixt the following Experiment, and most of the others deliver'd in these Papers, that in this, the Colour that a Body already had, is not chang'd into another, but betwixt two Bodies, each of them apart devoid of Colour, there is in a moment generated a very deep Colour, and which if it were let alone, would be permanent; and yet by a very small Parcel of a third Body, that has no Colour of its own, (lest some may pretend I know not what Antipathy betwixt Colours) this otherwise permanent Colour will be in another trice so quite Destroy'd, that there will remain no foot-steps either of it or of any other Colour in the whole Mixture.

The Experiment is very easie, and it is thus perform'd: Take good common Sublimate, and fully satiate with it what quantity of Water you please, Filtre the Solution carefully through clean and close Paper, that it may drop down as Clear and Colourless as Fountain water. Then when you'l shew the Experiment, put of it about a Spoonfull into a small Wine-glass, or any other convenient Vessel made of clear Glass, and dropping in three or four drops of good Oyl of Tartar, *per Deliquium*; well Filtred that it may likewise be without Colour, these two Limpid Liquors will in the twinkling of an Eye turn into an Opacous mixture of a deep Orange Colour, which by keeping the Glass continually shaking in your hand, you must preserve from settling too soon to the Bottom; And when the Spectators have a little beheld this first Change, then you must presently drop in about four or five drops of Oyl of Vitriol, and continuing to shake the Glass pretty strongly, that it may the Nimbler diffuse it self, the whole Colour, if you have gone Skilfully to work, will immediately disappear, and all the Liquor in the Glass will be Clear and Colourless as before, without so much as a Sediment at the Bottom. But for the more gracefull Trial of this Experiment, 'twill not be amiss to observe, First, That there should not be taken too much of the Solution of Sublimate, nor too much of the Oyl of Tartar drop'd in, to avoid the necessity of putting in so much Oyl of Vitriol as may make an Ebullition, and perhaps run over the Glass. Secondly, That 'tis convenient to keep the Glass always a little shaking, both for the better mixing of the Liquors, and to keep the Yellow Substance from Subsiding, which else it would in a short time do, though when 'tis subsided it will retain its Colour, and also be capable of being depriv'd of it by the Oyl newly mention'd. Thirdly, That if any Yellow matter stick at the sides of the Glass, 'tis but inclining the Glass, till the clarify'd Liquor can wash alongst it, and the Liquor will presently imbibe it, and deprive it of its Colour.

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Many have somewhat wondred, how I came to light upon this Experiment, but the Notions or Conjectures I have about the differing Natures of the Several Tribes of Salts, having led me to devise the Experiment, it will not be difficult for me to give you the Chymical Reason, if I may so speak, of the *Phaenomenon*. Having then observ'd, that *Mercury* being dissolv'd in Some *Menstruums*, would yield a dark Yellow Precipitate, and supposing that, as to this, common Water, and the Salts that stick to the *Mercury* would be equivalent to those Acid *Menstruums*, which work upon the *Quick-silver*, upon the account of their Saline particles, I substituted a Solution of Sublimate in fair Water, instead of a Solution of *Mercury* in *Aqua-fortis*, or Spirit of *Nitre*, that simple Solution being both clearer and free from that very offensive Smell, which accompanies the Solutions of *Mercury* made with those other corrosive Liquors; then I consider'd, that That, which makes the Yellow Colour, is indeed but a Precipitate made by the means of the Oyl of Tartar, which we drop in, and which, as *Chymists* know, does generally precipitate Metalline Bodies corroded by Acid Salts; so that the Colour in our case results from the Coalition of the Mercurial particles with the Saline ones, wherewith they were formerly associated, and with the Alcalizate particles of the Salt of Tartar that swim up and down in the Oyl. Wherefore considering also, that very many of the effects of Lixivate Liquors, upon the Solutions of other Bodies, may be destroy'd by Acid *Menstruums*, as I elsewhere more particularly declare, I concluded, that if I chose a very potently Acid Liquor, which by its Incisive power might undo the work of the Oyl of Tartar, and disperse again those Particles, which the other had by Precipitation associated, into such minute Corpuscles as were before singly Inconspicuous, they would become Inconspicuous again, and consequently leave the Liquor as Colourless as before the Precipitation was made.

This, as I said, *Pyrophilus*, seems to be the Chymical reason of this Experiment, that is such a reason, as, supposing the truth of those Chymical Notions I have elsewhere I hope evinc'd, may give such an account of the *Phaenomena* as Chymical Notions can supply us with; but I both here and elsewhere make use of this way of speaking, to intimate that I am sufficiently aware of the difference betwixt a Chymical Explication of a *Phaenomenon*, and one that is truly Philosophical or Mechanical; as in our present case, I tell you something, when I tell you that the Yellowness of the Mercurial Solution and the Oyl of Tartar is produc'd by the Precipitation occasion'd by the affusion of the latter of those Liquors, and that the destruction of the Colour proceeds from the Dissipation of that Curdl'd matter, whose Texture is destroy'd, and which is dissolv'd into Minute and Invisible particles by the potently

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Acid Menstruum, which is the reason, why there remains no Sediment in the Bottom, because the infused Oyl takes it up, and resolves it into hidden or invisible Parts, as Water does Salt or Sugar. But when I have told you all this, I am far from thinking I have told all that such an Inquisitive Person as your self would know, for I presume you would desire as well as I to learn (at least) why the Particles of the *Mercury*, of the Tartar, and of the Acid Salts convening together, should make rather an Orange Colour than a Red, or a Blew, or a Green, for 'tis not enough to say what I related a little before, that divers Mercurial Solutions, though otherwise made, would yield a Yellow precipitate, because the Question will recurr concerning them; and to give it a satisfactory answer, is, I freely acknowledge, more than I dare as yet pretend to.

But to confirm my conjecture about the Chymical reason of our Experiment, I may add, that as I have (*viz.* pag. 34th. of this Treatise) elsewhere (on another occasion) told you, with Saline Liquors of another kind and nature than Salt of Tartar, (namely, with Spirit of Urine, and Liquors of kin to that) I can make the *Mercury* precipitate out of the first simple Solution quite of another Colour than that hitherto mention'd; Nay, if instead of altering the Precipitating liquor, I alter'd the Texture of the Sublimate in such a way as my Notions about Salt requir'd, I could produce the same *Phaenomenon*. For having purposely Sublim'd together Equal parts (or thereabout) of Sal-Armoniack and Sublimate, first diligently Mix'd, the ascending Flowers being diffolv'd in fair Water, and Filtred, gave a Solution Limpid and Colourless, like that of the other Sublimates, and yet an *Akaly* drop'd into this Liquor did not turn it Yellow but White. And upon the same Grounds we may with *Quick-silver*, without the help of common Sublimate, prepare another sort of Flowers dissoluble in Water without Discolouring it, with which I could likewise do what I newly mention'd; to which I shall add, (what possibly you'l somewhat wonder at) That so much does the Colour depend upon the Texture resulting from the Convention of the several sorts of Corpuscles, that though in our Experiment, Oyl of Vitriol destroys the Yellow Colour, yet with *Quick-silver* and fair Water, by the help of Oyl of Vitriol alone, we may easily make a kind of Precipitate of a fair and permanent Yellow, as you will e're long (in the forty second Expement of this third Part) be taught. And I may further add, that I chose Oyl of Vitriol, not so much for any other or peculiar Quality, as for its being, when 'tis well rectify'd, (which 'tis somewhat hazardous to bring it to be) not only devoid of Colour and in Smells, but extremely Strong and Incisive; For though common and undeplegmatized *Aqua-fortis* will not perform the same thing well, yet that which is made exceeding Strong by being carefully Dephlegm'd,

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will do it pretty well, though not so well as Oyl of Vitriol which is so Strong, that even without Rectification it may for a need be made use of. I will not here tell you what I have try'd, that I may be able to deprive at pleasure the Precipitate that one of the Sulphureous Liquors had made, by the copious Affusion of the other: Because I found, though this Experiment is too ticklish to let me give a full account of it in few words, I shall therefore tell you, that it is not only for once, that the other above-mention'd Experiment may be made, the same Numerical parcels of Liquor being still employ'd in it; for after I have Clarify'd the Orange Colour'd Liquor, by the addition of as little of the Oyl of Viriol as will suffice to perform the effect, I can again at pleasure re-produce the Opacous Colour, by the dropping in of fresh Oyl of Tartar, and destroy it again by the Re-affusion of more of the Acid *Menstruum*; and yet oftner if I please, can I with these two contrariant Liquors recall and disperse the Colour, though by reason of the addition of so much new Liquor, in reference to the Mercurial particles, the Colour will at length appear more dilute and faint.

An improvement of the fortieth Experiment.

And, *Pyrophilus*, to confirm yet further the Notions that led me to think on the propos'd Experiment, I shall acquaint you with another, which when I had conveniency I have sometimes added to it, and which has to the Spectators appear'd little less Odd than the first; And though because the Liquor, requisite to make the Trial succeed well, must be on purpose prepar'd anew a while before, because it will not long retain its fitness for this work, I do but seldome annex this Experiment to the other, yet I shall tell you how I devis'd it, and how I make it. If you boyl Crude Antimony in a strong and clear *Lixivium*, you shall separate a Substance from it, which some Modern *Chymists* are pleas'd to call its Sulphur, but how deservedly I shall not here examine, having elsewhere done it in an Opportune place; wherefore I shall now but need to take notice, that when this suppos'd Sulphur (not now to call it rather a kind of *Crocus*) is let fall by the Liquor upon its Refrigeration, it often settles in Flakes, or such like parcels of a Yellow Substance, (which being by the precedent dissolution reduc'd into Minute parts, may peradventure be made to take Fire much more easily than the Grosser Powder of unprepar'd Antimony would have done.) Considering therefore, that common Sulphur boyl'd in a *Lixivium* may be Precipitated out of it by Rhenish-wine or White-wine, which are Sowrish Liquors, and have in them, as I elsewhere shew, an Acid Salt; and having found also by Trial, that with other Acid Liquors I could Precipitate out of Lixivate Solvents some other Mineral concretions abounding with Sulphureous parts, of which sort is crude Antimony, I concluded it to be easie to Precipitate

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the Antimony dissolv'd, as was lately mention'd, with the Acid Oyl of Vitriol; and though common Sulphur yields a White Precipitate, which the *Chymists* call *Lac Sulphuris*, yet I suppos'd the Precipitated Antimony would be of a deep Yellow Colour, as well, if made with Oyl of Vitriol, as if made only by Refrigeration and length of Time. From this 'twas easie to deduce this Experiment, that if you put into one Glass some of the freshly Impregnated and Filtrated Solution of Antimony, and into another some of the Orange-Colour'd Mixture, (which I formerly shew'd you how to make with a Mercurial Solution and Oyl of Tartar) a few drops of Oyl of Vitriol dropp'd into the last mention'd Glass, would, as I told you before, turn the Deep Yellow mixture into a Cleer Liquor; whereas a little of the same Oyl dropp'd out of the same Viol into the other Glass would presently (but not without some ill sent) turn the moderately cleer Solution into a Deep Yellow Substance, But this, as I Said, succeeds not well, unless you employ a *Lixivium* that has but newly dissolv'd Antimony, and has not yet let it fall. But yet in Summer time, if your *Lixivium* have been duly Impregnated and well Filtrated after it is quite cold, it will for some dayes (perhaps much longer than I had occasion to try) retain Antimony enough to exhibit, upon the Affusion of the Corrosive Oyl, as much of a good Yellow Substance as is necessary to satisfie the Beholders of the Possibility of the Experiment.

Reflections upon the XL. Experiment Compared with the X. and XX.

The Knowledge of the Distinction of Salts which we have propos'd, whereby they are discriminated into *Acid*, *Volatile*, or *Salfuginous* (if I may for Distinction sake so call the Fugitive Salts of Animal Substances) and *fix'd* or *Alcalizate*, may possibly (by that little part which we have already deliver'd, of what we could say of its Applicableness) appear of so much Use in Natural Philosophy (especially in the Practick part of it) that I doubt not but it will be no Unwelcome Corollary of the Preceding Experiment, if by the help of it I teach you to distinguish, which of those Salts is Predominant in Chymical Liquors, as well as whether any of them be so or not. For though in our Notes upon the X. and XX. Experiments I have shown you a way by means of the Tincture of *Lignum Nephriticum*, or of Syrrup of Violets, to discover whether a propounded Salt be Acid or not, yet you can thereby only find in general that such and such Salts belong not to the Tribe of Acids, but cannot determine whether they belong to the Tribe of Urinous Salts (under which for distinction sake I comprehend all those Volatile Salts of Animal or other Substances that are contrary to Acids) or to that of Alcalies. For as well the one as the other of these Salino-Sulphurous Salts will restore the Caeruleous Colour to the Tincture of *Lignum Nephriticum*, and turn that of Syrrup of Violets into Green.

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Wherefore this XL. Experiment does opportunely supply the deficiency of those. For being solicitous to find out some ready wayes of discriminating the Tribes of Chymical Salts, I found that all those I thought fit to make Tryal of, would, if they were of a Lixivate Nature, make with Sublimate dissolv'd in Fair Water an *Orange Tawny* Precipitate; whereas if they were of an Urinous Nature the Precipitate would be *White* and Milky. So that having always by me some Syrrup of Violets and some Solution of Sublimate, I can by the help of the first of those Liquors discover in a trice, whether the propounded Salt or Saline Body be of an Acid Nature or no, if it be I need (you know) inquire no further; but if it be not, I can very easily, and as readily distinguish between the other two kinds of Salts, by the White or Orange-Colour that is immediately produc'd, by letting fall a few Drops or Grains of the Salt to be examin'd, into a spoonfull of the clear Solution of Sublimate. For Example, it has been suppos'd by some eminently Learned, That when Sal Armoniack being mingled with an Alcaly is forc'd from it by the Fire in close Vessels, the Volatile Salt that will thereby be obtain'd (if the Operation be skilfully perform'd,) is but a more fine and subtile sort of Sal Armoniack, which, 'tis presum'd, this Operation do's but more exquisitely purifie, than common Solutions, Filtrations, and Coagulations. But this Opinion may be easily shown to be Erroneous, as by other Arguments, so particularly by the lately deliver'd Method of distinguishing the Tribes of Salts. For the Saline Spirit of Sal Armoniack, as it is in many other manifest Qualities very like the Spirit of Urine, so like, that it will in a trice make Syrrup of Violets of a Lovely Green, turn a Solution of good Verdigrease into an Excellent Azure, and make the Solution of a Sublimate yield a White Precipitate, insomuch that in most (for I say not all of the Experiments) where I Aim onely at producing a sudden change of Colour, I scruple not to use Spirit of Sal Armoniack when it is at hand, instead of Spirit of Urine, as indeed it seems chiefly to consist (besides the flegm that helps to make it fluid) of the Volatile Urinous Salt (yet not excluding that of Soot) that abounds in the Sal Armoniack and is set at liberty from the Sea Salt wherewith it was formerly associated, and clogg'd, by the Operation of the Alcaly, that divides the Ingredients of Sal Armoniack, and retains that Sea Salt with it self. What use may be made of the like way of exploration in that inquiry which puzzles so many Modern Naturalists, whether the Rich Pigment (which we have often had occasion to mention) belongs to the Vegetable or Animal Kingdome, you may find in another place where I give you some account of what I try'd about Cocheneel. But I think it needless to exemplifie here our Method by any other Instances, many such being to be met with in divers parts of this Treatise; but I will rather advertise you, that, by this way of examining Chymical

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Liquors, you may not onely in most Cases conclude *Affirmatively*, but in some Cases *Negatively*. As since Spirit of Wine, and as far as I have try'd, those Chymical Oyles which Artists call Essential, did not (when I us'd them as I had us'd the several Families of Salts upon that Syrrup) turn Syrrup of Violets Red or Green, nor the Solution of Sublimate White or Yellow, I inferr'd it may thence be probably argued, that either they are destitute of Salt, or have such as belongs not to either of the three Grand families already often mention'd. When I went to examine the Spirit of Oak or of such like Concretes forced over through a Retort, I found by this means amongst others, that (as I elsewhere show) these Chymists are much mistaken in it, that account it a simple Liquor, and one of their Hypostatical Principles: for not to mention what flegm it may have, I found that with a few drops of one of this sort of Spirits mix'd with a good proportion of Syrrup of Violets, I could change the Colour and make it Purplish, by the affinity of which Colour to Redness, I conjectur'd that this Spirit had some Acid Corpuscles in it, and accordingly I found that as it would destroy the Blewness of a Tincture of *Lignum Nephriticum*, so being put upon Corals it would Corrode them, as common Spirit of Vinegar, and other Acid Liquors are wont to do. And farther to examine whether there were not a great part of the Liquor that was not of an Acid nature, having separated the Sour or Vinegar-like part from the rest, which (if I mistake not) is far the more Copious, we concluded as we had conjectured, the other or remaining part, though it had a strong taste as well as smell, to be of a nature differing from that of either of the three sorts of Salts above mention'd, since it did as little as Spirit of Wine, and Chymical Oyls, alter the Colour either of Syrrup of Violets or Solution of Sublimate, whence we also inferr'd that the change that had been made of that Syrrup into a Purple Colour, was effected by the Vinegar, that was one of the two Ingredients of the Liquor, which was wont to pass for a Simple or Uncompounded Spirit. And, upon this account, 'twas of the Spirit of Oak (and the like Concretes) freed from it's Vinegar that I elsewhere told you, that I had not then observ'd it, (and I have repeated the Tryal but very lately) to destroy the Caeruleous Tincture of *Lignum Nephriticum*. But this onely, *en passant*; for the Chief thing I had to add was this, That by the same way may be examin'd and discover'd, divers changes that are produc'd in Bodies either by Nature only, or by Art; either of them being able by changing the Texture of some Concretes I could name, to qualifie them to Operate after a New manner upon the above mention'd Syrrup, or Solution, or both. And by this means, to tell you that upon the by, I have been able to discover, that there may be made Bodies, which though they run *per Deliquium*, as readily as Salt of Tartar, belong in other respects,

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not to the family of Alcaliz, much less to that of Salfuginous, or that of Acid Salts. Perhaps too, I may know a way of making a highly operative Saline Body that shall neither change the Colour of Syrrup of Violets, nor Precipitate the Solution of Sublimate; And, I can likewise if I please conceal by what Liquors I perform such changes of Colour, as I have been mentioning to you, by quite altering the Texture of some ordinary Chymical productions, the Exploration of which is the main use of the fortieth Experiment, which I think teaches not a little, if it teach us to discover the nature of those things (in reference to Salt) that are obtain'd by the ordinary Chymical Analysis of mix'd Bodyes, though perhaps there may be other Bodyes prepar'd by Chymistry which may have the same Effects in the change of Colours; and yet be produc'd not from what Chymists call the Resolution of Bodies, but from their Composition. But the discoursing of things of this nature is more proper for another place. I shall now onely add, what might perhaps have been more seasonably told you before; That the Reason why the way of Exploration of Salts hitherto deliver'd, succeeds in the Solution of Sublimate, depends upon the particular Texture of that Solution, as well as upon the differing Natures of the Saline Liquors imploy'd to Precipitate it. For Gold dissolv'd in *Aqua Regia*, whether you Precipitate it with Oyl of Tartar which is an Alcaly, or with Spirit of Urine, or Sal Armoniack which belongs to the family of Volatile Salts, will either way afford a Yellow substance: though with such an Acid Liquor, as, I say not Spirit of Salt, the Body that yields it, being upon the matter an Ingredient of *Aqua Regis*, but Oyl of Vitriol it self, I did not find that I could Precipitate the Metall out of the Solution, or destroy the Colour of it, though the same Oyl of Vitriol would readily Precipitate Silver dissolv'd in *Aqua-fortis*. And if you dissolve pure Silver in *Aqua-fortis*, and suffer it to shoot into Crystals, the cleer Solution of these made in fair Water, will afford a very White Precipitate, whether it be made with an Alcaly, or an Acid Spirit, as that of Salt, whereas, which may seem somewhat strange, with Spirit of Sal Armoniack (that I us'd was made of Quicklime) I could obtain no such White Precipitate; that Volatile Spirit, nor (as I remember) that of Urine, scarce doing any more than striking down a very small quantity of Matter, which was neither White nor Whitish, so that the remaining Liquor being suffer'd to evaporate till the superfluous Moisture was gone, the greatest part of the Metalline Corpuscles with the Saline ones that had imbib'd them, concoagulated into Salt, as is usual in such Solutions, wherein the Metall has not been Precipitated.

EXPERIMENT XLI.

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Of Kin to the last or fortieth Experiment is another which I remember I have sometimes shewn to *Virtuosi* that were pleas'd not to dislike it. I took Spirit of Urine made by Fermentation, and with a due proportion of Copper brought into small parts, I obtain'd a very lovely Azure Solution, and when I saw the Colour was such as was requisite, pouring into a clean Glass, about a spoonfull of this tinted Liquor, (of which I us'd to keep a Quantity by me,) I could by shaking into it some drops of Strong Oyl of Vitriol, deprive it in a trice of its Deep Colour, and make it look like Common-water.

Annotation.

This Experiment brings into my mind this other, which oftentimes succeeds well enough, though not quite so well as the former; Namely, that if into about a small spoonfull of a Solution of good French Verdigrease made in fair Water, I drop't and shak'd some strong Spirit of Salt, or rather deflegm'd *Aqua Fortis*, the Greenness of the Solution would be made in a trice almost totally to disappear, & the Liquor held against the Light would scarce seeme other than Cleer or Limpid, to any but an Attentive Eye, which is therefore remarkable; because we know that *Aqua-fortis* corroding Copper, which is it that gives the Colour to Verdigrease, is wont to reduce it to a Green Blew Solution. But if into the other altogether or almost Colourless Liquor I was speaking of, you drop a just quantity either of Oyl of Tartar or Spirit of Urine, you shall find that after the Ebullition is ceas'd, the mixture will disclose a lively Colour, though somewhat differing from that which the Solution of Verdigrease had at first.

EXPERIMENT XLII.

That the Colour (*Pyrophilus*) of a Body may be chang'd by a Liquor which of it self is of no Colour, provided it be Saline, we have already manifested by a multitude of instances. Nor doth it seem so strange, because Saline Particles swimming up and down in Liquors, have been by many observ'd to be very operative in the Production and change of Colours. But divers of our Friends that are not acquainted with Chymical Operations have thought it very strange that a White Body, and a Dry one too, should immediately acquire a rich new Colour upon the bare affusion of Spring-Water destitute as well of adventitious Salt as of Tincture. And yet (*Pyrophilus*) the way of producing such a change of Colours may be easily enough lighted on by those that are conversant in the Solutions of Mercury. For we have try'd, that though by Evaporating a Solution of Quick-Silver in *Aqua-fortis*, and abstracting the Liquor till the remaining matter began to be well, but not too strongly dried, fair Water pour'd on the remaining *Calx* made it but somewhat Yellowish; yet when we took good Quick-Silver, and three or four times its weight of Oyl of Vitriol, in case we in a Glass Retort plac'd in Sand drew off the Saline *Menstruum* from the Metalline



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Liquor, till there remain'd a dry *Calx* at the bottome, though this Precipitate were a Snow White Body, yet upon pouring on it a large quantity of fair Water, we did almost in a moment perceive it to pass from a Milky Colour to one of the loveliest Light Yellows that ever we had beheld. Nor is the Turbith Mineral, that Chymists extol for its power to Salivate, and for other vertues, of a Colour much inferiour to this, though it be often made with a differing proportion of the Ingredients, a more troublesome way. For *Beguinus*, [22] who calls it *Mercurius praecipitatus optimus*, takes to one part of Quick-Silver, but two of Liquor, and that is Rectifi'd Oyl of Sulphur, which is (in *England* at least) far more scarce and dear than Oyl of Vitriol; he also requires a previous Digestion, two or three Cohobations, and frequent Ablutions with hot Distill'd Water, with other prescriptions, which though they may conduce to the Goodness of the Medicine, which is that he aims at, are troublesome, and, our Tryals have inform'd you unnecessary to the *obtaining the Lemmon Colour* which he regards not. But though we have very rarely seen either in Painters Shops, or elsewhere a finer Yellow than that which we have divers times this way produc'd (which is the more considerable, because durable and pleasant Yellows are very hard to be met with, as may appear by the great use which Painters are for its Colours sake fain to make of that pernicious and heavy Mineral, Orpiment) yet I fear our Yellow is too costly, to be like to be imploy'd by Painters, unless about Choice pieces of Work, nor do I know how well it will agree with every Pigment, especially, wick Oyl'd Colours. And whether this Experiment, though it have seem'd somewhat strange to most we have shown it to, be really of another Nature than those wherein Saline Liquors are imploy'd, may, as we formerly also hinted, be so plausibly doubted, that whether the Water pour'd on the *Calx*, do barely by imbibing some of its Saline parts alter its Colour by altering its Texture, or whether by dissolving the Concoagulated Salts, it does become a Saline *Menstruum*, and, as such, work upon the Mercury, I freely leave to you (*Pyrophilus*) to consider. And that I may give you some Assistance in your Enquiry, I will not only tell you, that I have several times with fair Water wash'd from this *Calx*, good store of strongly tasted Corpuscles, which by the abstraction of the *Menstruum*, I could reduce into Salt; but I will also subjoyn an Experiment, which I devis'd, to shew among other things, how much a real and permanent Colour may be as it were drawn forth by a Liquor that has neither Colour, nor so much as Saline or other Active parts, provided it can but bring the parts of the Body it imbibes to convene into clusters dispos'd after the manner requisite to the exhibiting of the emergent Colour. The Experiment was this.

[22] *Beguinus*, Tyr. Chy. Lib. 2^o. Cap. 13^o.



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EXPERIMENT XLIII.

We took good common Vitriol, and having beaten it to Powder, and put it into a Crucible, we kept it melted in a gentle heat, till by the Evaporation of some parts, and the shuffling of the rest, it had quite lost its former Colour, what remain'd we took out, and found it to be a friable *Calx*, of a dirty Gray. On this we pour'd fair Water, which it did not Colour Green or Blew, but only seem'd to make a muddy mixture with it, then stopping the Vial wherein the Ingredients were put, we let it stand in a quiet place for some dayes, and after many hours the water having dissolv'd a good part of the imperfectly calcin'd Body, the Vitriolate Corpuscles swimming to and fro in the Liquor, had time by their opportune Occursions to constitute many little Masses of Vitriol, which gave the water they impregnated a fair Vitriolate Colour; and this Liquor being pour'd off, the remaining dirty Powder did in process of time communicate the like Colour, but not so deep, to a second parcel of cleer Water that we pour'd on it. But this Experiment *Pyrophilus* is, (to give you that hint by the way) of too Luciferous a Nature to be fit to be fully prosecuted, now that I am in haste, and willing to dispatch what remains. And we have already said of it, as much as is requisite to our present purpose.

EXPERIMENT XLIV.

It may (*Pyrophilus*) somewhat contribute towards the shewing how much some Colours depend upon the less or greater mixture, and (as it were,) Contemperation of the Light with shades, to observe, how that sometimes the number of Particles, of the same Colour, receiv'd into the Pores of a Liquor, or swimming up and down in it, do seem much to vary the Colour of it. I could here present you with particular instances to show, how in many (if not most) consistent Bodyes, if the Colour be not a Light one, as White, Yellow, or the like, the closeness of parts in the Pigments makes it look Blackish, though when it is display'd and laid on thinly, it will perhaps appear to be either Blew, or Green, or Red. But the Colours of consistent Pigments, not being those which the Preamble of this Experiment has lead you to expect Examples in, I shall take the instances I am now to give you, rather from Liquors than Dry Bodyes. If then you put a little fair Water into a cleer and slender Vial, (or rather into one of those pipes of Glass, which we shall by and by mention;) and let fall into it a few drops of a strong Decoction or Infusion of *Cochineel*, or (for want of that) of *Brazil*; you may see the tinted drops descend like little Clouds into the Liquor; through which, if, by shaking the Vial, you diffuse them, they will turn the water either of a Pinck Colour, or like that which is wont to be made by the washing of raw flesh in fair Water; by dropping a little more of the Decoction, you may heighten the Colour into a fine Red, almost like that which ennobles Rubies; by continuing the affusion, you may



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bring the Liquor to a kind of a Crimson, and afterwards to a Dark and Opacous Redness, somewhat like that of Clotted Blood. And in the passage of the Liquor from one of these Colours to the other, you may observe, if you consider it attentively, divers other less noted Colours belonging to Red, to which it is not easie to give Names; especially considering how much the proportion of the Decoction to the fair Water, and the strength of that Decoction, together with that of the trajected Light and other Circumstances, may vary the Phaenomena of this Experiment. For the convenienter making whereof, we use instead of a Vial, any slender Pipe of Glass of about a foot or more in length, and about the thickness of a mans little finger; For, if leaving one end of this Pipe open, you Seal up the other Hermetically, (or at least stop it exquisitely with a Cork well fitted to it, and over-laid with hard Sealing Wax melted, and rubb'd upon it;) you shall have a Glass, wherein may be observ'd the Variations of the Colours of Liquors much better than in large Vials, and wherein Experiments of this Nature may be well made with very small quantities of Liquor. And if you please, you may in this Pipe produce variety of Colours in the various parts of the Liquor, and keep them swimming upon one another unmix'd for a good while. And some have marveil'd to see, what variety of Colours we have sometimes (but I confess rather by chance than skill) produc'd in those Glasses, by the bare infusion of Brazil, variously diluted with fair Water, and alter'd by the Infusion of several Chymical Spirits and other Saline Liquors devoid themselves of Colour, and when the whole Liquor is reduc'd to an Uniform degree of Colour, I have taken pleasure to make that very Liquor seem to be of Colours gradually differing, by filling with it Glasses of a Conical figure, (whether the Glass have its basis in the ordinary position, or turn'd upwards.) And yet you need not Glasses of an extraordinary shape to see an instance of what the vari'd mixture of Light and Shadow can do in the diversifying of the Colour. For if you take but a large round Vial, with a somewhat long and slender Neck, and filling it with our Red Infusion of Brazil, hold it against the Light, you will discern a notable Disparity betwixt the Colour of that part of the Liquor which is in the Body of the Vial, and that which is more pervious to the Light in the Neck. Nay, I remember, that I once had a Glass and a Blew Liquor (consisting chiefly (or only, if my memory deceive me not,) of a certain Solution of Verdigrease) so fitted for my purpose, that though in other Glasses the Experiment would not succeed, yet when that particular Glass was fill'd with that Solution, in the Body of the Vial it appear'd of a Lovely Blew, and in the neck, (where the Light did more dilute the Colour,) of a manifest Green; and though I suspected there might be some latent Yellowness in the substance of the neck of the Glass, which might



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with the Blew compose that Green, yet was I not satisfi'd my self with my Conjecture, but the thing seem'd odd to me, as well as to divers curious persons to whom it was shown. And I lately had a Broad piece of Glass, which being look'd on against the Light seem'd clear enough, and held from the Light appear'd very lightly discolour'd, and yet it was a piece knock'd off from a great lump of Glass, to which if we rejoyn'd it, where it had been broken off, the whole Mass was as green as Grass. And I have several times us'd Bottles and stopples that were both made (as those, I had them from assur'd me) of the very same Metall, and yet whilst the bottle appear'd but inclining towards a Green, the Stopples (by reason of its great thickness) was of so deep a Colour that you would hardly believe they could possibly be made of the same materials. But to satisfie some Ingenious Men, on another occasion, I provided my self of a flat Glass (which I yet have by me,) with which if I look against the Light with the Broad side obverted to the Eye, it appeares like a good ordinary window Glass; but if I turn the Edge of it to my Eye, and place my Eye in a convenient posture in reference to the Light, it may contend for deepness of Colour with an Emerald. And this Greeness puts me in mind of a certain thickish, but not consistent Pigment I have sometimes made, and can show you when you please, which being dropp'd on a piece of White Paper appears, where any quantity of it is fallen, of a somewhat Crimson Colour, but being with ones finger spread thinly on the Paper does presently exhibit a fair Green, which seems to proceed only from its disclosing its Colour upon the Extenuation of its Depth into Superficies, if the change be not somewhat help'd by the Colours degenerating upon one or other of the Accounts formerly mention'd. Let me add, that having made divers Tryals with that Blew substance, which in Painters shops is call'd *Litmase*, we have sometimes taken Pleasure to observe, that being dissolv'd in a due proportion of fair Water, the Solution either oppos'd to the Light, or dropp'd upon White paper, did appear of a deep Colour betwixt Crimson and Purple; and yet that being spread very thin on the Paper and suffer'd to dry on there, the Paper was wont to appear Stain'd of a Fine Blew. And to satisfie my selfe, that the diversity came not from the Paper, which one might suspect capable of inbibing the Liquor, and altering the Colour, I made the Tryal upon a flat piece of purely White Glass'd Earth, (which I sometimes make use of about Experiments of Colours) with an Event not unlike the former.



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And now I speak of *Litmass*, I will add, that having this very day taken a piece of it, that I had kept by me these several years, to make Tryals about Colours, and having let fall a few drops of the strong Infusion of it in fair water, into a fine Crystal Glass, shap'd like an inverted Cone, and almost full of fair Water, I had now (as formerly) the pleasure to see, and to show others, how these few tinted drops variously dispersing themselves through the Limpid Water, exhibited divers Colours, or varieties of Purple and Crimson. And when the Corpuscles of the Pigment seem'd to have equally diffus'd themselves through the whole Liquor, I then by putting two or three drops of Spirit of Salt, first made an odd change in the Colour of the Liquor, as well as a visible commotion among its small parts, and in a short time chang'd it wholly into a very Glorious Yellow, like that of a Topaz. After which if I let fall a few drops of the strong and heavy Solution of Pot-ashes, whose weight would quickly carry it to the sharp bottome of the Glass, there would soon appear four very pleasant and distinct Colours; Namely, a Bright, but Dilute Colour at the picked bottome of the Glass; a Purple, a little higher; a deep and glorious Crimson, (which Crimson seem'd to terminate the operation of the Salt upward) in the confines betwixt the Purple and the Yellow; and an Excellent Yellow, the same that before enobled the whole Liquor, reaching from thence to the top of the Glass. And if I pleas'd to pour very gently a little Spirit of Sal Armoniack, upon the upper part of this Yellow, there would also be a Purple or a Crimson, or both, generated there, so that the unalter'd part of the Yellow Liquor appear'd intercepted betwixt the two Neighbouring Colours.

My scope in this 3d. Experiment (*Pyrophilus*) is manifold, as first to invite you to be wary in judging of the Colour of Liquors in such Glasses as are therein recommended to you, and consequently as much, if not more, when you imploy other Glasses. Secondly, That you may not think it strange, that I often content my self to rub upon a piece of White paper, the Juice of Bodies I would examine, since not onely I could not easily procure a sufficient Quantity of the juices of divers of them; but in several Cases the Tryals of the quantities of such Juices in Glasses would make us more lyable to mistakes, than the way that in those cases I have made use of. Thirdly, I hope you will by these and divers other particulars deliver'd in this Treatise, be easily induc'd to think that I may have set down many Phaenomena very faithfully, and just as they appear'd to me, and yet by reason of some unheeded circumstance in the conditions of the matter, and in the degree of Light, or the manner of trying the Experiment, you may find some things to vary from the Relations I make of them. Lastly, I design'd to give you an opportunity to free your self from the amazement which possesses most Men, at the Tricks of those Mountebancks



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that are commonly call'd Water-drinkers. For though not only the vulgar, but ev'n many persons that are far above that Rank, have so much admir'd to see, a man after having drunk a great deal of fair water, to spurt it out again in the form of Claret Wine, Sack, and Milk, that they have suspected the intervening of Magick, or some forbidden means to effect what they conceived above the power of Art; yet having once by chance had occasion to oblige a Wanderer that made profession of that and other Jugling Tricks, I was easily confirm'd by his Ingenious confession to me, That this so much Admir'd Art, indeed consisted rather in a few Tricks, than in any great Skill, in altering the Nature and Colours of things. And I am easy to be perswaded; that there may be a great deal of Truth in a little Pamphlet Printed divers years ago in English, wherein the Author undertakes to discover, and that (if I mistake not) by the confession of some of the Complices themselves, That a famous Water-drinker then much Admir'd in *England*, perform'd his pretended Transmutations of Liquors by the help of two or three inconsiderable preparations and mixtures of not unobvious Liquors, and chiefly of an Infusion of Brazil variously diluted and made Pale or Yellowish, (and otherwise alter'd) with Vinegar, the rest of their work being perform'd by the shape of the Glasses, by Craft and Legerdemane. And for my part, that which I marvel at in this business, is, the Drinkers being able to take down so much Water, and spout it out with that violence; though Custome and a Vomit seasonably taken before hand, may in some of them much facilitate the work. But as for the changes made in the Liquors, they were but few and slight in comparison of those, that the being conversant in Chymical Experiments, and dextrous in applying them to the Transmuting of Colours, may easily enough enable a man to make, as ev'n what has been newly deliver'd in this, and the foregoing Experiment; especially if we add to it the things contained in the XX, the XXXIX and the XL. Experiments, may perhaps have already perswaded You.

EXPERIMENT XLV.

You may I presume (*Pyrophilus*) have taken notice, that in this whole Treatise, I purposely decline (as far as I well can) the mentioning of Elaborate Chymical Experiments, for fear of frightening you by their tediousness and difficulty; but yet in confirmation of what I have been newly telling you about the possibility of Varying the Colours of Liquors, better than the Water-drinkers are wont to do, I shall add, that *Helmont* used to make a preparation of Steel, which a very Ingenious Chymist, his Sons Friend, whom you know, sometimes employes for a succedaneum to the Spaw-waters, by Diluting this *Essentia Martis Liquida* (as he calls it) with a due proportion of Water. Now that for which I mention to you this preparation, (which as he communicated to me, I know he will not refuse to *Pyrophilus*) is this, that though

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the Liquor (as I can shew you when you please) be almost of the Colour of a German (not an Oriental) Amethyst, and consequently remote enough from Green, yet a very few drops being let fall into a Large proportion of good Rhenish, or (in want of that) White Wine (which yet do's not quite so well) immediately turn'd the Liquor into a lovely Green, as I have not without delight shown several curious Persons. By which *Phaenomenon* you may learn, among other things, how requisite it is in Experiments about the changes of Colours heedfully to mind the Circumstances of them; for Water will not, as I have purposely try'd, concurr to the production of any such Green, nor did it give that Colour to moderate Spirit of Wine, wherein I purposely dissolv'd it, and Wine it self is a Liquor that few would suspect of being able to work suddenly any such change in a Metalline preparation of this Nature; and to satisfie my self that this new Colour proceeds rather from the peculiar Texture of the Wine, than from any greater Acidity, that Rhenish or White-wine (for that may not absurdly be suspected) has in comparison of Water; I purposely sharpen'd the Solution of this Essence in fair Water, with a good quantity of Spirit of Salt, notwithstanding which, the mixture acquir'd no Greenness. And to vary the Experiment a little, I try'd, that if into a Glass of Rhenish Wine made Green by this Essence, I dropp'd an Alcalizate Solution, or Urinous Spirit, the Wine would presently grow Turbid, and of an odd Dirty Colour; But if instead of dissolving the Essence in Wine, I dissolv'd it in fair Water sharpen'd perhaps with a little Spirit of Salt, then either the Urinous Spirit of Sal Armoniack, or the solution of the fix'd Salt of Pot-ashes would immediately turn it of a Yellowish Colour, the fix'd or Urinous Salt Precipitating the Vitriolate substance contain'd in the Essence. But here I must not forget to take notice of a circumstance that deserves to be compar'd with some part of the foregoing Experiment, for whereas our Essence imparts a Greenness to Wine, but not to Water, the Industrious *Olaus Wormius*[23] in his late *Musaeum* tells us of a rare kind of Turn-Sole which he calls *Bezetta Rubra* given him by an Apothecary that knew not how it was made, whose lovely Redness would be easily communicated to Water, if it were immers'd in it; but scarce to Wine, and not at all to Spirit of Wine, in which last circumstance it agrees with what I lately told you of our Essence, notwithstanding their disagreement in other particulars.

[23] Libr. 2do Cap. 34.

EXPERIMENT XLVI.

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We have often taken notice, as of a remarkable thing, that Metals as they appear to the Eye, before they come to be farther alter'd by other Bodies, do exhibit Colours very different from those which the Fire and the *Menstruum*, either apart, or both together, do produce in them; especially considering that these Metalline Bodies are after all these disguises reducible not only to their former Metalline Consistence and other more radical properties, but to their Colour too, as if Nature had given divers Metals to each of them a double Colour, an *External*, and an *Internal*; But though upon a more attentive Consideration of this difference of Colours, it seem'd probable to me, that divers (for I say not all) of those Colours which we have just now call'd *Internal*, are rather produc'd by the Coalition of Metalline Particles with those of the Salts, or other Bodies employ'd to work on them, than by the bare alteration of the parts of the Metals themselves: and though therefore we may call the obvious Colours, Natural or Common, & the others Adventitious, yet because such changes of Colours, from whatsoever cause they be resolv'd to proceed may be properly enough taken in to illustrate our present Subject, we shall not scruple to take notice of some of them, especially because there are among them such as are produc'd without the intervention of Saline *Menstruums*. Of the Adventitious Colours of Metalline Bodies the Chief sorts seem to be these three. The first, such Colours as are produc'd without other Additaments by the Action of the fire upon Metals. The next such as emerge from the Coalition of Metalline Particles with those of some *Menstruum* employ'd to Corrode a Metall or Precipitate it; And the last, The Colours afforded by Metalline Bodies either Colligated with, or otherwise Penetrating into, other Bodies, especially fusible ones. But these (*Pyrophilus*,) are only as I told you, the *Chief* sorts of the adventitious Colours of Metals, for there may others belong to them, of which I shall hereafter have occasion to take notice of some, and of which also there possibly may be others that I never took notice of.

And to begin with the first sort of Colours, 'tis well enough known to Chymists, that Tin being Calcin'd by fire alone is wont to afford a White *Calx*, and Lead Calcin'd by fire alone affords that most Common Red-Powder we call *Minium*: Copper also Calcin'd *per se*, by a long or violent fire, is wont to yield (as far as I have had occasion to take notice of it) a very Dark or Blackish Powder; That Iron likewise may by the Action of Reverberated flames be turn'd into a Colour almost like that of Saffron, may be easily deduc'd from the Preparation of that Powder, which by reason of its Colour and of the Metall 'tis made of is by Chymists call'd, *Crocus Martis per se*. And that *Mercury* made by the stress of Fire, may be turn'd into a Red Powder, which Chymists call Precipitate *per se*, I elsewhere more particularly declare.

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Annotation I.

It is not unworthy the Admonishing you, (*Pyrophilus*,) and it agrees very well with our Conjectures about the dependence of the change of a Body's Colour upon that of its Texture, that the same Metall may by the successive operation of the fire receive divers Adventitious Colours, as is evident in Lead, which before it come to so deep a Colour as that of *Minium*, may pass through divers others.

Annotation II.

Not only the *Calces*, but the Glasses of Metalls, Vitrify'd *per se*, may be of Colours differing from the Natural or Obvious Colour of the Metall; as I have observ'd in the Glass of Lead, made by long exposing Crude Lead to a violent fire, and what I have observ'd about the Glass or Slagg of Copper, (of which I can show you some of an odd kind of Texture,) may be elsewhere more conveniently related. I have likewise seen a piece of very Dark Glass, which an Ingenious Artificer that show'd it me profess'd himself to have made of Silver alone by an extreme *Violence* (which seems to be no more than is needfull) of the fire.

Annotation III.

Minerals also by the Action of the Fire may be brought to afford Colours very differing from their own, as I not long since noted to you about the variously Colour'd Flowers of Antimony, to which we may add the Whitish Grey-Colour of its *Calx*, and the Yellow or Reddish Colour of the Glass, where into that *Calx* may be flux'd.

And I remember, that I elsewhere told you, that Vitriol Calcin'd with a very gentle heat, and afterwards with higher and higher degrees of it, may be made to pass through several Colours before it descends to a Dark Purplish Colour, whereto a strong fire is wont at length to reduce it. But to insist on the Colours produc'd by the Operation of fire upon several Minerals would take up farr more time than I have now to spare.

EXPERIMENT XLVII.

The Adventitious Colours produc'd upon Metalls, or rather with them, by Saline Liquors, are many of them so well known to Chymists, that I would not here mention them, but that besides a not un-needed Testimony, I can add something of my own, to what I shall repeat about them, and divers Experiments which are familiar to Chymists, are as yet unknown to the greatest part of Ingenious Men.

That Gold dissolv'd in *Aqua Regia* ennobles the *Menstruum* with its own Colour, is a thing that you cannot (*Pyrophilus*,) but have often seen. The Solutions of Mercury in *Aqua-fortis* are not generally taken notice of, to give any notable Tincture to the *Menstruum*; but sometimes when the Liquor first falls upon the Quick Silver, I have



observ'd a very remarkable, though not durable, Greenness, or Blewness to be produc'd, which is a *Phaenomenon* not unfit for you to consider, though I have not now the leisure to discourse upon it. Tin Corroded by *Aqua-fortis* till the

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Menstruum will work no farther on it, becomes exceeding White, but as we elsewhere note, does very easily of it self acquire the consistence, not of a Metalline *Calx*, but of a Coagulated matter, which we have observ'd with pleasure to look so like, either to curdled Milk, or curdled Whites of Eggs, that a person unacquainted with such Solutions may easily be mistaken in it. But when I purposely prepar'd a *Menstruum* that would dissolve it as *Aqua-fortis* dissolves Silver, and not barely Corrode it, and quickly let it fall again, I remember not that I took notice of any particular Colour in the Solution, as if the more Whitish Metalls did not much Tinge their *Menstruums*, though the conspicuously Colour'd Metalls as Gold, and Copper, do. For Lead dissolv'd in Spirit of Vinegar or *Aqua-fortis* gives a Solution cleer enough, and if the *Menstruum* be abstracted appears either Diaphanous or White. Of the Colour of Iron we have elsewhere said something: And 'tis worth noting, that though if that Metall be dissolv'd in oyl of Vitriol diluted with water, it affords a Salt or Magistery so like in colour, as well as some other Qualities, to other green Vitriol, that Chymists do not improperly call it *Vitriolum Martis*; yet I have purposely try'd, that, by changing the *Menstruum*, and pouring upon the filings of Steel, instead of oyl of Vitriol, *Aqua Fortis*, (whereof as I remember, I us'd 4 parts to one of the Metall) I obtain'd not a Green, but a Saffron Colour Solution; or rather a thick Liquor of a deep but yellowish Red. Common Silver, such as is to be met with in Coines, being dissolv'd in *Aqua fortis*, yields a Solution tinted like that of Copper, which is not to be wondred at, because in the coining of Silver, they are wont (as we elsewhere particularly inform you) to give it an Allay of Copper, and that which is sold in shops for refined silver, is not (so far as we have tryed) so perfectly free from that ignobler Metall, but that a Solution of It in *Aqua fortis*, will give a Venereal Tincture to the *Menstruum*. But we could not observe upon the solution of some Silver, which was perfectly refin'd, (such as some that we have, from which 8 or 10 times its weight of Lead has been blown off) that the *Menstruum* though held against the Light in a Crystal Vial did manifestly disclose any Tincture, only it seem'd sometimes not to be quite destitute of a little, but very faint Blewishness.

But here I must take notice, that of all the Metalls, there is not any which doth so easily and constantly disclose its unobvious colour as Copper doth. For not only in acid *Menstruums* as *Aqua Fortis* and Spirit of Vinegar, it gives a Blewish green solution, but if it be almost any way corroded, it *appears of one of those two colours*, as may be observ'd in Verdigreese made several wayes, in that odd preparation of *Venus*, which we elsewhere teach you to make

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with Sublimate, and in the common Vitriols of *Venus* deliver'd by Chymists; and so constant is the disposition of Copper, notwithstanding the disguise Artists put upon it, to disclose the colour we have been mentioning, that we have by forcing it up with *Sal Armoniack* obtain'd a Sublimate of a Blewish Colour. Nay a famous Spagyrist affirms, that the very Mercury of it is green, but till he teach us an intelligible way of making such a Mercury, we must content ourselves to inform you, that we have had a Cupreous Body, that was Praecipitated out of a distill'd Liquor, that seem'd to be the the Sulphur of *Venus*, and seem'd even when flaming, of a Greenish Colour. And indeed Copper is a Metall so easily wrought upon by Liquors of several kinds, that I should tell you, I know not any Mineral, that will concur to the production of such a variety of Colours as Copper dissol'd in several *Menstruums*, as Spirit of Vinegar, *Aqua fortis*, *Aqua Regis*, Spirit of Nitre, of Urine, of Soot, Oyls of several kinds, and I know not how many other Liquors, if the variety of somewhat differing colours (that Copper will be made to assume, as it is wrought upon by several Liquors) were not comprehended within the Limits of Greenish Blew, or Blewish Green.

And yet I must advertise you (*Pyrophilus*) that being desirous to try if I could not make with crude Copper a Green Solution without the Blewishness that is wont to accompany its Vulgar Solutions, I bethought my self of using two *Menstruums*, which I had not known employ'd to work on this Metall, and which I had certain Reasons to make Tryal of, as I successfully did. The one of these Liquors (if I much misremember not) was Spirit of Sugar distill'd in a Retort, which must be warily done, (if you will avoid breaking your glasses) and the other, Oyl or Spirit of Turpentine, which affords a fine Green Solution that is useful to me on several occasions. And yet to shew that the adventitious colour may result, as well from the true and permanent Copper it self, as the Salts wherewith 'tis corroded, I shall add, that if you take a piece of good *Dantzick* Copperis, or any other Vitriol wherein *Venus* is praedominant, and having moistened it in your Mouth, or with fair water, rubb it upon a whetted knife, or any other bright piece of Steel or Iron, it will (as we have formerly told you) present'y stain the Steel with a Reddish colour, like that of Copper, the reason of which, we must not now stay to inquire.

Annotation I.

I presume you may have taken notice (*Pyrophilus*) that I have borrowed some of the Instances mention'd in this 47th Experiment, from the Laboratories of Chymists, and because in some (though very few) other passages of this Essay, I have likewise made use of Experiments mention'd also by some Spagyrical Writers, I think it not amiss to represent to you on this Occasion once for all, some things besides



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those which I intimated in the praeamble of this present Experiment; For besides, that 'tis very allowable for a Writer to repeat an Experiment which he invented not, in case he improve it; And besides that many Experiments familiar to Chymists are unknown to the generality of Learned Men, who either never read Chymical processes, or never understood their meaning, or never durst believe them; besides these things, I say, I shall represent, That, as to the few Experiments I have borrowed from the Chymists, if they be very Vulgar, 'twould perhaps be difficult to ascribe each of them its own Author, and 'tis more than the generality of Chymists themselves can do: and if they be not of very known and familiar practise among them, unless the Authors wherein I found them had given me cause to believe, themselves had try'd them, I know not why I might not set them down, as a part of the *Phaenomena* of Colours which I present you; Many things unanimously enough deliver'd as matters of fact by (I know not how many Chymical Writers) being not to be rely'd on, upon the single Authority of such Authors: For Instance, as some Spagyrist deliver (perhaps amongst several deceitful processes) that *Saccarum Saturni* with Spirit of Turpentine will afford a Balsom, so *Beguinus* and many more tell us, that the same Concrete (*Saccarum Saturni*) will yield an incomparably fragrant Spirit, and a pretty Quantity of two several Oyles, and yet since many have complain'd, as well as I have done, that they could find no such odoriferous, but rather an ill-sented Liquor, and scarce any oyl in their Distillation of that sweet Vitriol, a wary person would as little build any thing on what they say of the former Experiment, as upon what they averr of the later, and therefore I scrupled not to mention this Red Balsom of which I have not seen any, (but what I made) among my other experiments about redness.

Annot. II.

We have sometimes had the Curiosity to try what Colours Minerals, as Tinglass, Antimony, Spelter, &c. would yield in several *Menstruums*, nor have we forborn to try the Colours of stones, of which that famous one, (which *Helmont* calls *Paracelsus's Ludus*) though it be digg'd out of the Earth and seem a true stone, has afforded in *Menstruums* capable to dissolve so solid a stone, sometimes a Yellowish, sometimes a Red solution of both which I can show you. But though I have from Minerals obtain'd with several *Menstruums* very differing Colours, and some such as perhaps you would be surpriz'd to see drawn from such Bodies: yet I must now pass by the particulars, being desirous to put an End to this Treatise, before I put an end to your Patience and my own.

Annotation III.

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And yet before I pass to the next Experiment, I must put you in mind, that the Colours of Metals may in many cases be further alter'd by employing, either praecipitating Salts, or other convenient Substances to act upon their Solutions. Of this you may remember, that I have given you several Instances already, to which may be added such as these, That if Quicksilver be dissolv'd in *Aqua fortis*, and Praecipitated out of the Solution, either with water impregnated with Sea salt, or with the spirit of that Concrete, it falls to the Bottom in the form of a white powder, whereas if it be Praecipitated with an Alcaly, it will afford a Yellowish or tawny powder, and if there be no Praecipitation made, and the *Menstruum* be drawn off with a convenient fire, the corroded Mercury will remain in the bottom, in the form of a substance that may be made to appear of differing Colours by differing degrees of Heat; As I remember that lately having purposely abstracted *Aqua fortis* from some Quicksilver that we had dissolv'd in it, so that there remain'd a white *Calx*, exposing that to several degrees of Fire, and afterwards to a naked one, we obtain'd some new Colours, and at length the greatest part of the *Calx* lying at the Bottome of the Vial, and being brought partly to a Deep Yellow, and partly to a Red Colour, the rest appear'd elevated to the upper part and neck of the Vial, some in the form of a Reddish, and some of an Ash-Colour Sublimate. But of the differing Colours which by differing wayes and working of Quick Silver with Fire, and Saline Bodies, may be produc'd in Precipitates, I may elsewhere have occasion to take further notice. I also told you not long since, that if you corrode Quick-silver with Oyl of Vitriol instead of *Aqua-fortis*, and abstract the *Menstruum*, there will remain a White *Calx* which by the Affusion of Fair Water presently turns into a Lemmon Colour. And ev'n the *Succedaneum* to a *Menstruum* may sometimes serve the turn to change the Colours of a Metal. The lovely Red which Painters call Vermillion, is made of Mercury, which is of the Colour of Silver, and of Brimstone which is of Kin to that of Gold, Sublim'd up together in a certain proportion, as is vulgarly known to Spagyristis.

EXPERIMENT XLVIII.

The third chief sort of the Adventitious Colours of Metals, is, that which is produc'd by associating them (especially when Calcin'd) with other fusible Bodies, and Principally Venice, and other fine Glass devoid of Colour.

I have formerly given you an Example, whereby it may appear, that a Metal may impart to Glass a Colour much differing from its own, when I told you, how with Silver, I had given Glass a lovely Golden Colour. And I shall now add, that I have Learn'd from one of the Chief Artificers that sells Painted Glass, that those of his Trade Colour it Yellow with a preparation of the *Calx* of Silver. Though having lately

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had occasion among other Tryals to mingle a few grains of Shell-silver (such as is employ'd with the Pensil and Pen) with a convenient proportion of powder'd Crystal Glass, having kept them two or three hours in fusion, I was surpriz'd to find the Colliquated Mass to appear upon breaking the Crucible of a lovely Saphirine Blew, which made me suspect my Servant might have brought me a wrong Crucible, but he constantly affirm'd it to be the same wherein the Silver was put, and considerable Circumstances countenanc'd his Assertion, so that till I have opportunity to make farther Tryal, I cannot but suspect, either that Silver which is not (which is not very probable) brought to a perfect Fusion and Colliquation with Glass, may impart to it other Colours than when Neal'd upon it, or else (which is less unlikely) that though Silver Beaters usually chuse the finest Coyn they can get, as that which is most extensive under the Hammer, yet the Silver-leaves of which this Shel-silver was made, might retain so much Copper as to enable it to give the predominant tincture to the Glass.

For, I must proceed to tell you (*Pyrophilus*) as another instance of the Adventitious Colours of Metals, that which is something strange, Namely, That though Copper Calcin'd *per se* affords but a Dark and basely Colour'd *Calx*, yet the Glassmen do with it, as themselves inform me, Tinge their Glass green. And I remember, that when once we took some crude Copper, and by frequent Ignition quenching it in Water had reduc'd it to a Dark and Ill-colour'd Powder, and afterward kept it in Fusion in about a 100. times its weight of fine Glass, we had, though not a Green, yet a Blew colour'd Mass, which would perhaps have been Green, if we had hit right upon the Proportion of the Materials, and the Degree of Fire, and the Time wherein it ought to be kept in Fusion, so plentifully does that Metal abound in a Venereal Tincture, as Artists call it, and in so many wayes does it disclose that Richness. But though Copper do as we have said give somewhat near the like Colour to Glass, which it does to *Aqua-fortis*, yet it seems worth inquiry, whether those new Colours which Mineral Bodies disclose in melted Glass, proceed from the Coalition of the Corpuscles of the Mineral with the Particles of the Glass as such, or from the Action (excited or actuated by fire) of the Alcalizate Salt (which is a main Ingredient of Glass,) upon the Mineral Body, or from the concurrence of both these Causes, or else from any other. But to return to that which we were saying, we may observe that *Putty* made by calcining together a proportion of Tin and Lead, as it is it self a *White Calx*, so does it turn the *Pitta di Crystallo* (as the Glassmen call the matter of the Purer sort of Glass, wherewith it is Colliquated into a White Mass, which if it be opacous enough is employ'd, as we elsewhere declare, for White Amel. But of the Colours which the other Metals may be made to produce in Colourless Glass, and other Vitrifiable Bodies, that have native Colours of their own, I must leave you to inform your self upon Tryal, or at least must forbear to do it till another time, considering how many Annotations are to follow, upon what has in this and the two former Experiments been said already.



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Annotation I.

When the Materials of Glass being melted with Calcin'd Tin, have compos'd a Mass Undiaphanous and White, this White Amel is as it were the Basis of all those fine Concretes that Goldsmiths and several Artificers imploy in the curious Art of Enamelling. For this White and Fusible substance will receive into it self, without spoyling them, the Colours of divers other Mineral substances, which like it will indure the fire.

Annotation II.

So that as by the present (XLVIII.) Experiment it appears, that divers Minerals will impart to fusible Masses, Colours differing from their own; so by the making and compounding of Amels, it may appear, that divers Bodies will both retain their Colour in the fire, and impart the *same* to some others wherewith they were vitrifi'd, and in such Tryals as that mention'd in the 17. Experiment, where I told you, that ev'n in Amels a Blew and Yellow will compound a Green. 'Tis pretty to behold, not only that some Colours are of so fix'd a Nature, as to be capable of mixture without receiving any detriment by the fire, that do's so easily destroy or spoyl those of other Bodies; but Mineral Pigments may be mingled by fire little less regularly and successfully, than in ordinary Dyeing Fatts, the vulgar Colours are wont to be mingled by the help of Water.

Annotation III.

'Tis not only Metalline, but other Mineral Bodies, that may be imploy'd, to give Tinctures unto Glass (and 'tis worth noting how small a quantity of some Mineral substances, will Tinge a Comparatively vast proportion of Glass, and we have sometimes attempted to Colour Glass, ev'n with Pretious Stones, and had cause to think the Experiment not cast away. And 'tis known by them that have look'd into the Art of Glass, that the Artificers use to tinge their Glass Blew, with that Dark Mineral *Zaffora*, (some of my Tryals on which I elsewhere acquaint you) which some would have to be a Mineral Earth, others a Stone, and others neither the one, nor the other, but which is confessedly of a Dark, but not a Blew Colour, though it be not agreed of what particular Colour it is. 'Tis likewise though a familiar yet a remarkable practise among those that Deal in the making of Glass, to imploy (as some of themselves have inform'd me) what they call Manganess, and some Authors call *Magnesia* (of which I make particular mention in another Treatise) to exhibit in Glass not only other Colours than its own, (which is so like in Darkness or blackishness to the Load stone, that 'tis given by Mineralists, for one of the Reasons of its Latine Name) but Colours differing from one another. For though they use it, (which is somewhat strange) to Clarifye their Glass, and free it from that Blewish Greenish Colour, which else it would too often be subject to, yet they also imploy it in certain proportions, to tinge their Glass both with a Red colour, and with a Purplish or Murry, and



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putting in a greater Quantity, they also make with it that deep obscure Glass which is wont to pass for Black, which agrees very well with, and may serve to confirm what we noted near the beginning of the 44th Experiment, of the seeming Blackness of those Bodies that are overcharg'd with the Corpuscles of such Colours, as Red, or Blew, or Green, &c. And as by several Metals and other Minerals we can give various Colours to Glass, so on the other side, by the differing Colours that Mineral Oars, or other Mineral Powders being melted with Glass disclose in it, a good Conjecture may be oftentimes made of the Metall or known Mineral, that the Oar propos'd, either holds, or is most of kin to. And this easie way of examining Oars, may be in some cases of good use, and is not ill deliver'd by *Glauber*, to whom I shall at present refer you, for a more particular account of it: unless your Curiosity command also what I have observ'd about these matters; only I must here advertise you, that great circumspection is requisite to keep this way from proving fallacious, upon the account of the variations of Colour that may be produc'd by the differing proportions that may be us'd betwixt the Oar and the Glass, by the Richness or Poorness of the Oar it self, by the Degree of Fire, and (especially) by the Length of Time, during which the matter is kept in fusion; as you will easily gather from what you will quickly meet with in the following Annotation upon this present 48th Experiment.

Annotation IV.

There is another way and differing enough from those already mention'd, by which Metalls may be brought to exhibit adventitious Colours: For by This, the Metall do's not so much impart a Colour to another Body, as receive a Colour from it, or rather both Bodies do by the new Texture resulting from their mision produce a new Colour. I will not insist to this purpose upon the Examples afforded us by yellow Orpiment, and common Sea Salt, from which, sublim'd together, Chymists unanimously affirm their White or Crystalline Arsenick to be made: But 'tis not unworthy our noting, That though Yellow Orpiment be acknowledg'd to be the Copiousest by far of the two Ingredients of Arsenick, yet this last nam'd Body being duely added to the highest Colour'd Metall Copper, when 'tis in fusion, gives it a whiteness both within and without. Thus *Lapis Calaminaris* changes and improves the Colour of Copper by turning it into Brass. And I have sometimes by the help of Zinck duely mix'd after a certain manner, given Copper one of the Richest Golden Colours that ever I have seen the Best true Gold Ennobled with. But pray have a care that such Hints fall not into any hands that may mis-employ them.

Annotation V.

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Upon the Knowledge of the differing wayes of making Minerals and Metalls produce their adventitious Colours in Bodies capable of Vitrification, depends the pretty Art of making what Chymists by a Barbarous Word are pleas'd to call *Amanses*, that is counterfeit, or factitious Gemms, as Emeralds, Rubies, Saphires, Topazes, and the like. For in the making of these, though pure Sand or Calcin'd Crystal give the Body, yet 'tis for the most part some Metalline or Mineral *Calx*, mingled in a small proportion that gives the Colour. But though I have many years since taken delight, to divert my self with this pleasing Art, and have seen very pretty Productions of it, yet besides that I fear I have now forgot most of the little Skill I had in it, this is no place to entertain you with what would rather take up an intire Discourse, than be comprehended in an Annotation; wherefore the few things which I shall here take notice of to you, are only what belong to the present Argument, Namely,

First, That I have often observ'd that Calcin'd Lead Colliquated with fine White Sand or Crystal, reduc'd by ignitions and subsequent extinctions in Water to a subtile Powder, will of it self be brought by a due Decoction to give a cleer Mass Colour'd like a *German* Amethyst. For though this glass of Lead, is look'd upon by them that know no better way of making *Amanses*, as the grand Work of them all, yet which is an inconvenience that much blemishes this way, the Calcin'd Lead it self does not only afford matter to the *Amanses*, but has also as well as other Metals a Colour of its own, which as I was saying, I have often found to be like that of *German* (as many call them) not Eastern Amethysts.

Secondly, That nevertheless this Colour may be easily over-powr'd by those of divers other Mineral Pigments (if I may so call them) so that with a glass of Lead, you may Emulate (for Instance) the fresh and lovely Greenness of an Emerald, though in divers cases the Colour which the Lead it self upon Vitrification tends to, may vitiate that of the Pigment, which you would introduce into the Mass.

Thirdly, That so much ev'n these Colours depend upon Texture, that in the Glass of Lead it self made of about three parts of *Lytharge* or *Minium* Colliquated with one of very finely Powder'd Crystal or Sand, we have taken pleasure to make the mixture pass through differing Colours, as we kept it more or less in the Fusion. For it was not usually till after a pretty long Decoction that the Mass attain'd to the Amethystin Colour.

Fourthly and lastly, That the degrees of Coction and other Circumstances may so vary the Colour produc'd in the same mass, that in a Crucible that was not great I have had fragments of the same Mass, in some of which perhaps not so big as a Hazel-Nut, you may discern four distinct Colours.

Annotation VI.

You may remember (*Pyrophilus*) that when I mention'd the three sorts of adventitious Colours of Metals, I mention'd them but as the chief, not the only. For there may be

other wayes, which though they do not in so strict a sense belong to the adventitious Colours of Metals, may not inconveniently be reduc'd to them. And of these I shall name now a couple, without denying that there may be more.



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The first may be drawn from the practise of those that Dye Scarlet. For the famousest Master in that Art, either in *England* or *Holland*, has confess'd to me, that neither others, nor he can strike that lovely Colour which is now wont to be call'd the *Bow-Dye*, without their Materials be Boyl'd in Vessels, either made of, or lin'd with a particular Metall. But of what I have known attempted in this kind, I must not as yet for fear of prejudicing or displeasing others give you any particular Account.[24]

The other way (*Pyrophilus*) of making Metals afford unobvious Colours, is by imbuing divers Bodies with Solutions of them made in their proper *Menstruum's*, As (for Instance) though Copper plentifully dissolv'd in *Aqua fortis*, will imbue several Bodies with the Colour of the Solution; Yet Some other Metalls will not (as I elsewhere tell you) and have often try'd. Gold dissolv'd in *Aqua Regia*, will, (which is not commonly known) Dye the Nails and Skin, and Hafts of Knives, and other things made of Ivory, not with a Golden, but a Purple Colour, which though it manifest it self but slowly, is very durable, and scarce ever to be wash'd out. And if I misremember not, I have already told you in this Treatise, that the purer Crystals of fine Silver made with *Aqua fortis*, though they appear White, will presently Dye the Skin and Nails, with a Black, or at least a very Dark Colour, which Water will not wash off, as it will ordinary Ink from the same parts. And divers other Bodies may the Same way be Dy'd, some of a Black, and others of a Blackish Colour.

[24] See the latter end of the fiftieth Experiment.

And as Metalline, so likewise Mineral Solutions may produce Colours differing enough from those of the Liquors themselves. I shall not fetch an Example of this, from what we daily see happen in the powdring of Beef, which by the Brine employ'd about it (especially if the flesh be over salted) do's oftentimes appear at our Tables of a Green, and sometimes of a Reddish Colour, (deep enough) nor shall I insist on the practise of some that deal in Salt Petre, who, (as I suspected, and as themselves acknowledg'd to me) do, with the mixture of a certain proportion of that; and common Salt, give a fine Redness, not only to Neats Tongues, but which is more pretty as well as difficult, to such flesh, as would otherwise be purely White; These Examples, I say, I shall decline insisting on, as chusing rather to tell you, that I have several times try'd, that a Solution of the Sulphur of Vitriol, or ev'n of common Sulphur, though the Liquor appear'd clear enough, would immediately tinge a piece of new Coin, or other clean Silver, sometimes with a Golden, sometimes with a deeper, and more Reddish colour, according to the strength of the Solution, and the quantity of it, that chanc'd to adhere to the Metall; which may take off your wonder that the water of the hot Spring at *Bath*, abounding with dissolv'd Substances



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of a very Sulphureous Nature, should for a while, as it were gild, the new or clean pieces of Silver coyn, that are for a due time immers'd in it. And to these may be added those formerly mention'd Examples of the adventitious Colours of Mineral Bodies; which brings into my mind, that, ev'n Vegetable Liquors, whether by degeneration, or by altering the Texture of the Body that imbibes them, may stain other Bodies with Colours differing enough, from their own, of which very good Herbarists have afforded us a notable Example, by affirming that the Juice of *Alcanna* being green (in which state I could never here procure it) do's yet Dye the Skin and Nails of a Lasting Red. But I see this Treatise is like to prove too bulky without the addition of further Instances of this Nature.

EXPERIMENT XLIX.

Meeting the other day, *Pyrophilus*, in an *Italian* book, that treats of other matters, with a way of preparing what the Author calls a *Lacca* of Vegetables, by which the *Italians* mean a kind of Extract fit for Painting, like that rich *Lacca* in English commonly call'd *Lake*, which is employ'd by Painters as a glorious Red. And finding the Experiment not to be inconsiderable, and very defectively set down, it will not be amiss to acquaint you with what some Tryals have inform'd us, in reference to this Experiment, which both by our Italian Author, and by divers of his Countrymen, is look'd upon as no trifling Secret.

Take then the root call'd in Latin *Curcuma*, and in English Turmerick, (which I made use of, because it was then at hand, and is among Vegetables fit for that purpose one of the most easiest to be had) and when it is beaten, put what Quantity of it you please into fair Water, adding to every pound of Water about a spoonfull or better of as strong a *Lixivium* or Solution of Potashes as you can well make, clarifying it by Filtration before you put it to the Decocting water. Let these things boyl, or rather simmer over a soft Fire in a clean glaz'd Earthen Vessel, till you find by the Immersion of a sheet of White Paper (or by some other way of Tryal) that the Liquor is sufficiently impregnated with the Golden Tincture of the Turmerick, then take the Decoction off the Fire, and Filter or Strain it that it may be clean, and leisurely dropping into it a strong Solution of Roch Allum, you shall find the Decoction as it were curdl'd, and the tinted part of it either to emerge, to subside, or to swim up and down, like little Yellow flakes; and if you pour this mixture into a Tunnel lin'd with Cap Paper, the Liquor that Filtred formerly so Yellow, will now pass clean thorow the Filtre, leaving its tinted, and as it were curdled parts in the Filtre, upon which fair Water must be so often pour'd, till you have Dulcifi'd the matter therein contain'd, the sign of which Dulcification is (you know) when the Water that has pass'd through it, comes from it as tasteless

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as it was pour'd on it. And if without Filtration you would gather together the flakes of this Vegetable Lake, you must pour a great Quantity of fair Water upon the Decoction after the affusion of the Alluminous Solution, and you shall find the Liquor to grow clearer, and the Lake to settle together at the bottom, or emerge to the top of the Water, though sometimes having not pour'd out a sufficient Quantity of fair Water, we have observ'd the Lake partly to subside, and partly to emerge, leaving all the middle of the Liquor clear. But to make this Lake fit for use, it must by repeated affusions of fresh Water, be Dulcifi'd from the adhering Salts, as well as that separated by Filtration, and be spread and suffer'd to dry leisurely upon pieces of Cloth, with Brown Paper, or Chalk, or Bricks under them to imbibe the Moisture[25].

[Page 372] *Annotation I.*

Whereas it is presum'd that the Magistry of Vegetables obtain'd this way consists but of the more Soluble and Coloured parts of the Plants that afford it, I must take the liberty to Question the supposition. And for my so doing, I shall give you this account.

According to the Notions (such as they were) that I had concerning Salts; Allom, though to sense a Homogeneous Body, ought not to be reckon'd among true Salts, but to be it self look'd upon as a kind of Magistry, in regard that as Native Vitriol (for such I have had) contains both a Saline substance and a Metall, whether Copper, or Iron, corroded by it, and associated with it; so Allom which may be of so near a kin to Vitriol, that in some places of *England* (as we are assur'd by good Authority the same stone will sometimes afford both) seems manifestly to contain a peculiar kind of Acid Spirit, generated in the Bowels of the Earth, and some kind of stony matter dissolv'd by it. And though in making our ordinary Allom, the Workmen use the Ashes of a Sea Weed (vulgarly call'd Kelp) and Urine: yet those that should know, inform us, that, here in *England*, there is besides the factitious Allom, Allom made by Nature Without the help of those Additaments. Now (*Pyrophilus*) when I consider'd this composition of Allom, and that Alcalizate Salts are wont to Praecipitate what acid Salts have dissolv'd, I could not but be prone to suspect that the Curdled Matter, which is call'd the Magistry of Vegetables, may have in it no inconsiderable proportion of a stony substance Praecipitated out of the Allom by the *Lixivium*, wherein the Vegetable had been decocted, and to shew you, that there is no necessity, that all the curdl'd substance must belong to the Vegetable, I shall add, that I took a strong Solution of Allom, and having Filtred it, by pouring in a convenient Quantity of a strong Solution of Potashes, I presently, as I expected, turn'd the mixture into a kind of white Curds, which being put to Filtre, the Paper retain'd a stony *Calx*, copious enough, very White, and which seem'd to be of a Mineral Nature, both

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by some other signes, and this, that little Bits of it being put upon a live Coal, which was Gently Blown whilst they were on it, they did neither melt nor fly away, and you may keep a Quantity of this White substance for a good while, (nay for ought I can guess for a very long one) in a red hot Crucible without losing or spoiling it; nor did hot Water wherein I purposely kept another parcel of such *Calx*, seem to do any more than wash away the looser adhering Salts from the stony substance, which therefore seem'd unlikely to be separable by ablutions (though reiterated) from the Praecipitated parts of the Vegetable, whose Lake is intended. And to shew you, that there is likewise in Allom a Body, with which the fix'd Salt of the Alcalizate Solution will concoagulate into a Saline Substance differing from either of them, I shall add, that I have taken pleasure to recover out of the slowly exhal'd Liquor, that pass'd through the filtre, and left the foremention'd *Calx* behind, a Body that at least seem'd a Salt very pretty to look on, as being very White, and consisting of an innumerable company of exceeding slender, and shining Particles, which would in part easily melt at the flame of a Candle, and in part flye away with some little noise. But of this substance, and its odd Qualities more perhaps elsewhere; for now I shall only take notice to you, that I have likewise with Urinous Salts, such as the Spirit of Sal Armoniack, as well as with the Spirit of Urine it self, Nay, (if I much mistake not) ev'n with Stale Urine undistil'd, easily Precipitated such a White *Calx* as I was formerly speaking of, out of a Limpid Solution of Allom, so that there is need of Circumspection in judging of the Natures of Liquors by Precipitations wherein Allom intervenes, else we may sometimes mistakingly imagine that to be Precipitated out of a Liquor by Allom, which is rather Precipitated out of Allom by the Liquor: And this puts me in mind to tell you, that 'tis not unpleasant to behold how quickly the Solution of Allom (or injected lumps of Allom) do's occasion the severing of the colour'd parts of the Decoction from the Liquor that seem'd to have so perfectly imbib'd them.

[25] *The Curious Reader that desires further Information concerning Lakes, may Resort to the 7th Book of Neri's Art of Glass, Englished (6 or 7 years since the Writing of this 49th Experiment) and Illustrated with Learned Observations, by the Inquisitive and experienc'd Dr. Charles Merret.*

Annot. II.

The above mention'd way of making Lakes we have tryed not only with Turmerick, but also with Madder, which yielded us a Red Lake; and with Rue, which afforded us an extract, of (almost if not altogether) the same Colour with that of the leaves.



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But in regard that 'tis Principally the Alcalizate Salt of the Pot-ashes, which enables the water to Extract so powerfully the Tincture of the Decocted Vegetables, I fear that our Author may be mistaken by supposing that the Decoction will always be of the very same Colour with the Vegetable it is made off. For Lixivate Salts, to which Pot-ashes eminently belong, though by peircing and opening the Bodies of Vegetables, they prepare and dispose them to part readily with their Tincture, yet some Tinctures they do not only draw out, but likewise alter them, as may be easily made appear by many of the Experiments already set down in this Treatise, and though Allom being of an Acid Nature, its Solutions may in some Cases destroy the Adventitious Colours produc'd by the Alcaly, and restore the former: yet besides that Allom is not, as I have lately shown, a meer Acid Salt, but a mixt Body, and besides, that its operations are languid in comparison of the activity of Salts freed by Distillation, or by Incineration and Dissolution, from the most of their Earthy parts, we have seen already Examples, that in divers Cases an Acid Salt will not restore a Vegetable substance to the Colour of which an Alcalizate one had depriv'd it, but makes it assume a third very differing from both, as we formerly told you, that if Syrrup of Violets were by an Alcaly turn'd Green, (which Colour, as I have try'd, may be the same way produc'd in the Violet-leaves themselves without any Relation to a Syrrup) an Acid Salt would not make it Blew again, but Red. And though I have by this way of making Lakes, made Magisteries (for such they seem to be) of Brazil, and as I remember of Cochinele it self, and of other things, Red, Yellow or Green which Lakes were enobled with a Rich Colour, and others had no bad one; yet in some the colour of the Lake seem'd rather inferiour than otherwise to that of the Plant, and in others it seem'd both very differing, and much worse; but Writing this in a time and place where I cannot provide my self of Flowres and other Vegetables to prosecute such Tryals in a competent variety of Subjects, I am content not to be positive in delivering a judgment of this way of Lakes, till Experience, or You, *Pyrophilus*, shall have afforded me a fuller and more particular Information.

Annotation III.

And on this occasion (*Pyrophilus*) I must here (having forgot to do it sooner) advertise you once for all, that having written several of the foregoing Experiments, not only in haste but at seasons of the year, and in places wherein I could not furnish my self with such Instruments, and such a variety of Materials, as the design of giving you an Introduction into the History of Colours requir'd, it can scarce be otherwise but that divers of the Experiments, that I have set down, may afford you some matter of new Tryals, if you think fit to supply the deficiencies of some of them (especially the freshly mention'd about Lakes, and those that concern Emphatical Colours) which deficiencies for want of being befriended with accommodations I could better discern than avoid.

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Annotation IV.

The use of Allom is very great as well as familiar in the Dyers Trade, and I have not been ill pleas'd with the use I have been able to make of it in preparing other pigments than those they imploy with Vegetable Juices. But the Lucriforous practises of Dyers and other Tradesmen, I do, for Reasons that you may know when you please, purposely forbear in this Essay, though not strictly from pointing at, yet from making it a part of my present work explicitly and circumstantially to deliver, especially since I now find (though late and not without some Blushes at my prolixity) that what I intended but for a short Essay, is already swell'd into almost a Volume.

EXPERIMENT L.

Yet here, *Pyrophilus*, I must take leave to insert an Experiment, though perhaps you'll think its coming in here an Intrusion, For I confess its more proper place would have been among those Experiments, that were brought as proofs and applications of our Notions concerning the differences of Salts; but not having remembred to insert it in its fittest place, I had rather take notice of it in this, than leave it quite unmention'd: partly because it doth somewhat differ from the rest of our Experiments about Colours, in the way whereby 'tis made; and partly because the grounds upon which I devis'd it, may hint to you somewhat of the Method I use in Designing and Varying Experiments about Colours, and upon this account I shall inform you, not only What I did, but Why I did it.

I consider'd then that the work of the former Experiments was either to change the Colour of a Body into another, or quite to destroy it, without giving it a successor, but I had a mind to give you also a way, whereby to turn a Body endued with one Colour into two Bodies, of Colours, as well as consistencies, very distinct from each other, and that by the help of a Body that had it self no Colour at all. In order to this, I remembred, that finding the Acidity of Spirit of Vinegar to be wholly destroy'd by its working upon *Minium* (or calcin'd Lead) whereby the Saline particles of the *Menstruum* have their Taste and Nature quite alter'd, I had, among other Conjectures I had built upon that change, rightly concluded, that the Solution of Lead in Spirit of Vinegar would alter the Colour of the Juices and Infusions of Several Plants, much after the like manner that I had found Oyl of Tartar to do; and accordingly I was quickly satisfied upon Tryal, that the Infusion of Rose-leaves would by a small quantity of this Solution well mingl'd with it, be immediately turn'd into a somewhat sad Green.

And further, I had often found, that Oyl of Vitriol, though a potently Acid *Menstruum*, will yet Praecipitate many Bodies, both Mineral and others, dissolv'd not onely in *Aqua fortis* (as some Chymists have observ'd) but particularly in Spirit of Vinegar, and I have further found, that the *Calces* or Powders Praecipitated by this Liquor were usually fair and White.

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Laying these things together, 'twas not difficult to conclude, that if upon a good Tincture of Red Rose-leaves made with fair Water, I dropp'd a pretty quantity of a strong and sweet Solution of *Minium*, the Liquor would be turn'd into the like muddy Green Substance, as I have formerly intimated to You, that Oyl of Tartar would reduce it to, and that if then I added a convenient quantity of good Oyl of Vitriol, this last nam'd Liquor would have two distinct operations upon the Mixture, the one, that it would Praecipitate that resolv'd Lead in the form of a White Powder; the other, that it would Clarifie the muddy Mixture, and both restore, and exceedingly heighten the Redness of the Infusion of Roses, which was the most copious Ingredient of the Green composition, and accordingly trying the Experiment in a Wine glass sharp at the bottom (like an inverted Cone) that the subsiding Powder might seem to take up the more room, and be the more conspicuous, I found that when I had shaken the Green Mixture, that the colour'd Liquor might be the more equally dispersed, a few drops of the rectifi'd Oyl of Vitriol did presently turn the opacous Liquor into one that was cleer and Red, almost like a Rubie, and threw down good store of a Powder, which when 'twas settl'd, would have appear'd very White, if some interspers'd Particles of the red Liquor had not a little Allay'd the Purity, though not blemish'd the Beauty of the Colour. And to shew you, *Pyrophilus*, that these Effects do not flow from the Oyl of Vitriol, as it is such, but as it is a strongly Acid *Menstruum*, that has the property both to Praecipitate Lead, as well as some other Concretes out of Spirit of Vinegar, and to heighten the Colour of Red Rose-leaves, I add, that I have done the same thing, though perhaps not quite so well with Spirit of Salt, and that I could not do it with *Aqua-fortis*, because though that potent *Menstruum* does as well as the others heighthen the Redness of Roses, yet it would not like them Praecipitate Lead out of Spirit of Vinegar, but would rather have dissolv'd it, if it had not found it dissolv'd already.

And as by this way we have produc'd a Red Liquor, and a White Praecipitate out of a Dirty Green magistry of Rose-leaves, so by the same Method, you may produce a fair Yellow, and sometimes a Red Liquor, and the like Praecipitate, out of an Infusion of a curious Purple Colour. For you may call to mind, that in the Annotation upon the 39th. Experiment I intimated to you, that I had with a few drops of an Alcaly turn'd the Infusion of Logg-wood into a lovely Purple. Now if instead of this Alcaly I substituted a very Strong and well Filtrated Solution of *Minium*, made with Spirit of Vinegar, and put about half as much of this Liquor as there was of the Infusion of Logg-wood, (that the mixture might afford a pretty deal of Praecipitate,) the affusion of a convenient proportion of Spirit of Salt, would (if the Liquors were well and nimbly stirr'd together) presently strike down a Praecipitate like that formerly mention'd, and turn the Liquor that swam above it, for the most part into a lovely Yellow.



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But for the advancing of this Experiment a little further, I consider'd, that in case I first turn'd a spoonfull of the infusion of Logg-wood Purple, by a convenient proportion of the Solution of *Minium*, the Affusion of Spirit of Sal Armoniack, would Precipitate the Corpuscles of Lead conceal'd in the Solution of *Minium*, and yet not destroy the Purple colour of the Liquor; whereupon I thus proceeded; I took about a spoonfull of the *fresh* Tincture of Logg-wood, (for I found that if it were *stale* the Experiment would not alwayes succeed,) and having put to it a convenient proportion of the Solution of *Minium* to turn it into a deep and almost opacous Purple, I then drop'd in as much Spirit of Sal Armoniack, as I guess'd would Precipitate about half or more (but not all) of the Lead, and immediately stirring the mixture well together, I mingled the Precipitated parts with the others, so that they fell to the bottom, partly in the form of a Powder, and partly in the form of a Curdled Substance, that (by reason of the Predominancy of the Ting'd Corpuscles over the White) retain'd as well as the Supernatant Liquor; a Blewish Purple colour sufficiently Deep, and then instantly (but yet Warily,) pouring on a pretty Quantity of Spirit of Salt, the matter first Precipitated, was, by the above specified figure of the bottome of the Glass preserv'd from being reach'd by the Spirituous Salt; which hastily Precipitated upon it a new Bed (if I may so call it) of White Powder, being the remaining Corpuscles of the Lead, that the Urinous Spirit had not struck down: So that there appear'd in the Glass three distinct and very differinglly colour'd Substances; a Purple or Violet-colour'd Precipitate at the bottom, a White and Carnation (sometimes a Variously colour'd) Precipitate over That, and at the Top of all a Transparent Liquor of a lovely Yellow, or Red.

Thus you see, *Pyrophilus*, that though to some I may have seem'd to have lighted on this (50th.) Experiment by chance, and though others may imagine, that to have excogitated it, must have proceeded from some extraordinary insight into the nature of Colours, yet indeed, the devising of it need not be look'd upon as any great matter, especially to one that is a little vers'd in the notions, I have in these, and other Papers hinted concerning the differences of Salts. And perhaps I might add upon more than conjecture, that these very notions and some particulars scatteringly deliver'd in this Treatise, being skilfully put together, may suggest divers matters (at least,) about Colours, that will not be altogether Despicable. But those hinted, *Pyrophilus*, I must now leave such as You to prosecute, having already spent farr more time than I intended to allow my self in acquainting You with particular Experiments and Observations concerning the changes of Colour, to which I might have added many more, but that I hope I may have presented You with a competent number



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to make out in some measure what I have at the beginning of this Essay either propos'd as my Design in this Tract, or deliver'd as my Conjectures concerning these matters. And it not being my present Designe, as I have more than once Declar'd, to deliver any Positive Hypothesis or solemn Theory of Colours, but only to furnish You with some Experiments towards the framing of such a Theory; I shall add nothing to what I have said already, but a request that you would not be forward to think I have been mistaken in any thing I have deliver'd as matter of Fact concerning the changes of Colours, in case you should not every time you trye it, find it exactly to succeed. For besides the Contingencies to which we have elsewhere shewn some other Experiments to be obnoxious, the omission or variation of a seemingly unconsiderable circumstance, may hinder the success of an Experiment, wherein no other fault has been committed. Of which truth I shall only give you that single and almost obvious, but yet illustrious instance of the Art of Dying Scarlets, for though you should see every Ingredient that is us'd about it, though I should particularly inform You of the weight of each, and though you should be present at the kindling of the fire, and at the increasing and remitting of it, when ever the degree of Heat is to be alter'd, and though (in a word) you should see every thing done so particularly that you would scarce harbour the least doubt of your comprehending the whole Art: Yet if I should not disclose to You, that the Vessels, that immediately contain the Tinging Ingredients, are to be made of or to be lin'd with Tin, You would never be able by all that I could tell you else (at-least, if the Famousest and Candidest Artificers do not strangely delude themselves) to bring your Tincture of Chochinele to Dye a perfect Scarlet. So much depends upon the very Vessel, wherein the Tinging matters are boyl'd, and so great an Influence may an unheeded Circumstance have on the Success of Experiments concerning Colours.

* * * * *

FINIS.

* * * * *

A SHORT
ACCOUNT
OF SOME
OBSERVATIONS
Made by Mr. *BOYLE*

About a *Diamond* that *Shines* in the Dark.

First enclosed in a Letter written to
a Friend,



And now together with it annexed to the Foregoing
Treatise, upon the score of the
Affinity Betwixt
Light and Colours.

* * * * *

LONDON,

Printed for *Henry Herringman.* 1664

* * * * *

A COPY
OF THE
LETTER

That Mr. *Boyle* wrote to Sir *Robert Morray*,
to accompany the *Observations* touching
the *Shining Diamond.*

SIR,



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Though Sir *Robert Morray* and Monsieur *Zulichem* be Persons that have deserv'd so well of the Commonwealth of Learning, that I should think my self unworthy to be look'd upon as a Member of it, if I declin'd to Obey them, or to Serve them; yet I should not without Reluctancy send you the Notes, you desire for him, if I did not hope that you will transmit together with them, some Account why they are not less unworthy of his perusal; which, that you may do; I must inform you, how the writing of them was Occasion'd, which in short was thus. As I was just going out of Town, hearing that an Ingenious Gentleman of my Acquaintance, lately return'd from *Italy*, had a Diamond, that being rubb'd, would shine in the Dark, and that he was not far off, I snatch'd time from my Occasions to make him a Visit, but finding him ready to go abroad, and having in vain try'd to make the Stone yield any Light in the Day time, I borrow'd it of him for that Night, upon condition to restore it him within a Day or two at furthest, at *Gresham* College, where we appointed to attend the meeting of the Society, that was then to be at that place. And hereupon I hastened that Evening out of Town, and finding after Supper that the Stone which in the Day time would afford no discernable Light, was really Conspicuous in the Dark, I was so taken with the Novelty, and so desirous to make some use of an opportunity that was like to last so little a while, that though at that time I had no body to assist me but a Foot-Boy, yet sitting up late, I made a shift that Night to try a pretty number of such of the things that then came into my thoughts, as were not in that place and time unpracticable. And the next Day being otherwise employ'd, I was fain to make use of a drowsie part of the Night to set down hastily in Writing what I had observ'd, and without having the time in the Morning, to stay the transcribing of it, I order'd the Observations to be brought after me to *Gresham* College, where you may remember, that they were together with the Stone it self shown to the Royal Society, by which they had the good Fortune not to be dislik'd, though several things were through hast omitted, some of which you will find in the Margin of the inclosed Paper. The substance of this short Narrative I hope you will let Monsieur *Zulichem* know, that he may be kept from expecting any thing of finish'd in the Observations, and be dispos'd to excuse the want of it. But such as they are, I hope they will prove (without a Clinch) Luciferous Experiments, by setting the Speculations of the Curious on work, in a diligent Inquiry after the Nature of Light, towards the discovery of which, perhaps they have not yet met with so considerable an Experiment, since here we see Light produc'd in a dead and opacous Body, and that not as in rotten Wood, or in Fishes, or as in the *Bolonian* Stone, by a Natural Corruption, or by a Violent Destruction of the Texture of the Body, but by so slight a Mechanical



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operation upon its Texture, as we seem to know what it is, and as is immediately perform'd, and that several wayes without at all prejudicing the Body, or making any sensible alterations in its Manifest Qualities. And I am the more willing to expose my hasty Tryals to Monsieur *Zulichem*, and to You, because, he being upon the Consideration of Dioptricks, so odd a *Phaenomenon* relateing to the Subject, as probably he treats of, Light will, I hope, excite a person to consider it, that is wont to consider things he treats of very well. And for you Sir, I hope you will both recrate and perfect the Observations you receive, For you know that I cannot add to them, having a good while since restor'd to Mr. *Clayton* the Stone, which though it be now in the hands of a Prince that so highly deserves, by understanding them, the greatest Curiosities; yet he vouchsafes you that access to him as keeps me from doubting, you may easily obtain leave to make further Tryals with it, of such a Monarch as ours, that is not more inquisitive himself, than a favourer of them that are so. I doubt not but these Notes will put you in mind of the Motion you made to the Society, to impose upon me the Task of bringing in, what I had on other occasions observ'd concerning shining Bodies. But though I deny not, that I sometimes made observations about the *Bolonian* Stone, and try'd some Experiments about some other shining Bodies; Yet the same Reasons that reduc'd me then to be unwilling to receive ev'n their commands, must now be my Apology for not answering your Expectations, Namely the abstruse nature of Light, and my being already over-burden'd, and but too much kept employ'd by the Urgency of the Press, as well as by more concerning and distracting Occasions. But yet I will tell you some part of what I have met with in reference to the Stone, of which I send you an account. Because I find on the one side, that a great many think it no Rarity upon a mistaken perswasion, that not only there are store of Carbuncles, of which this is one; but that all Diamonds and other Glistering Jewels shine in the Dark. Whereas on the other side there are very Learn'd Men, who (plausibly enough) deny that there are any Carbuncles or shining Stones at all.

And certainly, those Judicious men have much more to say for themselves, than the others commonly Plead, and therefore did deservedly look upon Mr. *Clayton's* Diamond as a great Rarity. For not only *Boetius de Boot*, who is judg'd the best Author on this Subject, ascribes no such Virtue to Diamonds, but begins what he delivers of Carbuncles, with this passage.[26] *Magna fama est Carbunculi. Is vulgo putatur in tenebris Carbonis instar lucere; fortassis quia Pyropus seu Anthrax appellatus a veteribus fuit. Verum hactenus nemo nunquam vere asserere ausus fuit, se gemmam noctu lucentem vidisse. Garcias ab Horto proregis Indiae Medicus, refert se allocutum fuisse, qui se vidisse affirmarent.*



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Sed iis fidem non habuit. And a later Author, the Diligent and Judicious *Johannes de Laet* in his Chapter of Carbuncles and of Rubies, has this passage. *Quia autem Carbunculi, Pyropi & Anthraces a veteribus nominantur, vulgo creditum fuit, Carbonis instar in tenebris lucere, quod tamen nulla gemma hastenus deprehensum, licet a quibusdam temere jactetur.* And the recentest Writer I have met with on this Subject, *Olaus Wormius*, in his Account of his well furnish'd *Musaeum*, do's, where he treats of Rubies, concurr with the former Writers by these Words.[27] *Sunt qui Rubinum veterum Carbunculum esse existimant, sed deest una illa nota, quod in tenebris instar Anthracis non luceat: Ast talem Carbunculum in rerum natura non inveniri major pars Authoram existimant. Licet unum aut alterum in India apud Magnates quosdam reperiri scribant, cum tamen ex aliorum relatione id habeant saltem, sed ipsi non viderint.* In confirmation of which I shall only add, that hearing of a Rubie, so very Vivid, that the Jewellers themselves have several times begg'd leave of the fair Lady to whom it belong'd, that they might try their choicest Rubies by comparing them with That, I had the Opportunity by the Favour of this Lady and her Husband, (both which I have the Honour to be acquainted with) to make a Trial of this famous Rubie in the Night, and in a Room well Darkn'd, but not only could not discern any thing of Light, by looking on the Stone before any thing had been done to it, but could not by all my Rubbing bring it to afford the least Glimmering of Light.

[26] Boetius de Boot. Gem. & Lapid. Histor. Lib. 3. Cap. 8.

[27] Musaei Wormiani. Cap. 17.

But, Sir, though I be very backward to admit strange things for truths, yet I am not very forward to reject them as impossibilities, and therefore I would not discourage any from making further Inquiry, whether or no there be Really in *Rerum natura*, any such thing as a true Carbuncle or Stone that without Rubbing will shine in the Dark. For if such a thing can be found, it may afford no small Assistance to the Curious in the Investigation of Light, besides the Nobleness and Rarity of the thing it selfe. And though *Vartomannus* was not an Eye witness of what he relates, that the King of *Pegu*, one of the Chief Kings of the *East-Indies*, had a true Carbuncle of that Bigness and Splendour, that it shin'd very Gloriously in the Dark, and though *Garcias ab Horto*, the *Indian* Vice-Roys Physician, speaks of another Carbuncle, only upon the Report of one, that he Discours'd with, who affirmed himself to have seen it; yet as we are not sure that these Men that gave themselves out to be Eye-witnesses speak true, yet they may have done so for ought we know to the contrary. And I could present you with a much considerabler Testimony to the same purpose, if I had the permission of a Person concern'd, without whose leave I must not do



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it. I might tell you that *Marcus Paulus Venetus*[28] (whose suppos'd Fables, divers of our later Travellours and Navigatours have since found to be truths) speaking of the King of *Zeilan* that then was, tells us, that he was said to have the best Rubie in the World, a Palm long and as big as a mans Arm, without spot, shining like a Fire, and he subjoyns, that the Great *Cham*, under whom *Paulus* was a considerable Officer, sent and offer'd the value of a City for it; But the King answer'd, he would not give it for the treasure of the World, nor part with it, having been his Ancestours. And I could add, that in the Relation made by two *Russian* Cossacks of their Journey into *Catay*[29], written to their Emperour, they mention'd their having been told by the people of those parts, that their King had a Stone, which Lights as the Sun both Day and Night, call'd in their Language *Sarra*, which those Cossacks interpret a Ruby. But these Relations are too uncertain for me to build any thing upon, and therefore I shall proceed to tell you, that there came hither about two years since out of *America*, the Governour of one of the Principal Colonies there, an Ancient *Virtuoso*, and one that has the Honour to be a member of the Royal Society; this Gentleman finding some of the chief Affairs of his Country committed to another and me, made me divers Visits, and in one of them when I enquir'd what Rare Stones they had in those parts of the *Indies* he belong'd to, he told me, that the *Indians* had a Tradition that in a certain hardly accessible Hill, a pretty way up in the Country, there was a Stone which in the Night time shin'd very vividly, and to a great distance, and he assur'd me, that though he thought it not fit to venture himself so far among those Savages, yet he purposely sent thither a bold *Englishman*, with some Natives to be his guides, and that this Messenger brought him back word, that at a distance from the Hillock he had plainly perceiv'd such a shining Substance as the *Indians* Tradition mention'd, and being stimulated by Curiosity, had slighted those Superstitious Fears of the Inhabitants, and with much ado by reason of the Difficulty of the way, had made a shift to clamber up to that part of the Hill, where, by a very heedful Observation, he suppos'd himself to have seen the Light: but whether 'twere that he had mistaken the place, or for some other Reason, he could not find it there, though when he was return'd to his former Station, he did agen see the Light shining in the same place where it shone before. A further Account of this Light I expect from the Gentleman that gave me this, who lately sent me the news of his being landed in that Country. And though I reserve to my self a full Liberty of Believing no more than I see cause; yet I do the less scruple to relate this, because a good part of it agrees well enough with another Story that I shall in the next place have



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occasion to subjoyn, in order whereunto I shall tell you, that though the Learned Authors I formerly mention'd, tell us, that no Writer has affirm'd his having himself seen a real Carbuncle, yet, considering the Light of Mr. *Claytons* Diamond, it recall'd into my mind, that some years before, when I was Inquisitive about Stones, I had met with an old *Italian* Book highly extoll'd to me by very competent Judges, and that though the Book were very scarce, I had purchas'd it at a dear Rate, for the sake of a few considerable passages I met with in it, and particularly one, which being very remarkable in it self, and pertinent to our present Argument, I shall put it for you, though not word for word, which I fear I have forgot to do, yet as to the Sense, into *English*.

[28] *Purchas's* Pilgrim. lib. 1. cap. 4. pag. 104.

[29] In the year 1619.

Having promis'd (Says our Author)[30] *to say something of that most precious sort of Jewels, Carbuncles, because they are very rarely to be met with, we shall briefly deliver what we know of them. In Clement the seventh's time, I happen'd to see one of them at a certain Ragusian Merchants, nam'd Beigoio di Bona, This was a Carbuncle white, of that kind of whiteness which we said was to be found in those Rubies of which we made mention a little above, (where he had said that those Rubies had a kind of Livid Whiteness or Paleness like that of a Calcidonian) but it had in it a Lustre so pleasing and so marvellous, that it shin'd in the Dark, but not as much as colour'd Carbuncles, though it be true, that in an exceeding Dark place I saw it shine in the manner of fire almost gone out. But as for colour'd Carbuncles, it has not been my Fortune to have seen any, wherefore I will onely set down what I Learn'd about them Discoursing in my Youth with a Roman Gentleman of antient Experience in matters of Jewels, who told me, That one Jacopo Cola being by Night in a Vineyard of his, and espying something in the midst of it, that shin'd like a little glowing Coal, at the foot of a Vine, went near towards the place where he thought himself to have seen that fire, but not finding it, he said, that being return'd to the same place, whence he had first descry'd it, and perceiving there the same splendor as before, he mark'd it so heedfully, that he came at length to it, where he took up a very little Stone, which he carry'd away with Transports and Joy. And the next day carrying it about to show it divers of his Friends, whilst he was relating after what manner he found it, there casually interven'd a Venetian Embassadour, exceedingly expert in Jewels, who presently knowing it to be a Carbuncle, did craftily before he and the said Jacopo parted (so that there was no Body present that understood the Worth of so Precious a Gemm) purchase it for the Value of 10. Crowns, and the next day left Rome to shun the*



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being necessitated to restore it, and (as he affirm'd) it was known within some while after that the said *Venetian* Gentleman did in *Constantinople* sell that Carbuncle to the then Grand Seignior, newly come to the Empire, for a hundred thousand Crowns. *And this is what I can say concerning Carbuncles*, and this is not a little at least as to the first part of this account, where our *Cellini* affirms himself to have seen a Real Carbuncle with his own Eyes, especially since this Author appears wary in what he delivers, and is inclin'd rather to lessen, than increase the wonder of it. And his Testimony is the more considerable, because though he were born a Subject neither to the Pope nor the then King of *France* (that Royal *Virtuoso Francis* the first) yet both the one and the other of those Princes employ'd him much about making of their Noblest Jewels. What is now reported concerning a Shining Substance to be seen in one of the Islands about *Scotland*, were very improper for me to mention to Sr. *Robert Morray*, to whom the first Information was Originally brought, and from whom I expect a farther (for I scarce dare expect a convincing) account of it. But I must not omit that some *Virtuoso* questioning me the other day at *White-Hall* about Mr. *Claytons* Diamond, and meeting amongst them an Ingenious *Dutch* Gentleman, whose Father was long Ambassador for the Netherlands in *England*, I Learn'd of him, that, he is acquainted with a person, whose Name he told (but I do not well remember it) who was Admiral of the *Dutch* in the *East-Indies*, and who assur'd this Gentleman *Monsieur Boreel*, that at his return from thence he brought back with him into *Holland* a Stone, which though it look'd but like a Pale Dull Diamond, such as he saw Mr. *Claytons* to be, yet was it a Real Carbuncle, and did without rubbing shine so much, that when the Admiral had occasion to open a Chest which he kept under Deck in a Dark place, where 'twas forbidden to bring Candles for fear of Mischances, as soon as he open'd the Trunck, the Stone would by its Native Light, shine so as to Illustrate a great part of it, and this Gentleman having very civilly and readily granted me the request I made him, to Write to the Admiral, who is yet alive in *Holland*, (and probably may still have the Jewel by him,) for a particular account of this Stone, I hope ere long to receive it, which will be the more welcome to me, not onely because so unlikely a thing needs a cleer evidence, but because I have had some suspicion of that (supposing the truth of the thing) what may be a shining Stone in a very hot Countrey as the *East-Indies*, may perhaps cease to be so (at least in certain seasons,) in one as cold as *Holland*. For I observ'd in the Diamond I send you an account of, that not onely rubbing but a very moderate degree of warmth, though excited by other wayes, would make it shine a little. And



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'tis not impossible that there may be Stones as much more susceptible than that, of the Alterations requisite to make a Diamond shine, as that appears to be more susceptible of them, than ordinary Diamonds. And I confess to you, that this is not the only odd suspicion (for they are not so much as conjectures) that what I try'd upon this Diamond suggested to me. For not here to entertain you with the changes I think may be effected ev'n in harder sorts of Stones, by wayes not vulgar, nor very promising, because I may elsewhere have occasion to speak of them, and this Letter is but too Prolix already, that which I shall now acknowledge to you is, That I began to doubt whether there may not in some Cases be some Truth in what is said of the right Turquois, that it often changes Colour as the wearer is Sick or Well, and manifestly loses its splendor at his Death. For when I found that ev'n the warmth of an Affrication that lasted not above a quarter of a minute, Nay, that of my Body, (whose Constitution you know is none of the hottest) would make a manifest change in the solidest of Stones a Diamond, it seem'd not impossible, that certain warm and Saline steams issuing from the Body of a living man, may by their plenty or paucity, or by their peculiar Nature, or by the total absence of them, diversifie the Colour, and the splendor of so soft a Stone as the Turquois. And though I admir'd to see, that I know not how many Men otherwise Learn'd, should confidently ascribe to Jewels such Virtues as seem no way competible to Inanimate Agents, if to any Corporeal ones at all, yet as to what is affirm'd concerning the Turquois's changing Colour, I know not well how to reject the Affirmation of so Learned (and which in this case is much more considerable) so Judicious a Lapidary as *Boetius de Boot*[31], who upon his own particular and repeated Experience delivers so memorable a Narrative of the Turquois's changing Colour, that I cannot but think it worth your Perusal, especially since a much later and very Experienc'd Author, *Olaus Wormius*,[32] where he treats of that Stone, Confirms it with this Testimony. *Imprimis memorandum exemplum quod Anshelmus Boetius de seipso refert, tam mutati Coloris, quam a casu preservationis. Cui & ipse haud dissimile adferre possum, nisi ex Anshelmo petitum quis putaret.* I remember that I saw two or three years since a *Turcois* (worn in a Ring) wherein there were some small spots, which the *Virtuoso* whose it was asur'd me he had observ'd to grow sometimes greater sometimes less, and to be sometimes in one part of the Stone, sometimes in another. And I having encourag'd to make Pictures from time to time of the Stone, and of the Situation of the cloudy parts, thatso their Motion may be more indisputable, and better observ'd, he came to me about the midle of this very week, and assur'd me that he had, as I wish'd, made from time to time Schemes or Pictures of the differing parts of the Stone, whereby the several Removes and motions



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of the above mentioned Clouds are very manifest, though the cause seem'd to him very occult: these Pictures he has promis'd to show me, and is very ready to put the Stone it self into my hands. But the ring having been the other day casually broken upon his finger, unless it can be taken out, and set again without any considerable heat, he is loath to have it medled with, for fear its peculiarity should be thereby destroy'd. And possibly his apprehension would have been strengthen'd, if I had had opportunity to tell him what is related by the Learned *Wormius*[33] of an acquaintance of his, that had a *Nephritick* stone, of whose eminent Virtues he had often Experience ev'n in himself, and for that cause wore it still about his Wrist; and yet going upon a time into a Bath of fair Water only, wherein certain Herbs had been boyl'd, the Stone by being wetted with this decoction, was depriv'd of all his Virtue, whence *Wormius* takes Occasion to advertise the sick, to lay by such stones whensoever they make use of a Bath. And we might expect to find *Turcos* likewise, easily to be wrought upon in point of Colour, if that were true, which the curious *Antonio Neri*, in his ingenious *Arte Vetraria*[34] teaches of it, namely, That *Turcois's* discolour'd and grown white, will regain and acquire an excellent Colour, if you but keep them two or three days at most cover'd with Oyl of sweet Almonds kept in a temperate heat by warm ashes, I say if it were true, because I doubt whether it be so, and have not as yet had opportunity to satisfie my self by Tryals, because I find by the confession of the most Skilfull Persons among whom I have laid out for *Turcoises*, that the true ones are great rarities, though others be not at all so. And therefore I shall now only mind you of one thing that you know as well as I, namely, that the rare Stone which is called *Oculus Mundi*, if it be good in its Kind, will have so great a change made in its Texture by being barely left a while in the Languidest of Liquors, common Waters, that from Opacous it will become Transparent, and acquire a Lustre of which it will again be depriv'd, without using any other Art or Violence, by leaving it a while in the Air. And before experience had satisfy'd us of the truth of this, it seem'd as unlikely that common Water or Air, should work such great changes in that Gemm, as it now seems that the Effluvioms of a human Body should effect lesser changes in a *Turcois*, especially if more susceptible of them, than other Stones of the same kind. But both my Watch and my Eyes tell me that 'tis now high time to think of going to sleep, matters of this Nature, will be better, as well as more easily, clear'd by Conference, than Writing. And therefore since I think you know me too well to make it needfull for me to disclame Credulity, notwithstanding my having entertain'd you with all these Extravagancies; for you know well, how wide a difference I am wont



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to put betwixt things that barely *may be*, and things that *are*, and between those Relations that are but not unworthy to be inquir'd into, and those that are not worthy to be actually believ'd; without making Apologies for my Ravings, I shall readily comply with the drowsiness that calls upon me to release You, and the rather, because Monsieur *Zulichem* being concern'd in your desire to know the few things I have observed about the shining Stone. To entertain those with Suspicions that are accustomed not to acquiesce but in Demonstrations, were a thing that cannot be look'd upon as other than very improper by,

SIR,

Your most Affectionate

and

most Faithfull Servant,

RO. BOYLE.

[30] Benvonuto Cellini *nell Arte del Gioiellare, Lib. 1. pag. 10.*

[31] The Narrative in the Authors own words, is this. *Ego (sayes he) sancte affirmare possum me unam aureo Annulo inclusam perpetuo gestare, cujus facultatem (si gemmae est) nunquam satis admirari potui. Gestaverat enim ante Triginta annos Hispanus quidam non procula puternis aedibus habitans. Is cum vita functus esset, & ipsius suspelles (ut moris apud nos est) venum exposita esset, inter caetera etiam Turcois exponebatur. Verum nemo (licet complures eo concurrissent, ut eam propter Coloris Elegantiam, quam vivo Domino habuerat emerent) sibi emptam voluit, pristinum enim nitorem & Colorem prorsus amiserat, ut potius Malachites, quam Turcois videretur. Aderat tum temporis gemmae habendae desiderio etiam parens & frater meus, qui antea saepius gratiam & elegantiam ipsius viderant, mirabundi eam nunc tam esse deformem, Emit eam nihilominus pater, satisque vili pretio, qua omnibus contemptui erat, ac presentes non eam esse quam Hispanus gestarat, arbitrarentur. Domum reversus Pater, qui tam turpem Gemmam gestare sibi indecorum putabat, eam mihi dono dat, inquiring; Quandoquidem, fili mi, vulgi fama est, Turcoidem, ut facultates suas exercere possit, dono dari debere tibi eam devoveo, ego acceptam Gemmam sculptori trado, at gentilitia mea insignia illi, quamadmodum fieri solet, in Jaspide Chalcedono, aliisque Ignobilioribus Gemmis, insculperat. Turpe enim existimabam, hujusmodi Gemma ornatus gratia, dum gratiam nullam haberet, uti. Pater Sculptor redditque Gemmam, quam gesto pro annulo Signatorio. Vix per mensem gestaram, redit illi pristinus color, sed non ita nitens propter Sculpturam, ac inaequalem superficiem. Miramur omnes gemmam, atque id praecipue quod color Indies pulchrior*



fieret. Id quia observabam, nunquam fere eam a manu deposui, ita ut nunc adhuc candem gestem.

[32] *Olaus Wormius, in Musae. 18^o pag. 186.*

[33] *Musae. Worm. pag. 99.*

[34] *Arte Vetraria, lib. 7 cap. 102.*

* * * * *

OBSERVATIONS

Made this 27th.[35]
of *October* 1663. about
Mr. *Clayton's*
Diamond.[36]



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Being look'd on in the Day time, though in a Bed, whose Curtains were carefully drawn, I could not discern it to Shine at all, though well Rubb'd, but about a little after Sun-set, whilst the Twilight yet lasted, Nay, this Morning[37] a pretty while after Sun-rising, (but before I had been abroad in the more freely inlightned Air of the Chamber) I could upon a light Affriction easily perceive the Stone to Shine.

[35] These were brought in and Read before the Royal Society, (the Day following) Oct. 28. 1663.

[36] *The Stone it self being to be shown to the Royal Society, when the Observations were deliver'd, I was willing (being in haste) to omit the Description of it, which is in short, That it was a Flat or Table Diamond, of about a third part of an Inch in length, and somewhat less in breadth, that it was a Dull Stone, and of a very bad Water, having in the Day time very little of the Vividness of ev'n ordinary Diamonds, and being Blemished with a whitish Cloud about the middle of it, which covered near a third part of the Stone.[37] Hast made me forget to take notice that I went abroad the same Morning, the Sun shining forth clear enough, to look upon the Diamond though a Microscope, that I might try whether by that Magnifying Glass any thing of peculiar could be discern'd in the Texture of the Stone, and especially of the whitish Cloud that possest a good part of it. But for all my attention I could not discover any peculiarity worth mentioning.*

Secondly, The Candles being removed, I could not in a Dark place discern the Stone to have any Light, when I looked on it, without having Rubb'd or otherwise prepar'd it.

Thirdly, By two white Pibbles though hard Rubb'd one against another, nor by the long and vehement Affriction of Rock Crystal against a piece of Red cloath, nor yet by Rubbing two Diamonds set in Ring, as I had Rubb'd this Stone, I could produce any sensible degree of Light.

Fourthly, I found this Diamond hard enough, not only to enable me to write readily with it upon Glass, but to Grave on Rock Crystal it self.

Fifthly, I found this to have like other Diamonds, an Electrical faculty.[38]

[38] *V. For it drew light Bodies like Amber, Jet, and other Concretes that are noted to do so; But its attractive power seem'd inferiour to theirs.*

Sixthly, Being rubb'd upon my Cloaths, as is usual for the exciting of Amber, Wax, and other Electrical Bodies, it did in the Dark manifestly shine like Rotten Wood, or the Scales of Whitings, or other putrified Fish.



Seventhly, But this Conspicuousness was Fainter than that of the Scales, and Slabber (if I may so call it) of Whitings, and much Fainter than the Light of a Glow-worm, by which I have been sometimes able to Read a short Word, whereas after an ordinary Affriction of this Diamond I was not able to discern distinctly by the Light of it any of the nearest Bodies: And this Glimmering also did very manifestly and considerably Decay presently upon the ceasing of the Affriction, though the Stone continued Visible some while after.



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Eighthly, But if it were Rubb'd upon a convenient Body for a pretty while, and Briskly enough, I found the Light would be for some moments much more considerable, almost like the Light of a Glow-worm, insomuch after I ceased Rubbing, I could with the Chaf'd stone exhibit a little Luminous Circle, like that, but not so bright as that which Children make by moving a stick Fir'd at the end, and in this case it would continue Visible about seven or eight times as long as I had been in Rubbing it.

Ninthly, I found that holding it a while near^[39] the Flame of a Candle, (from which yet I was carefull to avert my Eyes) and being immediately remov'd into the Dark, it disclosed some faint Glimmering, but inferiour to that, it was wont to acquire by Rubbing. And afterward holding it near a Fire that had but little Flame, I found the Stone to be rather less than more excited, than it had been by the Candle.

[39] IX. We durst not hold it in the Flame of a Candle, no more than put it into a naked Fire; For fear too Violent a Heat (which has been observ'd to spoil many other precious Stones) should vitiate and impair a Jewel, that was but borrow'd, and was suppos'd to be the only one of its Kind.

Tenthly, I likewise indeavour'd to make it Shine, by holding it a pretty while in a very Dark place, over a thick piece of Iron, that was well Heated, but not to that Degree as to be Visibly so. And though at length I found, that by this way also, the Stone acquired some Glimmering, yet it was less than by either of the other ways above mention'd.

Eleventhly, I also brought it to some kind of Glimmering Light, by taking it into Bed with me, and holding it a good while upon a warm part of my Naked Body.

Twelfthly, To satisfie my self, whether the Motion introduc'd into the Stone did generate the Light upon the account of its producing Heat there, I held it near the Flame of a Candle, till it was qualify'd to shine pretty well in the Dark, and then immediately I apply'd a slender Hair to try whether it would attract it, but found not that it did so; though if it were made to shine by Rubbing, it was as I formerly noted Electrical. And for further Confirmation, though I once purposely kept it so near the hot Iron I just now mention'd, as to make it sensibly Warm, yet it shin'd more Dimly than it had done by Affriction or the Flame of a Candle, though by both those ways it had not acquir'd any warmth that was sensible.

Thirteenthly, Having purposely rubb'd it upon several Bodies differing as to Colour, and as to Texture, there seem'd to be some little Disparity in the excitation (if I may so call it) of Light. Upon White and Red Cloths it seem'd to succeed best, especially in comparison of Black ones.

Fourteenthly, But to try what it would do rubb'd upon Bodies more hard, and less apt to yield Heat upon a light Affriction, than Cloath, I first rubb'd it upon a white wooden Box, by which it was excited, and afterwards upon a piece of purely Glazed Earth, which



seem'd during the Attrition to make it Shine better than any of the other Bodies had done, without excepting the White ones, which I add, lest the Effect should be wholly ascrib'd to the disposition White Bodies are wont to have to Reflect much Light.



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Fifteenthy, Having well excited the Stone, I nimbly plung'd it under Water[40], that I had provided for that purpose, and perceiv'd it to Shine whilst it was beneath the Surface of that Liquor, and this I did divers times. But when I indeavour'd to produce a Light by rubbing it upon the lately mentioned Cover of the Box, the Stone and it being both held beneath the Surface of the Water, I did not well satisfie my self in the Event of the Trial; But this I found, if I took the Stone out, and Rubb'd it upon a piece of Cloath, it would not as else it was wont to do, presently acquire a Luminousness, but needed to be rubb'd manifestly much longer before the desired Effect was found.

[40] XV. *We likewise Plung'd it as soon as we had excited it, under Liquors of several sorts, as Spirit of Wine, Oyl both Chymical and express'd, an Acid Spirit, and as I remember an Alcalizate Solution, and found not any of those various Liquors to destroy its Shining property.*

Sixteenthy, I also try'd several times, that by covering it with my warm Spittle (having no warm Water at hand) it did not lose his Light.[41]

[41] XVI. *Having found by this Observation, that a warm Liquor would not extinguish Light in the Diamond, I thought fit to try, whether by reason of its warmth it would not excite it, and divers times I found, that if it were kept therein, till the Water had leisure to communicate some of its Heat to it, it would often shine as soon as it was taken out, and probably we should have seen it Shine more, whilst it was in the Water, if some degree of Opacity which heated Water is wont to acquire, upon the score of the Numerous little Bubbles generated in it, had not kept us from discerning the Lustre of the Stone.*

Seventeenthy, Finding that by Rubbing the Stone with the Flat side downwards, I did by reason of the Opacity of the Ring; and the sudden Decay of Light upon the ceasing of the Attrition, probably lose the sight of the Stones greatest Vividness; and supposing that the Commotion made in one part of the stone will be easily propagated all over, I sometimes held the piece of Cloath upon which I rubb'd it, so, that one side of the Stone was exposed to my Eye, whilst I was rubbing the other, whereby it appear'd more Vivid than formerly, and to make Luminous Tracts by its Motions too and fro. And sometimes holding the Stone upwards, I rubb'd its Broad side with a fine smooth piece of Transparent Horn, by which means the Light through that Diaphanous Substance, did whilst I was actually rubbing the Stone, appear so Brisk that sometimes and in some places it seem'd to have little Sparks of fire.



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Eighteenthly, I took also a piece of flat Blew Glass, and having rubb'd the Diamond well upon a Cloath, and nimbly clapt the Glass upon it, to try whether in case the Light could peirce it, it would by appearing Green, or of some other Colour than Blew, assist me to guess whether it self were sincere or no. But finding the Glass impervious to so faint a Light, I then thought it fit to try whether that hard Bodies would not by Attrition increase the Diamonds Light so as to become penetrable thereby, and accordingly when I rubb'd the Glass briskly upon the Stone, I found the Light to be Conspicuous enough, and somewhat Dy'd in its passage, but found it not easie to give a Name to the Colour it exhibited.

Lastly, To comply with the Suspition I had upon the whole Matter, that the chief manifest Change wrought in the Stone, was by Compression of its parts, rather than Incalescence, I took a piece of white Tile well Glaz'd, and if I press'd the Stone hard against it, it seem'd though I did not rub it to and fro, to shine at the Sides: And however it did both very manifestly and vigorously Shine, if whilst I so press'd it, I mov'd it any way upon the Surface of the Tile, though I did not make it draw a Line of above a quarter of an Inch long, or thereabouts. And though I made it not move to and fro, but only from one end of the short Line to the other, without any return or Lateral motion. Nay, after it had been often rubb'd, and suffer'd to lose its Light again, not only it seem'd more easie to be excited than at the beginning of the Night; but if I did press hard upon it with my Finger, at the very instant that I drew it briskly off, it would disclose a very Vivid but exceeding short Liv'd Splendour, not to call it a little Coruscation.[42] So that a *Cartesian* would scarce scruple to think he had found in this Stone no slight Confirmation of his Ingenious Masters *Hypothesis*, touching the Generation of Light in Sublunary Bodies, not sensibly Hot.

[42] *I after bethought my self of imploying a way, which produc'd the desir'd Effect both sooner and better. For holding betwixt my Fingers a Steel Bodkin, near the Lower part of it, I press'd the point hard against the Surface of the Diamond, and much more if I struck the point against it, the Coruscation would be extremely suddain, and very Vivid, though very Vanishing too, and this way which commonly much surpris'd and pleas'd the Spectators, seem'd far more proper than the other, to show that pressure alone, if forcible enough, though it were so suddain, and short, that it could not well be suppos'd to give the Stone any thing near a sensible degree of Warmth, as may be suspected of Rubbing, yet 'tis sufficient to generate a very Vivid Light.*

* * * * *

A Postscript.

Annexed some Hours after the Observations were Written.



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So many particulars taken notice of in one Night, may make this Stone appear a kind of Prodigie, and the rather, because having try'd as I formerly noted, not only a fine Artificial Crystal, and some also that is Natural, but a Ruby and two Diamonds, I did not find that any of these disclos'd the like Glimmering of Light;[43] yet after all, perceiving by the Hardness, and the Testimony of a Skilfull Goldsmith, that this was rather a Natural than Artificial Stone; for fear lest there might be some difference in the way of Setting, or in the shape of the Diamonds I made use of, neither of which was like this, a flat Table-stone, I thought fit to make a farther Trial of my own Diamonds, by such a brisk and assiduous Affriction as might make amends for the Disadvantages above-mention'd, in case they were the cause of the unsuccessfulness of the former Attempts: And accordingly I found, that by this way I could easily bring a Diamond I wore on my Finger to disclose a Light, that was sensible enough, and continued so though I cover'd it with Spittle, and us'd some other trials about it. And this will much lessen the wonder of all the formerly mention'd Observations, by shewing that the properties that are so strange are not peculiar to one Diamond, but may be found in others also, and perhaps in divers other hard and Diaphanous Stones. Yet I hope that what this Discovery takes away from the Wonder of these Observations, it will add to the Instructiveness of them, by affording pregnants Hints, towards the Investigation of the Nature of Light.

[43] We afterwards, try'd precious Stones, as Diamonds, Rubies, Sapphires, and Emeralls, &c. but found not any of them to Shine except some Diamonds, and of these we were not upon so little practice, able to fore-tell before hand, which would be brought to Shine, and which would not; For several very good Diamonds, either would not Shine at all, or much less than others that were farr inferiour to them. And yet those Ingenious Men are mistaken, that think a Diamond must be foul and cloudy, as Mr. *Claytons* was, to be fit for Shining; for as we could bring some such to afford a Glimmering Light, so with some clear and excellent Diamonds, we could do the like. But none of those many that we try'd of all Kinds, were equal to the Diamond on which the Observations were made, not only considering the degree of Light it afforded, but the easiness wherewith it was excited, and the Comparatively great duration of its Shining.

FINIS.

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Transcriber's notes.

The Errata of the printed book have all been corrected.
They were as follows:



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Pag. 142. l. 20. These words, And to manifest, with the rest of what is by a mistake further printed in this fourth Experiment, belongeth, and is to be referred to the end of the second Eperiment, p.137. pag. 145. l. 1. leg. matter. 146. l. 4. leg. Bolts-head. pag 161. in the marginal note l. 2. dele de ib. l. 3. lege lib 1. p 163. l. ult. insert where between the words places and the. p. 164 l. 1. dele that. ibid, l. 8. leg Epidermis. ibid. l. 19 leg. 300. for 200. p. 169. l. 22. leg. into it. p. 170. l. 23. & 24. leg. Some Solutions hereafter to be mentioned, for the Solutions of Potashes, and other Lixivate Salts. p. 171. l. 6. insert part of between the words most and dissolved p. 176. l. ult. insert the participle it between the words Judged and not p. 234. l. 4. leg. Woud-wax or Wood-wax. p. 320 l. 29. leg. urine for urne.

In addition I have corrected the following original typos:

The preface: I devis'd tbem -> I devis'd them

The preface: make Expements -> make Experiments

The Publisher to the reader: made of Eperiments -> made of Experiments

I. Ch. III.6 divers Expements -> divers Experiments

I. Ch. III.13 epecially with some sorts -> especially with some sorts

II. Ch. II.8 Slightet Texture -> Slightest Texture

II. Exp. I two Colonrs -> two Colours

II. Exp. XIII were the change of Colour -> where the change

III. Exp. XII avoiding of Ambignity -> avoiding of Ambiguity

III. Exp. XXIX Juice of this Sipce -> Juice of this Spice

III. Exp. XL forty second Expement -> forty second Experiment

III. Exp. XLIV keep them swimming -> keep them swimming

III. Exp. XLVI it seem'd propable to me -> it seem'd probable to me

III. Exp. XLVII where not comprehended -> were not comprehended

III. Exp. XLVIII frequent Igintion -> frequent Ignition

III. Exp. L I could tell yon -> I could tell you

A Copy of the Letter: nemo unqnam vere -> nemo nunquam vere

(ib.): what is reladed -> what is related

Observations: carefulty drawn -> carefully drawn

- and emended

Phoenomenon/a to Phaenomenon/a 10 times and

Coeruleous etc. -> Caeruleous 20 times