Experiments and Considerations Touching Colours

by Robert Boyle

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EXPERIMENTS AND CONSIDERATIONS Touching

COLOURS.

First occasionally Written, among some other Essays, to a Friend; and now suffer'd to come abroad as

THE BEGINNING Of An Experimental History OF COLOURS.

By the Honourable ROBERT BOYLE, Fellow of the ROYAL SOCIETY.

Non fingendum, aut excogitandum, sed inveniendum, quid Natura faciat, aut ferat. Bacon.

LONDON.

Printed for Henry Herringman at the Anchor on the Lower walk of the New Exchange. MDCLXIV.

Decorative tile

THE PREFACE.

Illuminated H in Having Aving in convenient places of the following Treatise, mention'd the Motives, that induc'd me to write it, and the Scope I propos'd to my self in it; I think it superfluous to entertain the Reader now, with what he will meet with hereafter. And I should judge it needless, to trouble others, or my self, with any thing of Preface: were it not that I can scarce doubt, but this Book will fall into the hands of some Readers, who being unacquainted with the difficulty of attempts of this nature, will think itn strange that I should publish any thing about Colours, without a particular Theory of them. But I dare expect that Intelligent and Equitable Readers will consider on my behalf: That the professed Design of this Treatise is to deliver things rather Historical than Dogmatical, and consequently if I have added

divers new speculative Considerations and hints, which perhaps may afford no despicable Assistance, towards the framing of a solid and comprehensive Hypothesis, I have done at least as much as I promis'd, or as the nature of my undertaking exacted. But another thing there is, which if it should be objected, I fear I should not be able so easily to answer it, and that is; That in the following treatise (especially in the Third part of it) the Experiments might have been better Marshall'd, and some of them deliver'd in fewer words. For I must confess that this Essay was written to a private Friend, and that too, by snatches, at several times, and places, and (after my manner) in loose sheets, of which I oftentimes had not all by me that I had already written, when I was writing more, so that it needs be no wonder if all the Experiments be not rang'd to the best Advantage, and if some connections and consecutions of them might easily have been mended. Especially since having carelessly laid by the loose Papers, for several years after they were written, when I came to put them together to dispatch them to the Press, I found some of those I reckon'd upon, to be very unseasonably wanting. And to make any great change in the order of the rest, was more than the Printers importunity, and that, of my own avocations (and perhaps also considerabler solicitations) would permit. But though some few preambles of the particular Experiments might have (perchance) been spar'd, or shorten'd, if I had had all my Papers under my View at once; Yet in the most of those Introductory passages, the Reader will (I hope) find hints, or Advertisements, as well as Transitions. If I sometimes seem to insist long upon the circumstances of a Tryall, I hope I shall be easily excused by those that both know, how nice divers experiments of Colours are, and consider that I was not barely to relate them, but so as to teach a young Gentleman to make them. And if I was not sollicitous, to make a nicer division of the whole Treatise, than into three parts, whereof the One contains some Considerations about Colours in general. The Other exhibits a specimen of an Account of particular Colours, Exemplifi'd in Whiteness and Blackness. And the Third promiscuous Experiments about the

remaining Colours (especially Red) in order to a Theory of them. If, I say, I contented my self with this easie Division of my Discourse, it was perhaps because I did not think it so necessary to be Curious about the Method or Contrivance of a Treatise, wherein I do not pretend to present my Reader with a compleat Fabrick, or so much as Modell; but only to bring in Materials proper for the Building; And if I did not well know how Ingenious the Curiosity and Civility of Friends makes them, to perswade Men by specious allegations, to gratifie their desires; I should have been made to believe by persons very well qualify'd to judge of matters of this nature, that the following Experiments will not need the addition of accurate Method and speculative Notions to procure Acceptance for the Treatise that contains them: For it hath been represented, That in most of them, as the Novelty will make them surprizing, and the Quickness of performance, keep them from being tedious; so the sensible changes, that are effected by them, are so manifest, so great, and so sudden, that scarce any will be displeased to see them, and those that are any thing Curious will scarce be able to see them, without finding themselves excited, to make Reflexions upon Them. But though with me, who love to measure Physical things by their use, not their strangeness, or prettiness, the partiality of others prevails not to make me over value these, or look upon them in themselves as other than Trifles: Yet I confess, that ever since I did divers years ago shew some of them to a Learned Company of Virtuosi: so many persons of differing Conditions, and ev'n Sexes, have been Curious to see them, and pleas'd not to Dislike them, that I cannot Despair, but that by complying with those that urge the Publication of them, I may both gratifie and excite the Curious, and lay perhaps a Foundation whereon either others or my self may in time superstruct a substantial theory of Colours. And if Aristotle, after his Master Plato, have rightly observ'd Admiration to be the Parent of Philosophy, the wonder, some of these Trifles have been wont to produce in all sorts of Beholders, and the access they have sometimes gain'd ev'n to the Closets of Ladies, seem to promise, that since the subject is so pleasing, that the Speculation appears as

Delightful! as Difficult, such easie and recreative Experiments, which require but little time, or charge, or trouble in the making, and when made are sensible and surprizing enough, may contribute more than others, (far more important but as much more difficult) to recommend those parts of Learning (Chymistry and Corpuscular Philosophy) by which they have been produc'd, and to which they give Testimony ev'n to such kind of persons, as value a pretty Trick more than a true Notion, and would scarce admit Philosophy, if it approach'd them in another Dress: without the strangeness or endearments of pleasantness to recommend it. I know that I do but ill consult my own Advantage in the consenting to the Publication of the following Treatise: For those things, which, whilst men knew not how they were perform'd, appear'd so strange, will, when the way of making them, and the Grounds on which I devis'd them, shall be Publick, quickly lose all that their being Rarityes, and their being thought Mysteries, contributed to recommend them. But 'tis fitter for Mountebancks than Naturalis to desire to have their discoverys rather admir'd than understood, and for my part I had much rather deserve the thanks of the Ingenious, than enjoy the Applause of the Ignorant. And if I can so farr contribute to the discovery of the nature of Colours, as to help the Curious to it, I shall have reach'd my End, and sav'd my self some Labour which else I may chance be tempted to undergo in prosecuting that subect, and Adding to this Treatise, which I therefore call a History, because it chiefly contains matters of fact, and which History the Title declares me to look upon but as Begun: Because though that above a hundred, not to say a hundred and fifty Experiments, (some loose, and others interwoven amongst the discourses themselves) may suffice to give a Beginning to a History not hitherto, that I know, begun, by any; yet the subject is so fruitfull, and so worthy, that those that are Curious of these Matters will be farr more wanting to themselves than I can suspect, if what I now publish prove any more than a Beginning. For, as I hope my Endeavours may afford them some assistance towards this work, so those Endeavours are much too Vnfinish'd to give them any discouragement, as if there

were little left for others to do towards the History of Colours.

For (first) I have been willing to leave unmention'd the most part of those Phænomena of Colours, that Nature presents us of her own accord, (that is, without being guided or over-ruld by man) such as the different Colours that several sorts of Fruites pass through before they are perfectly ripe, and those that appear upon the fading of flowers and leaves, and the putrifaction (and its several degrees) of fruits, &c. together with a thousand other obvious Instances of the changes of colours. Nor have I much medled with those familiar Phænomena wherein man is not an Idle spectator; such as the Greenness produc'd by salt in Beef much powder'd, and the Redness produc'd in the shells of Lobsters upon the boyling of those fishes; For I was willing to leave the gathering of Observations to those that have not the Opportunity to make Experiments. And for the same Reasons, among others, I did purposly omit the Lucriferous practise of Trades-men about colours; as the ways of making Pigments, of Bleanching wax, of dying Scarlet, &c. though to divers of them I be not a stranger, and of some I have myself made Tryall.

Next; I did purposely pass by divers Experiments of other Writers that I had made Tryall of (and that not without registring some of their Events) unless I could some way or other improve them, because I wanted leasure to insert them, and had thoughts of prosecuting the work once begun of laying together those I had examin'd by themselves in case of my not being prevented by others diligence. So that there remains not a little, among the things that are already published, to imploy those that have a mind to exercise themselves in repeating and examining them. And I will not undertake, that none of the things deliver'd, ev'n in this Treatise, though never so faithfully set down, may not prove to be thus farr of this Sort, as to afford the Curious somewhat to add about them. For I remember that I have somewhere in the Book it self acknowledged, that having written it by snatches, partly in the Counntrey, and partly at unseasonable times of the year, when the want of fit Instruments, and of a competent variety of flowers, salts, Pigments, and other

materials made me leave some of the following Experiments, (especialy those about Emphatical Colours) far more unfinish'd than they should have been, if it had been as easie for me to supply what was wanting to compleat them, as to discern. Thirdly to avoyd discouraging the young Gentleman I call Pyrophilus, whom the less Familiar, and more Laborious operations of Chymistry would probably have frighted, I purposely declin'd in what I writ to him, the setting down any Number of such Chymicall Experiments, as, by being very elaborate or tedious, would either require much skill, or exercise his patience. And yet that this sort of Experiments is exceedingly Numerous, and might more than a little inrich the History of Colours, those that are vers'd in Chymical processes, will, I presume, easily allow me.

And (Lastly) for as much as I have occasion more than once in my several Writings to treat either porposely or incidentally of matters relating to Colours; I did not, perhaps, conceive my self oblig'd, to deliver in one Treatise all that I would say concerning that subject.

But to conclude, by summing up what I would say concerning what I have and what I have not done, in the following Papers; I shall not (on the one side) deny, that considering that I pretended not to write an accurate Treatise of Colours, but an Occasional Essay to acquaint a private friend with what then occurrd to me of the things I had thought or try'd concerning them; I might presume I did enough for once, if I did clearly and faithfully set down, though not all the Experiments I could, yet at least such a variety of them, that an attentive Reader that shall consider the Grounds on which they have been made, and the hints that are purposely (though dispersedly) couched in them, may easily compound them, and otherwise vary them, so as very much to increase their Number. And yet (on the other side) I am so sensible both of how much I have, either out of necessity or choice, left undone, and of the fruitfullness of the subject I have begun to handle; that though I had performed far more then 'tis like many Readers will judge I have, I should yet be very free to let them apply to my Attempts that of Seneca, where having spoken of

the Study of Natures Mysteries, and Particularly of the Cause of Earth-Quakes, he subjoins.1 Nulla res consummata est dum incipit. Nec in hac tantum re omnium maxima ac involutissimá, in quâ etiam cum multum actum erit, omnis ætas, quod agat inveniet; sed in omni alio Negotio, longè semper à perfecto fuere Principia.

Decorative rule

The Publisher to the READER.

Friendly Reader,

Illuminated H in HereEre is presented to thy view one of the Abstrusest as well as the Gentilest Subjects of Natural Philosophy, the Experimentall History of Colours; which though the Noble Author be pleased to think but Begun, yet I must take leave to say, that I think it so well begun, that the work is more than half dispatcht. Concerning which I cannot but give this advertisement to the Reader, that I have heard the Author express himself, that it would not surprise him, if it should happen to be objected, that some of these Experiments have been already published, partly by Chymists, and partly by two or three very fresh Writers upon other Subjects. And though the number of these Experiments be but very small, and though they be none of the considerablest, yet it may on this occasion be further represented, that it is easie for our Author to name several men, (of whose number I can truly name my self) who remember either their having seen him make, or their having read, his Accounts of the Experiments delivered in the following Tract several years since, and long before the publication of the Books, wherein they are mentioned. Nay in divers passages (where he could do it without any great inconvenience) he hath struck out Experiments, which he had tryed many years ago, because he since found them divulged by persons from whom he had not the least hint of them; which yet is not touched, with design to reflect upon any Ingenious Man, as if he were a Plagiary: For, though our Generous Author were not reserved enough in showing his

Experiments to those that expressed a Curiosity to see them (amongst whom a very Learned Man hath been pleased publickly to acknowledge it several years ago2; yet the same thing may be well enough lighted on by persons that know nothing of one another. And especially Chymical Laboratories may many times afford the same Phænomenon about Colours to several persons at the same or differing times. And as for the few Phænomena mentioned in the same Chymical writers, as well as in the following Treatise, our Author hath given an account, why he did not decline rejecting them, in the Anotations upon the 47th Experiment of the third part. Not here to mention, what he elsewhere saith, to shew what use may be Justifiably made of Experiments not of his own devising by a writer of Natural History, if, what he employes of others mens, be well examined or verified by himself.

In the mean time, this Treatise is such, that there needs no other invitation to peruse it, but that tis composed by one of the Deepest & Most indefatigable searchers of Nature, which, I think the World, as far as I know it, affords. For mine own part, I feel a Secret Joy within me, to see such beginings upon such Themes, it being demonstratively true, Mota facilius moveri, which causeth me to entertain strong hopes, that this Illustrious Virtuoso and Restless Inquirer into Nature's Secrets will not stop here, but go on and prosper in the Disquisition or the other principal Colours, Green, Red, and Yellow. The Reasoning faculty set once afloat, will be carried on, and that with ease, especially, when the productions thereof meet, as they do here, with so greedy an Entertainment at home and abroad. I am confident, that the ROYAL SOCIETY, lately constituted by his MOST EXCELLENT MAJESTY for improving Natural knowledge, will Judge it their interest to exhort our Author to the prosecution of this Argument, considering, how much it is their design and business to accumulate a good stock of such accurate Observations and Experiments, as may afford them and their Offpring genuine Matter to raise a Masculine Philosophy upon, whereby the Mind of Man may be enobled with the Knowledge of solid Truths, and the Life of Man benefited with ampler

accommodations, than it hath been hitherto.

Our Great Author, one of the Pillars of that Illustrious Corporation, is constantly furnishing large Symbola's to this work, and is now falln, as you see, upon so comprehensive and important a theme, as will, if insisted on and compleated, prove one of the considerablest peeces of that structure. To which, if he shall please to add his Treatise of Heat and Flame, as he is ready to publish his Experimental Accounts of Cold, I esteem, the World will be obliged to Him for having shewed them both the Right and Left Hand of Nature, and the Operations thereof.

The considering Reader will by this very Treatise see abundant cause to sollicit the Author for more; sure I am, that of whatever of the Productions of his Ingeny comes into Forein parts (where I am happy in the acquaintance of many intelligent friends) is highly valued; And to my knowledge, there are those among the French, that have lately begun to learn English, on purpose to enable themselves to read his Books, being impatient of their Traduction into Latin. If I durst say all, I know of the Elogies received by me from abroad concerning Him, I should perhaps make this Preamble too prolix, and certainly offend the modesty of our Author.

Wherefore I shall leave this, and conclude with desiring the Reader, that if he meet with other faults besides those, that the Errata take notice of (as I believe he may) he will please to consider both the weakness of the Authors eyes, for not reviewing, and the manifold Avocations of the Publisher for not doing his part; who taketh his leave with inviting those, that have also considered this Nice subject experimentally, to follow the Example of our Noble Author, and impart such and the like performances to the now very inquisitive world. Farewell.

H. O.

Decorative rule

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Part the Third.

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Decorative rule

Decorative rule

THE EXPERIMENTAL HISTORY OF COLOURS BEGUN.

THE FIRST PART.

CHAP. I.

1 Illuminated I

have seen you so passionately addicted, Pyrophilus to the delightful Art of Limning and Painting, that I cannot but think my self obliged to acquaint you with some of those things that have occurred to mee concerning the changes of Colours. And I may expect that I shall as well serve the Virtuosi in general, as gratifie you in particular, by furnishing a person, who, I hope, will both improve my Communications, and communicate his Improvements, with such Experiments and Observations as may both invite you to enquire seriously into the Nature of Colours,

and assist you in the Investigation of it. This being the principal scope of the following Tract, I should do that which might prevent my own design, if I should here attempt to deliver you an accurate and particular Theory of Colours; for that were to present you with what I desire to receive from you; and, as farr as in mee lay, to make that study needless, to which I would engage you.

2 Wherefore my present work shall be but to divert and recreate, as well as excite you by the delivery of matters of fact, such as you may for the most part try with much ease, and possibly not without some delight: And lest you should expect any thing of Elaborate or Methodical in what you will meet with here, I must confess to you before-hand, that the seasons I was wont to chuse to devise and try Experiments about Colours, were those daies, wherein having taken Physick, and finding my self as unfit to speculate, as unwilling to be altogether idle, I chose this diversion, as a kind of Mean betwixt the one and the other. And I have the less scrupled to set down the following Experiments, as some of them came to my mind, and as the Notes wherein I had set down the rest, occurr'd to my hands, that by declining a Methodical way of delivering them, I might leave you and my self the greater liberty and convenience to add to them, and transpose them as shall appear expedient.

3 Yea, that you may not think mee too reserv'd, or look upon an Enquiry made up of meer Narratives, as somewhat jejune, am content to premise a few considerations, that now offer themselves to my thoughts, which relate in a more general way, either to the Nature of Colours, or to the study of it. And I shall insert an Essay, as well Speculative as Historical, of the Nature of Whiteness and Blackness, that you may have a Specimen of the History of Colours, I have sometimes had thoughts of; and if you dislike not the Method I have made use of, I hope, you, and some of the Virtuosi, your friends, may be thereby invited to go thorow with Red, Blew, Yellow, and the rest of the particular Colours, as I have done with White and Black, but with farr more sagacity and success. And if I can invite Ingenious men to undertake such Tasks, I doubt not but the Curious will quickly obtain a better Account of Colours,

than as yet we have, since in our Method the Theorical part of the Enquiry being attended, and as it were interwoven with the Historical, whatever becomes of the disputable Conjectures, the Philosophy of Colours will be promoted by the indisputable Experiments.

CHAP. II.

1 To come then in the first place to our more general Considerations, I shall begin with saying something as to the Importance of examining the Colours of Bodies. For there are some, especially Chymists, who think, that a considerable diversity of Colours does constantly argue an equal diversity of Nature, in the Bodies wherein it is conspicuous; but I confess I am not altogether of their mind; for not to mention changeable Taffaties, the blew and golden necks of Pidgeons, and divers Water-fowl, Rainbows Natural and Artificial, and other Bodies, whose Colours the Philosophers have been pleased to call not Real, but Apparent and Phantastical; not to insist on these, I say, (for fear of needlesly engaging in a Controversie) we see in Parrots, Goldfinches, and divers other Birds, not only that the contiguous feathers which are probably as near in properties as place, are some of them Red, and others White, some of them Blew, & others Yellow, &c. but that in the several parts of the self-same feather there may often be seen the greatest disparity of Colours; and so in the leaves of Tulips, July-flowers, and some other Vegetables the several leaves, and even the several parts of the same leaf, although no difference have been observed in their other properties, are frequently found painted with very different Colours. And such a variety we have much more admired in that lovely plant which is commonly, and not unjustly call'd the Marvayl of Peru; for of divers scores of fine Flowers, which in its season that gaudy Plant does almost daily produce, I have scarce taken notice of any two that were dyed perfectly alike. But though Pyro: such things as these, among others, keep mee from daring to affirm, that the Diversity and change of Colours does alwaies argue any great difference or alteration, betwixt, or in, the

Bodies, wherein it is to be discerned, yet that oftentimes the Alteration of Colours does signifie considerable Alterations in the disposition of parts of Bodies, may appear in the Extraction of Tinctures, and divers other Chymical Operations, wherein the change of Colours is the chief, and sometimes the only thing, by which the Artist regulates his proceeding, and is taught to know when 'tis seasonable for him to leave off. Instances of this sort are more obvious in divers sorts of fruits, as Cherries, Plums, &c. wherein, according as the Vegetable sap is sweetned, or otherwise ripened, by passing from one degree to another of Maturation, the external part of the fruit passes likewise from one to another Colour. But one of the noblest Instances I have met with of this kind, is not so obvious; and that is the way of tempering Steel to make Gravers, Drills, Springs, and other Mechanical Instruments, which we have divers times both made Artificers practise in our presence, and tryed our selves, after the following manner, First, the slender Steel to be tempered is to be hardened by heating as much of it as is requisite among glowing Coals, till it be glowing hot, but it must not be quenched assoon as it is taken from the fire (for that would make it too brittle, and spoil it) but must be held over a bason of water, till it descend from a White heat to a Red one, which assoon as ever you perceive, you must immediately quench as much as you desire to harden in the cold water. The Steel thus hardened, will, if it be good, look somewhat White and must be made bright at the end, that its change of Colours may be there conspicuous; and then holding it so in the flame of a Candle, that the bright end may be, for about half an inch, or more, out of the flame, that the smoak do not stain or sully the brightness of it, you shall after a while see that clean end, which is almost contiguous to the flame, pass very nimbly from one Colour to another, as from a brighter Yellow, to a deeper and reddish Yellow, which Artificers call a sanguine, and from that to a fainter first, and then a a deeper Blew. And to bring home this Experiment to our present purpose, it is found by daily Experience, that each of these succeeding Colours argue such a change made in the texture of the Steel, that if it be taken from the

flame, and immediately quenched in the tallow (whereby it is setled in whatever temper it had before) when it is Yellow, it is of such a hardness as makes it fit for Gravers Drills, and such like tools; but if it be kept a few minutes longer in the flame till it grow Blew, it becomes much softer, and unfit to make Gravers for Metalls, but fit to make Springs for Watches, and such like Instruments, which are therefore commonly of that Colour; and if the Steel be kept in the flame, after that this deep Blew hath disclosed it self, it will grow so soft, as to need to be new hardened again, before it can be brought to a temper, fit for Drills or Penknives. And I confess Pyro. I have taken much pleasure to see the Colours run along from the parts of the Steel contiguous to the flame, to the end of the Instrument, and succeed one another so fast, that if a man be not vigilant, to thrust the Steel into the tallow at the very nick of time, at which it has attain'd its due Colour, he shall miss of giving his tool the right temper. But because the flame of a Candle is offensive to my weak eyes, and because it is apt to either black or sully the contiguous part of the Steel which is held in it, and thereby hinder the change of Colours from being so long and clearly discern'd, I have sometimes made this Experiment by laying the Steel to be tempered upon a heated bar of Iron, which we finde also to be employ'd by some Artificers in the tempering of such great Instruments, as are too big to be soon heated sufficiently by the flame of a Candle. And you may easily satisfie your self Pyro: of the differing hardness and toughness, which is ascribed to Steel temper'd at different Colours, if you break but some slender wires of Steel so temper'd, and observe how they differ in brittleness, and if with a file you also make tryal of their various degrees of hardness.

2 But Pyrophilus, I must not at present any further prosecute the Consideration of the importance of Experiments about Colours, not only because you will in the following papers finde some instances, that would here be presented you out of their due place, of the use that may be made of such Experiments, in discovering in divers bodies, what kind the salt is, that is predominant in them; but also because a

speculative Naturalist might justly enough allege, that as Light is so pleasing an object, as to be well worth our looking on, though it discover'd to us nothing but its self; so modifi'd Light called Colour, were worth our contemplation, though by understanding its Nature we should be taught nothing else. And however, I need not make either you or my self excuses for entertaining you on the subject I am now about to treat of, since the pleasure Pyro: takes in mixing and laying on of Colours, will I presume keep him, and will (I am sure) keep mee from thinking it troublesome to set down, especially after the tedious processes (about other matters) wherewith I fear I may have tyr'd him, some easie, and not unpleasant Experiments relating to that subject.

3 But, before we descend to the more particular considerations, we are to present you concerning Colours, I presume it will be seasonable to propose at the very entrance a Distinction; the ignorance or neglect of which, seems to mee to have frequently enough occasioned either mistakes or confusion in the Writings of divers Modern Philosophers; for Colour may be considered, either as it is a quality residing in the body that is said to be coloured, or to modifie the light after such or such a manner; or else as the Light it self, which so modifi'd, strikes upon the organ of sight, and so causes that Sensation which we call Colour; and that this latter may be look'd upon as the more proper, though not the usual acception of the word Colour, will be made probable by divers passages in the insuing part of our discourse; and indeed it is the Light it self, which after a certain manner, either mingled with shades, or some other waies troubled, strikes our eyes, that does more immediately produce that motion in the organ, upon whose account men say they see such or such a Colour in the object; yet, because there is in the body that is said to be coloured, a certain disposition of the superficial particles, whereby it sends the Light reflected, or refracted, to our eyes thus and thus alter'd, and not otherwise, it may also in some sense be said, that Colour depends upon the visible body; and therefore we shall not be against that way of speaking of Colours that is most used among the

Modern Naturalists, provided we be allowed to have recourse when occasion shall require to the premis'd distinction, and to take the more immediate cause of Colour to be the modifi'd Light it self, as it affects the Sensory; though the disposition also of the colour'd body, as that modifies the Light, may be call'd by that name Metonimically (to borrow a School term) or Efficiently, that is in regard of its turning the Light, that rebounds from it, or passes thorow it, into this or that particular Colour.

4 I know not whether I may not on this occasion add, that Colour is so far from being an Inherent quality of the object in the sense that is wont to be declar'd by the Schools, or even in the sense of some Modern Atomists, that, if we consider the matter more attentively, we shall see cause to suspect, if not to conclude, that though Light do more immediately affect the organ of sight, than do the bodies that send it thither, yet Light it self produces the sensation of a Colour, but as it produces such a determinate kind of local motion in some part of the brain; which, though it happen most commonly from the motion whereinto the slender strings of the Retina are put, by the appulse of Light, yet if the like motion happen to be produc'd by any other cause, wherein the Light concurrs not at all, a man shall think he sees the same Colour. For proof of this, I might put you in mind, that 'tis usual for dreaming men to think they see the Images that appear to them in their sleep, adorn'd some with this, and some with that lively Colour, whilst yet, both the curtains of their bed, and those of their eyes are close drawn. And I might add the confidence with which distracted persons do oftentimes, when they are awake, think, they see black fiends in places, where there is no black object in sight without them. But I will rather observe, that not only when a man receives a great stroak upon his eye, or a very great one upon some other part of his head, he is wont to see, as it were, flashes of lightning, and little vivid, but vanishing flames, though perhaps his eyes be shut: But the like apparitions may happen, when the motion proceeds not from something without, but from something within the body, provided the unwonted fumes that

wander up and down in the head, or the propagated concussion of any internal part in the body, do cause about the inward extremities of the Optick Nerve, such a motion as is wont to be there produc'd, when the stroak of the Light upon the Retina makes us conclude, that we see either Light, or such and such a Colour: This the most ingenious Des Cartes hath very well observ'd, but because he seems not to have exemplifi'd it by any unobvious or peculiar observation, I shall indeavour to illustrate this doctrine by a few Instances.

5 And first, I remember, that having, through Gods goodness, been free for several years, from troublesome Coughs, being afterwards, by an accident, suddenly cast into a violent one, I did often, when I was awaked in the night by my distempers, observe, that upon coughing strongly, it would seem to mee, that I saw very vivid, but immediately disappearing flames, which I took particular notice of, because of the conjecture I am now mentioning.

6 An excellent and very discreet person, very near ally'd both to you and mee, was relating to mee, that some time since, whilst she was talking with some other Ladies, upon a sudden, all the objects, she looked upon, appeared to her dyed with unusual Colours, some of one kind, and some of another, but all so bright and vivid, that she should have been as much delighted, as surpriz'd with them, but that finding the apparition to continue, she fear'd it portended some very great alteration as to her health: As indeed the day after she was assaulted with such violence by Hysterical and Hypocondrical Distempers, as both made her rave for some daies, and gave her, during that time, a Bastard Palsey.

7 Being a while since in a Town, where the Plague had made great havock, and inquiring of an ingenious man, that was so bold, as without much scruple to visit those that were sick of it, about the odd symptomes of a Disease that had swept away so many there; he told mee, among other things, that he was able to tell divers Patients, to whom he was called, before they took their beds, or had any evident

symptomes of the Plague, that they were indeed infected upon peculiar observations, that being asked, they would tell him that the neighbouring objects, and particularly his cloths, appear'd to them beautifi'd with most glorious Colours, like those of the Rainbow, oftentimes succeeding one another; and this he affirm'd to be one of the most usual, as well as the most early symptomes, by which this odd Pestilence disclos'd it self: And when I asked how long the Patients were wont to be thus affected, he answered, that it was most commonly for about a day; and when I further inquired whether or no Vomits, which in that Pestilence were usually given, did not remove this symptome (For some used the taking of a Vomit, when they came ashore, to cure themselves of the obstinate and troublesome giddiness caus'd by the motion of the ship) reply'd, that generally, upon the evacuation made by the Vomit, that strange apparition of Colours ceased, though the other symptomes were not so soon abated, yet he added (to take notice of that upon the by, because the observation may perchance do good) that an excellent Physician, in whose company he was wont to visit the sick, did give to almost all those to whom he was called, in the beginning before Nature was much weakened, a pretty odd Vomit consisting of eight or ten dramms of Infusion of Crocus Metallorum, and about half a dramm, or much more, of White Vitriol, with such success, that scarce one of ten to whom it was seasonably administred, miscarried.

8 But to return to the consideration of Colours: As an apparition of them may be produced by motions from within, without the assistance of an outward object, so I have observed, that 'tis sometimes possible that the Colour that would otherwise be produced by an outward object, may be chang'd by some motion, or new texture already produced in the Sensory, as long as that unusual motion, or new disposition lasts; for I have divers times try'd, that after I have through a Telescope look'd upon the Sun, though thorow a thick, red, or blew glass, to make its splendor supportable to the eye, the impression upon the Retina, would be not only so vivid, but so permanent, that if afterwards I turned my eye towards a flame, it would appear to

mee of a Colour very differing from its usual one. And if I did divers times successively shut and open the same eye, I should see the adventitious Colour, (if I may so call it) changed or impair'd by degrees, till at length (for this unusual motion of the eye would not presently cease) the flame would appear to mee, of the same hew that it did to other beholders; a not unlike effect I found by looking upon the Moon, when she was near full, thorow an excellent Telescope, without colour'd Glass to screen my eye with; But that which I desire may be taken notice of, because we may elsewhere have occasion to reflect upon it, and because it seems not agreeable to what Anatomists and Optical Writers deliver, touching the relation of the two eyes to each other, is this circumstance, that though my Right eye, with which I looked thorow the Telescope, were thus affected by the over-strong impression of the light, yet when the flame of a Candle, or some other bright object appear'd to me of a very unusual Colour, whilst look'd upon with the Discompos'd Eye, or (though not so notably) with both eyes at once; yet if I shut that Eye, and looked upon the same object with the other, it would appear with no other than its usual Colour, though if I again opened, and made use of the Dazled eye, the vivid adventitious Colour would again appear. And on this occasion I must not pretermit an Observation which may perswade us, that an over-vehement stroak upon the Sensory, especially if it be naturally of a weak constitution, may make a more lasting impression than one would imagine, which impression may in some cases, as it were, mingle with, and vitiate the action of vivid objects for a long time after.

For I know a Lady of unquestionable Veracity, who having lately, by a desperate fall, receiv'd several hurts, and particularly a considerable one upon a part of her face near her Eye, had her sight so troubl'd and disorder'd, that, as she hath more than once related to me, not only when the next morning one of her servants came to her bed side, to ask how she did, his cloaths appear'd adorn'd with such variety of dazling Colours, that she was fain presently to command him to withdraw, but the Images in her Hangings, did, for many daies after, appear to her, if the Room were

not extraordinarily darken'd, embellish'd with several offensively vivid Colours, which no body else could see in them; And when I enquir'd whether or no White Objects did not appear to her adorn'd with more luminous Colours than others, and whether she saw not some which she could not now well describe to any, whose eyes had never been distemper'd, she answer'd mee, that sometimes she thought she saw Colours so new and glorious, that they were of a peculiar kind, and such as she could not describe by their likeness to any she had beheld either before or since, and that White Objects did so much disorder her sight, that if several daies after her fall, she look'd upon the inside of a Book, she fanci'd she saw there Colours like those of the Rain-bow, and even when she thought her self pretty well recover'd, and made bold to leave her Chamber, the coming into a place where the Walls and Ceeling were whited over, made those Objects appear to her cloath'd with such glorious and dazling Colours, as much offended her sight, and made her repent her venturousness, and she added, that this Distemper of her Eyes lasted no less than five or six weeks, though, since that, she hath been able to read and write much without finding the least Inconvenience in doing so. I would gladly have known, whether if she had shut the Injur'd Eye, the Phænomena would have been the same, when she employ'd only the other, but I heard not of this accident early enough to satisfie that Enquiry.

9 Wherefore, I shall now add, that some years before, a person exceedingly eminent for his profound Skil in almost all kinds of Philological Learning, coming to advise with mee about a Distemper in his Eyes, told me, among other Circumstances of it, that, having upon a time looked too fixedly upon the Sun, thorow a Telescope, without any coloured Glass, to take off from the dazling splendour of the Object, the excess of Light did so strongly affect his Eye, that ever since, when he turns it towards a Window, or any White Object, he fancies, he seeth a Globe of Light, of about the bigness the Sun then appeared of to him, to pass before his Eyes: And having Inquir'd of him, how long he had been troubled with this Indisposition, he

reply'd, that it was already nine or ten years, since the Accident, that occasioned it, first befel him.

I could here subjoyn, Pyrophilus, some memorable Relations that I have met with in the Account given us by the experienc'd Epiphanius Ferdinandus, of the Symptomes he observ'd to be incident to those that are bitten with the Tarantula, by which (Relations) I could probably shew, that without any change in the Object, a change in the Instruments of Vision may for a great while make some Colours appear Charming, and make others Provoking, and both to a high degree, though neither of them produc'd any such Effects before. These things, I say, I could here subjoyn in confirmation of what I have been saying, to shew, that the Disposition of the Organ is of great Importance in the Dijudications we make of Colours, were it not that these strange Stories belonging more properly to another Discourse, I had rather, (contenting my self to have given you an Intimation of them here) that you should meet with them fully deliver'd there.

CHAP. III.

But, Pyrophilus, I would not by all that I have hitherto discours'd, be thought to have forgotten the Distinction (of Colour) that I mentioned to you about the beginning of the third Section of the former Chapter; and therefore, after all I have said of Colour, as it is modifi'd Light, and immediately affects the Sensory, I shall now re-mind you, that I did not deny, but that Colour might in some sense be consider'd as a Quality residing in the body that is said to be Colour'd, and indeed the greatest part of the following Experiments referr to Colour principally under that Notion, for there is in the bodyes we call Colour'd, and chiefly in their Superficial parts, a certain disposition, whereby they do so trouble the Light that comes from them to our Eye, as that it there makes that distinct Impression, upon whose Account we say, that the Seen body is either White or Black, or Red or Yellow, or of any one determinate Colour. But because we shall (God permiting) by the Experiments that are to follow

some Pages hence, more fully and particularly shew, that the Changes, and consequently in divers places the Production and the appearance of Colours depends upon the continuing or alter'd Texture of the Object, we shall in this place intimate (and that too but as by the way) two or three things about this Matter.

2. And first it is not without some Reason, that I ascribe Colour (in the sense formerly explan'd) chiefly to the Superficial parts of Bodies, for not to question how much Opacous Corpuscles may abound even in those Bodies we call Diaphanous, it seems plain that of Opacous bodies we do indeed see little else than the Superficies, for if we found the beams of Light that rebound from the Object to the Eye, to peirce deep into the Colour'd body, we should not judge it Opacous, but either Translucid, or at least Semi-diaphanous, and though the Schools seem to teach us that Colour is a Penetrative Quality, that reaches to the Innermost parts of the Object, as if a piece of Sealing-wax be broken into never so many pieces, the Internal fragments will be as Red as the External surface did appear, yet that is but a Particular Example that will not overthrow the Reason lately offer'd, especially since I can alleage other Examples of a contrary Import, and two or three Negative Instances are sufficient to overthrow the Generality of a Positive Rule, especially if that be built but upon One or a Few Examples. Not (then) to mention Cherries, Plums, and I know not how many other Bodies, wherein the skin is of one Colour, and what it hides of another, I shall name a couple of Instances drawn from the Colours of Durable bodies that are thought far more Homogeneous, and have not parts that are either Organical, or of a Nature approaching thereunto.

3 To give you the first Instance, I shall need but to remind you of what I told you a little after the beginning of this Essay, touching the Blew and Red and Yellow, that may be produc'd upon a piece of temper'd Steel, for these Colours though they be very Vivid, yet if you break the Steel they adorn, they will appear to be but Superficial; not only the innermost parts of the Metall, but those that are within a hairs breadth of the Superficies, having not any of these Colours, but retaining that

of the Steel it self. Besides that, we may as well confirm this Observation, as some other particulars we elsewhere deliver concerning Colours, by the following Experiment which we purposely made.

4 We took a good quantity of clean Lead, and melted it with a strong Fire, and then immediately pouring it out into a clean Vessel of a convenient shape and matter, (we us'd one of Iron, that the great and sudden Heat might not injure it) and then carefully and nimbly taking off the Scum that floated on the top, we perceiv'd, as we expected, the smooth and glossie Surface of the melted matter, to be adorn'd with a very glorious Colour, which being as Transitory as Delightfull, did almost immediately give place to another vivid Colour, and that was as quickly succeeded by a third, and this as it were chas'd away by a fourth, and so these wonderfully vivid Colours successively appear'd and vanish'd, (yet the same now and then appearing the second time) till the Metall ceasing to be hot enough to afford any longer this pleasing Spectacle, the Colours that chanc'd to adorn the Surface, when the Lead thus began to cool, remain'd upon it; but were so Superficial, that how little soever we scrap'd off the Surface of the Lead, we did in such places scrape off all the Colour, and discover only that which is natural to the Metall it self, which receiving its adventitious Colours, only when the heat was very Intense, and in that part which was expos'd to the comparatively very cold Air, (which by other Experiments seems to abound with subtil Saline parts, perhaps not uncapable of working upon Lead so dispos'd:) These things I say, together with my observing that whatever parts of the so strongly melted Lead were expos'd a while to the Air, turn'd into a kind of Scum or Litharge, how bright and clean soever they appear'd before, suggested to me some Thoughts or Ravings, which I have not now time to acquaint You with. One that did not know me, Pyrophilus, would perchance think I endeavour'd to impose upon You by relating this Experiment, which I have several times try'd, but the Reason why the Phænomena mention'd have not been taken notice of, may be, that unless Lead be brought to a much higher degree of Fusion or

Fluidity than is usual, or than is indeed requisite to make it melt, the Phænomena I mention'd will scarce at all disclose themselves; And we have also observ'd that this successive appearing and vanishing of vivid Colours, was wont to be impair'd or determin'd whilst the Metal expos'd to the Air remain'd yet hotter than one would readily suspect. And one thing I must further Note, of which I leave You to search after the Reason, namely, that the same Colours did not always and regularly succeed one another, as is usually in Steel, but in the diversify'd Order mention'd in this following Note, which I was scarce able to write down, the succession of the Colours was so very quick, whether that proceeded from the differing degrees of Heat in the Lead expos'd to the cool Air, or from some other Reason, I leave you to examine.

[Blew, Yellow, Purple, Blew; Green, Purple, Blew, Yellow, Red; Purple, Blew, Yellow and Blew, Yellow, Blew, Purple, Green mixt, Yellow, Red, Blew, Green, Yellow, Red, Purple, Green.]

5. The Atomists of Old, and some Learned men of late, have attempted to explicate the variety of Colours in Opacous bodies from the various Figures of their Superficial parts; the attempt is Ingenious, and the Doctrine seems partly True, but I confess I think there are divers other things that must be taken in as concurrent to produce those differing forms of Asperity, whereon the Colours of Opacous bodies seem to depend. To declare this a little, we must assume, that the Surfaces of all such Bodies how Smooth or polite soever they may appear to our Dull Sight and Touch, are exactly smooth only in a popular, or at most in a Physical sense, but not in a strict and rigid sense.

6. This, excellent Microscopes shew us in many Bodies, that seem Smooth to our naked Eyes; and this not only as to the little Hillocks or Protuberancies that swell above that which may be conceiv'd to be the Plain or Level of the consider'd Surface, for it is obvious enough to those that are any thing conversant with such

Glasses, but as to numerous Depressions beneath that Level, of which sort of Cavities by the help of a Microscope, which the greatest Artificer that makes them, judges to be the greatest Magnifying Glass in Europe, except one that equals it, we have on the Surface of a thin piece of Cork that appear'd smooth to the Eye, observ'd about sixty in a Row, within the length of less then an 31 and 32 part of an Inch, (for the Glass takes in no longer a space at one view) and these Cavities (which made that little piece of Cork look almost like an empty Honey-comb) were not only very distinct, and figur'd like one another, but of a considerable bigness, and a scarce credible depth; insomuch that their distinct shadows as well as sides were plainly discern'd and easiy to be reckon'd, and might have been well distinguish'd, though they had been ten times lesser than they were; which I thought it not amiss to mention to you Pyrophilus upon the by, that you may thence make some Estimate, what a strange Inequality, and what a multitude of little Shades, there may really be, in a scarce sensible part of the Physical superficies, though the naked Eye sees no such matter. And as Excellent Microscopes shew us this Ruggedness in many Bodies that pass for Smooth, so there are divers Experiments, though we must not now stay to urge them, which seem to perswade us of the same thing as to the rest of such Bodies as we are now treating off; So, that there is no sensible part of an Opacous body, that may not be conceiv'd to be made up of a multitude of singly insensible Corpuscles, but in the giving these surfaces that disposition, which makes them alter the Light that reflects thence to the Eye after the manner requisite to make the Object appear Green, Blew, &c. the Figures of these Particles have a great, but not the only stroak. 'Tis true indeed that the protuberant Particles may be of very great variety of Figures, Sphærical, Elliptical, Conical, Cylindrical, Polyedrical, and some very irregular, and that according to the Nature of these, and the situation of the Lucid body, the Light must be variously affected, after one manner from Surfaces (I now speak of Physical Surfaces) consisting of Sphaerical, and in another from those that are made up of Conical or Cylindrical Corpuscles; some being fitted

to reflect more of the incident Beams of Light, others less, and some towards one part, others towards another. But besides this difference of Shape, there may be divers other things that may eminently concurr to vary the forms of Asperity that Colours so much depend on. For, willingly allowing the Figure of the Particles in the first place, I consider secondly, that the superficial Corpuscles, if I may so call them, may be bigger in one Body, and less in another, and consequently fitted to allay the Light falling on them with greater shades. Next, the protuberant Particles may be set more or less close together, that is, there may be a greater or a smaller number of them within the compass of one, than within the compass of another small part of the Surface of the same Extent, and how much these Qualities may serve to produce Colour may be somewhat guess'd at, by that which happens in the Agitation of Water; for if the Bubbles that are thereby made be Great, and but Few, the Water will scarce acquire a sensible Colour, but if it be reduc'd to a Froth, consisting of Bubbles, which being very Minute and Contiguous to each other, are a multitude of them crowded into a narrow Room, the Water (turned to Froth) does then exhibit a very manifest White Colour,3 (to which these last nam'd Conditions of the Bubbles do as well as their Convex figure contribute) and that for Reasons to be mention'd anon. Besides, it is not necessary that the Superficial particles that exhibit one Colour, should be all of them Round, or all Conical, or all of any one Shape, but Corpuscles of differing Figures may be mingled on the Surface of the Opacous Body, as when the Corpuscles that make a Blew colour, and those that make a Yellow, come to be Accurately and Skilfully mix'd, they make up a Green, which though it seem one simple Colour, yet in this case appears to be made by Corpuscles of very differing Kinds, duely commix'd. Moreover the Figure and Bigness of the little Depressions, Cavities, Furrows or Pores intercepted betwixt these protuberant Corpuscles, are as well to be consider'd as the Sizes and Shapes of the Corpuscles themselves: For we may conceive the Physical superficies of a Body, where (as we said) its Colour does as it were reside, to be cut Transversly by a Mathematical

plain, which you know is conceiv'd to be without any Depth or Thickness at all, and then as some parts of the Physical Superficies will be Protuberant; or swell above this last plain, so others may be depress'd beneath it; as (to explane my self by a gross Comparison) in divers places of the Surface of the Earth, there are not only Neighbouring Hills, Trees, &c. that are rais'd above the Horizontal Level of the Valley, but Rivers, Wells, Pits and other Cavities that are depress'd beneath it, and that such Protuberant and Concave parts of a Surface may remit the Light so differingly, as much to vary a Colour, some examples and other things, that we shall hereafter have occasion to take notice off in this Tract, will sufficiently declare, till when, it may suffice to put you in mind, that of two Flat-sides of the same piece of, for example, red Marble, the one being diligently Polished, and the other left to its former Roughness, the differing degrees or sorts of Asperity, for the side that is smooth to the Touch wants not its Roughness, will so diversifie the Light reflected from the several Plains to the Eye, that a Painter would employ two differing Colours to represent them.

7. And I hope, Pyrophilus, you will not think it strange or impertinent, that I employ in divers passages of these Papers, examples drawn from Bodies and Shadows far more Gross, than those minute Protuberances and shady Pores on which in most cases the Colour of a Body as 'tis an Inherent Quality or Disposition of its Surface, seems to depend. For sometimes I employ such Examples, rather to declare my Meaning, than prove my Conjecture; things, whom their Smallness makes Insensible, being better represented to the Imagination by such familiar Objects, as being like them enough in other respects, are of a Visible bulk. And next, though the Beams of Light are such subtil Bodies, that in respect of them, even Surfaces that are sensibly Smooth, are not exactly so, but have their own degree of Roughness, consisting of little Protuberances and Depressions; and though consequently such Inequalities may suffice to give Bodies differing Colours, as we see in Marble that appears White or Black, or Red or Blew, even when the most carefully Polish'd, yet

'tis plain by the late Instance of Red Marble, and many others, that even bigger Protuberances and greater Shades may likewise so Diversifie the Roughness of a Bodies Superficies, as manifestly to concurr to the varying of its Colour, whereby such Examples appear to be proper enough to be employ'd in such a Subject as we have now in hand. And having hinted thus much on this Occasion, I now proceed.

8. The Situation also of the Superficial particles is considerable, which I distinguish into the Posture of the single Corpuscles, in respect of the Light, and of the Eye, and the Order of them in reference also to one another; for a Body may otherwise reflect the Light, when its Superficial particles are more erected upon the Plain that may be conceiv'd to pass along their Basis, and when the Points or Extremes of such Particles are Obverted to the Eye, than when those Particles are so Inclin'd, that their Sides are in great part Discernable, as the Colour of Plush or Velvet will appear Vary'd to you, if you carefully stroak part of it one way, and part of it another, the posture of the particular Thrids, in reference to the Light, or the Eye, becoming thereby different. And you may observe in a Field of ripe Corn blown upon by the Wind, that there will appear as it were Waves of a Colour (at least Gradually) differing from that of the rest of the Field, the Wind by Depressing some of the Ears, and not at the same time others, making the one Reflect more from the Lateral and Strawy parts, than do the rest. And so, when Doggs are so angry, as to Erect the Hairs upon their Necks, and upon some other parts of their Bodies, those Parts seem to acquire a Colour vary'd from that which the same Hairs made, when in their usual Posture they did farr more stoop. And that the Order wherein the Superficial Corpuscles are Rang'd is not to be neglected, we may guess by turning of Water into Froth, the beating of Glass, and the scraping of Horns, in which cases the Corpuscles that were before so marshall'd as to be Perspicuous, do by the troubling of that Order become Dispos'd to terminate and reflect more Light, and thereby to appear Whitish. And there are other ways in which the Order of the Protuberant parts, in reference to the Eye, may much contribute to the appearing of a particular Colour, for I have

often observ'd, that when Pease are Planted, or Set in Parallel Lines, and are Shot up about half a Foot above the Surface of the Ground, by looking on the Field or Plot of Ground from that part towards which the Parallel Lines tended, the greater part of the Ground by farr would appear of its own dirty Colour, but if I look'd upon it Transversly, the Plot would appear very Green, the upper parts of the Pease hindering the intercepted parts of the Ground, which as I said retain'd their wonted Colour, from being discover'd by the Eye. And I know not, Pyrophilus, whether I might not add, that even the Motion of the Small Parts of a Visible Object may in some cases contribute, though it be not so easie to say how, to the Producing or the Varying of a Colour; for I have several times made a Liquor, which when it has well settled in a close Vial, is Transparent and Colourless, but as soon as the Glass is unstopp'd, begins to fly away very plentifully in a White and Opacous fume; and there are other Bodies, whose Fumes, when they fill a Receiver, would make one suspect it contains Milk, and yet when these Fumes settle into a Liquor, that Liquor is not White, but Transparent; And such White Fumes I have seen afforded by unstopping a Liquor I know, which yet is it self Diaphanous and Red; Nor are these the only Instances of this Kind, that our Tryals can supply us with. And if the Superficial Corpuscles be of the Grosser sort, and be so Framed, that their differing Sides or Faces may exhibit differing Colours, then the Motion or Rest of those Corpuscles may be considerable, as to the Colour of the Superficies they compose, upon this account, that sometimes more, sometimes fewer of the Sides dispos'd to exhibit such a Colour may by this means become or continue more Obverted to the Eye than the rest, and compose a Physical Surface, that will be more or less sensibly interrupted; As, to explane my meaning, by proposing a gross Example, I remember, that in some sorts of Leavy Plants thick set by one another, the two sides of whose Leaves were of somewhat differing Colours, there would be a notable Disparity as to Colour, if you look'd upon them both when the Leaves being at Rest had their upper and commonly expos'd sides Obverted to the Eye, and when a breath of Wind

passing thorow them, made great Numbers of the usually Hidden sides of the Leaves become conspicuous. And though the Little Bodies, we were lately speaking of, may Singly and Apart seem almost Colourless, yet when Many of them are plac'd by one another, so near, that the Eye does not easily discern an Interruption, within a sensible space, they may exhibit a Colour; as we see, that though a Slenderest Thrid of Dy'd Silk do's, whilst look'd on Single, seem almost quite Devoyd of Redness, (for instance) yet when numbers of these Thrids are brought together into one Skein, their Colour becomes notorious.

9. But the same Occasion that invited me to say what I have mention'd concerning the Leaves of Trees, invites me also to give you some account of what happens in Changeable Taffities, where we see differing Colours, as it were, Emerge and Vanish upon the Ruffling of the same piece of Silk: As I have divers times with Pleasure observ'd, by the help of such a Microscope, as, though it do not very much Magnifie the Object, has in recompence this great Conveniency, that you may easily, as fast as you please, remove it from one part to another of a Large Object, of which the Glass taking a great part at once, you may thereby presently Survey the Whole. Now by the help of such a Microscope I could easily (as I began to say) discern, that in a piece of Changeable Taffity, (that appear'd, for Instance, sometimes Red, and sometimes Green) the Stuff was compos'd of Red thrids and Green, passing under and over each other, and crossing one another in almost innumerable points; and if I look'd through the Glass upon any considerable portion of the Stuff, that (for example sake) to the naked Eye appear'd to be Red, I could plainly see, that in that Position, the Red thrids were Conspicuous, and reflected a vivid Light; and though I could also perceive, that there were Green ones, yet by reason of their disadvantagious Position in the Physical Surface of the Taffity, they were in part hid by the more Protuberant Thrids of the other Colour; and for the same cause, the Reflection from as much of the Green as was discover'd, was comparatively but Dim and Faint. And if, on the contrary, I look'd through the Microscope upon any part

that appear'd Green, I could plainly see that the Red thrids were less fully expos'd to the Eye, and obscur'd by the Green ones, which therefore made up the Predominant Colour. And by observing the Texture of the Silken Stuff, I could easisy so expose the Thrids either of the one Colour or of the other to my Eye, as at pleasure to exhibit an apparition of Red or Green, or make those Colours succeed one another: So that, when I observ'd their Succession by the help of the Glass, I could mark how the Predominant Colour did as it were start out, when the Thrids that exhibited it came to be advanagiously plac'd; And by making little Folds in the Stuff after a certain manner, the Sides that met and terminated in those Folds, would appear to the naked Eye, one of them Red, and the other Green. When Thrids of more than two differing Colours chance to be Interwoven, the resulting changeableness of the Taffity may be also somewhat different. But I choose to give an Instance in the Stuff I have been speaking off, because the mixture being more Simple, the way whereby the Changeableness is produc'd, may be the more easily apprehended: and though Reason alone might readily enough lead a considering Man to guess at the Explication, in case he knew how Changeable Taffities are made: yet I thought it not impertinent to mention it, because both Scholars and Gentlemen are wont to look upon the Inquiry into Manufactures, as a Mechanick imployment, and consequently below Them; and because also with such a Microscope as I have been mentioning, the discovery is as well Pleasant as Satisfactory, and may afford Hints of the Solution of other Phænomena of Colours. And it were not amiss, that some diligent Inquiry were made, whether the Microscope would give us an account of the Variableness of Colour, that is so Conspicuous and so Delightfull in Mother of Pearl, in Opalls, and some other resembling Bodies: For though I remember I did formerly attempt something of that Kind (fruitlesly enough) upon Mother of Pearl, yet not having then the advantage of my best Microscope, nor some Conveniences that might have been wish'd, I leave it to you, who have better Eyes, to try what you can do further; since 'twill be Some discovery to find, that, in this case, the best Eyes

and Microscopes themselves can make None.

10. I confess, Pyrophilus, that a great part of what I have deliver'd, (or propos'd rather) concerning the differing forms of Asperity in Bodies, by which Differences the incident Light either comes to be Reflected with more or less of Shade, and with that Shade more or less Interrupted, or else happens to be also otherwise Modify'd or Troubl'd, is but Conjectural. But I am not sure, that if it were not for the Dullness of our Senses, either these or some other Notions of Kin to them, might be better Countenanc'd; for I am apt to suspect, that if we were Sharp sighted enough, or had such perfect Microscopes, as I fear are more to be wish'd than hop'd for, our promoted Sense might discern in the Physical Surfaces of Bodies, both a great many latent Ruggidnesses, and the particular Sizes, Shapes, and Situations of the extremely little Bodies that cause them, and perhaps might perceive among other Varieties that we now can but imagine, how those little Protuberances and Cavities do Interrupt and Dilate the Light, by mingling with it a multitude of little and singly undiscernable Shades, though some of them more, and some of them less Minute, some less, and some more Numerous; according to the Nature and Degree of the particular Colour we attribute to the Visible Object; as we see, that in the Moon we can with Excellent Telescopes discern many Hills and Vallies, and as it were Pits and other Parts, whereof some are more, and some less Vividly illustrated, and others have a fainter, others a deeper Shade, though the naked Eye can discern no such matter in that Planet. And with an Excellent Microscope, where the Naked Eye did see but a Green powder, the Assisted Eye as we noted above, could discern particular Granules, some of them of a Blew, and some of them of a Yellow colour, which Corpuscles we had beforehand caus'd to be exquisitly mix'd to compound the Green.

11. And, Pyrophilus, that you may not think me altogether extravagant in what I have said of the Possibility, (for I speak of no more) of discerning the differing forms of Asperity in the Surfaces of Bodies of several Colours, I'l here set down a

Memorable particular that chanc'd to come to my Knowledge, since I writ a good part of this Essay; and it is this. Meeting casually the other Day with the deservedly Famous4 Dr. J. Finch, Extraordinary Anatomist to that Great Patron of the Virtuosi, the now Great Duke of Toscany, and enquiring of this Ingenious Person, what might be the chief Rarity he had seen in his late return out of Italy into England, he told me, it was a Man at Maestricht in the Low-Countrys, who at certain times can discern and distinguish Colours by the Touch with his Fingers. You'l easily Conclude, that this is farr more strange, than what I propos'd but as not Impossible; since the Sense of the Retina seeming to be much more Tender and quick than that of those Grosser Filaments, Nerves or Membranes of our Fingers, wherewith we use to handle Gross and Hard Bodies, it seems scarce credible, that any Accustomance, or Diet, or peculiarity of Constitution, should enable a Man to distinguish with such Gross and Unsuitable Organs, such Nice and Subtile Differences as those of the forms of Asperity, that belong to differing Colours, to receive whose Languid and Delicate Impressions by the Intervention of Light, Nature seems to have appointed and contexed into the Retina the tender and delicate Pith of the Optick Nerve. Wherefore I confess, I propos'd divers Scruples, and particularly whether the Doctor had taken care to bind a Napkin or Hankerchief over his Eyes so carefully, as to be sure he could make no use of his Sight, though he had but Counterfeited the want of it, to which I added divers other Questions, to satisfie my Self, whether there were any Likelihood of Collusion or other Tricks. But I found that the Judicious Doctor having gone farr out of his way, purposely to satisfie Himself and his Learned Prince about this Wonder, had been very Watchfull and Circumspect to keep Himself from being Impos'd upon. And that he might not through any mistake in point of Memory mis-inform Me, he did me the Favour at my Request, to look out the Notes he had Written for his Own and his Princes Information, the summ of which Memorials, as far as we shall mention them here, was this, That the Doctor having been inform'd at Utrecht, that there Lived one at some Miles distance from

Maestricht, who could distinguish Colours by the Touch, when he came to the last nam'd Town, he sent a Messenger for him, and having Examin'd him, was told upon Enquiry these Particulars:

That the Man's name was John Vermaasen, at that time about 33 Years of Age; that when he was but two years Old, he had the Small Pox, which rendred him absolutely Blind: That at this present he is an Organist, and serves that Office in a publick Quire.

That the Doctor discoursing with him over Night, the Blind man affirm'd, that he could distinguish Colours by the Touch, but that he could not do it, unless he were Fasting; Any quantity of Drink taking from him that Exquisitness of Touch, which is requisite to so Nice a Sensation.

That hereupon the Doctor provided against the next Morning seven pieces of Ribbon, of these seven Colours, Black, White, Red, Blew, Green, Yellow, and Gray, but as for mingled Colours, this Vermaasen would not undertake to discern them, though if offer'd, he would tell that they were Mix'd.

That to discern the Colour of the Ribbon, he places it betwixt the Thumb and the Fore-finger, but his most exquisite perception was in his Thumb, and much better in the right Thumb than in the left.

That after the Blind man had four or five times told the Doctor the several Colours, (though Blinded with a Napkin for fear he might have some Sight) the Doctor found he was twice mistaken, for he call'd the White Black, and the Red Blew, but still, he, before his Errour, would lay them by in Pairs, saying, that though he could easily distinguish them from all others, yet those two Pairs were not easily distinguish'd amongst themselves, whereupon the Doctor desir'd to be told by him what kind of Discrimination he had of Colours by his Touch, to which he gave a reply, for whose sake chiefly I insert all this Narrative in this place, namely, That all the difference was more or less Asperity, for says he, (I give you the Doctor's own words) Black

feels as if you were feeling Needles points, or some harsh Sand, and Red feels very Smooth.

That the Doctor having desir'd him to tell in Order the difference of Colours to his Touch, he did as follows;

Black and White are the most asperous or unequal of all Colours, and so like, that 'tis very hard to distinguish them, but Black is the most Rough of the two, Green is next in Asperity, Gray next to Green in Asperity, Yellow is the fifth in degree of Asperity, Red and Blew are so like, that they are as hard to distinguish as Black and White, but Red is somewhat more Asperous than Blew, so that Red has the sixth place, and Blew the seventh in Asperity.

12. To these Informations the Obliging Doctor was pleas'd to add the welcome present of three of those very pieces of Ribbon, whose Colours in his presence the Blind man had distinguished, pronouncing the one Gray, the other Red, and the third Green, which I keep by me as Rarities, and the rather, because he fear'd the rest were miscarry'd.

13. Before I saw the Notes that afforded me the precedent Narrative, I confess I suspected this man might have thus discriminated Colours, rather by the Smell than by the Touch; for some of the Ingredients imployed by Dyers to Colour things, have Sents, that are not so Languid, nor so near of Kin, but that I thought it not impossible that a very Critical Nose might distinguish them, and this I the rather suspected, because he requir'd, that the Ribbons, whose Colours he was to Name, should be offer'd him Fasting in the morning; for I have observ'd in Setting Doggs, that the feeding of them (especially with some sorts of Aliments) does very much impair the exquisite sent of their Noses. And though some of the foregoing particulars would have prevented that Conjecture, yet I confess to you (Pyrophilus) that I would gladly have had the Opportunity of Examining this Man my self, and of Questioning him about divers particulars which I do not find to have been yet thought upon. And

though it be not incredible to me, that since the Liquors that Dyers imploy to tinge, are qualifi'd to do so by multitudes of little Corpuscles of the Pigment or Dying stuff, which are dissolved and extracted by the Liquor, and swim to and fro in it, those Corpuscles of Colour (as the Atomists call them) insinuating themselves into, and filling all the Pores of the Body to be Dyed, may Asperate its Superficies more or less according to the Bigness and Texture of the Corpuscles of the Pigment; yet I can scarce believe, that our Blind man could distinguish all the Colours he did, meerly by the Ribbons having more or less of Asperity, so that I cannot but think, notwithstanding this History, that the Blind man distinguish'd Colours not only by the Degrees of Asperity in the Bodies offer'd to him, but by Forms of it, though this (latter) would perhaps have been very difficult for him to make an Intelligible mention of, because those Minute disparities having not been taken notice of by men for want of touch as Exquisite as our Blind Mans, are things he could not have Intelligibly express'd, which will easily seem Probable, if you consider, that under the name of Sharp, and Sweet, and Sour, there are abundance of, as it were, immediate peculiar Relishes or Tasts in differing sorts of Wine, which though Critical and Experienc'd Palats can easily discern themselves cannot make them be understood by others, such Minute differences not having hitherto any Distinct names assign'd them. And it seems that there was somthing in the Forms of Asperity that was requisite to the Distinction of Colours, besides the Degree of it, since he found it so difficult to distingush Black and White from one another, though not from other Colours. For I might urge, that he seems not consonant to himself about the Red, which as you have seen in one place, he represents as somewhat more Asperous than the Blew; and in another, very Smooth: But because he speaks of this Smoothness in that place, where he mentions the Roughness of Black, we may favourably presume that he might mean but a comparative Smoothness; and therefore I shall not Insist on this, but rather Countenance my Conjecture by this, that he found it so Difficult, not only, to Discriminate Red and Blew, (though the

first of our promiscuous Experiments will inform you, that the Red reflects by great Odds more Light than the other) but also to distinguish Black and White from one another, though not from other Colours. And indeed, though in the Ribbonds that were offer'd him, they might be almost equally Rough, yet in such slender Corpuscles as those of Colour, there may easily enough be Conceiv'd, not only a greater Closeness of Parts, or else Paucity of Protuberant Corpuscles, and the little extant Particles may be otherwise Figur'd, and Rang'd in the White than in the Black, but the Cavities may be much Deeper in the one than the other.

14. And perhaps, (Pyrophilus) it may prove some Illustration of what I mean, and help you to conceive how this may be, if I Represent, that where the Particles are so exceeding Slender, we may allow the Parts expos'd to the Sight and Touch to be a little Convex in comparison of the Erected Particle of Black Bodies, as if there were Wyres I know not how many times Slenderer than a Hair: whether you suppose them to be Figur'd like Needles, or Cylindrically, like the Hairs of a Brush, with Hemisphærical (or at least Convex) Tops, they will be so very Slender, and consequently the Points both of the one sort and the other so very Sharp, that even an exquisite Touch will be able to distinguish no greater Difference between them, than that which our Blind man allow'd, when comparing Black and White Bodies, he said, that the latter was the less Rough of the two. Nor is every Kind of Roughness, though Sensible enough, Inconsistent with Whiteness, there being Cases, wherein the Physical Superficies of a Body is made by the same Operation both Rough and white, as when the Level Surface of clear Water being by agitation Asperated with a multitude of Unequal Bubbles, do's thereby acquire a Whiteness; and as a Smooth piece of Glass, by being Scratch'd with a Diamond, do's in the Asperated part of its Surface disclose the same Colour. But more (perchance) of this elsewhere.

15. And therefore, we shall here pass by the Question, whether any thing might be consider'd about the Opacity of the Corpuscles of Black Pigments, and the Comparative Diaphaneity of those of many White Bodies, apply'd to our present

Case; and proceed, to represent, That the newly mention'd Exiguity and Shape of the extant Particles being suppos'd, it will then be considerable what we lately but Hinted, (and therefore must now somewhat Explane) That the Depth of the little Cavities, intercepted between the extant Particles, without being so much greater in Black Bodies than in White ones, as to be perceptibly so to the Gross Organs of Touch, may be very much greater in reference to their Disposition of Reflecting the imaginary subtile Beams of Light. For in Black Bodies, those Little intercepted Cavities, and other Depressions, may be so Figur'd, so Narrow and so Deep, that the incident Beams of Light, which the more extant Parts of the Physical Superficies are dispos'd to Reflect inwards, may be Detain'd there, and prove unable to Emerge; whilst in a White Body, the Slender Particles may not only by their Figure be fitted to Reflect the Light copiously outwards, but the intercepted Cavities being not Deep, nor perhaps very Narrow, the Bottoms of them may be so Constituted, as to be fit to Reflect outwards much of the Light that falls even upon Them; as you may possibly better apprehend, when we shall come to treat of Whiteness and Blackness. In the mean time it may suffice, that you take Notice with me, that the Blind mans Relations import no necessity of Concluding, that, though, because, according to the Judgment of his Touch, Black was the Roughest, as it is the Darkest of Colours, therefore White, which (according to us) is the Lightest, should be also the Smoothest: since I observe, that he makes Yellow to be two Degrees more Asperous than Blew, and as much less Asperous than Green; whereas indeed, Yellow do's not only appear to the Eye a Lighter Colour than Blew, but (by our first Experiment hereafter to be mention'd) it will appear, that Yellow reflected much more Light than Blew, and manifestly more than Green, (which we need not much wonder at, since in this Colour and the two others (Blew and Yellow) 'tis not only the Reflected Light that is to be considered, since to produce both these, Refraction seems to Intervene, which by its Varieties may much alter the Case:) which both seems to strengthen the Conjecture I was formerly proposing, that there was something else in the Kinds of

Asperity, as well as in the Degrees of it, which enabled our Blind man to Discriminate Colours, and do's at least show, that we cannot in all Cases from the bare Difference in the Degrees of Asperity betwixt Colours, safely conclude, that the Rougher of any two always Reflects the least Light.

16. But this notwithstanding, (Pyrophilus) and what ever Curiosity I may have had to move some Questions to our Sagacious Blind man, yet thus much I think you will admit us to have gain'd by his Testimony, that since many Colours may be felt with the Circumstances above related, the Surfaces of such Coloured Bodies must certainly have differing Degrees, and in all probability have differing Forms or Kinds of Asperity belonging to them, which is all the Use that my present attempt obliges me to make of the History above deliver'd, that being sufficient to prove, that Colour do's much depend upon the Disposition of the Superficial parts of Bodies, and to shew in general, wherein 'tis probable that such a Disposition do's (principally at least) consist.

17. But to return to what I was saying before I began to make mention of our Blind Organist, what we have deliver'd touching the causes of the several Forms or Asperity that may Diversifie the Surfaces of Colour'd Bodies, may perchance somewhat assist us to make some Conjectures in the general, at several of the ways whereby 'tis possible for the Experiments hereafter to be mention'd, to produce the suddain changes of Colours that are wont to be Consequent upon them; for most of these Phænomena being produc'd by the Intervention of Liquors, and these for the most part abounding with very Minute, Active, and Variously Figur'd Saline Corpuscles, Liquors so Qualify'd may well enough very Nimbly after the Texture of the Body they are imploy'd to Work upon, and so may change the form of Asperity, and thereby make them Remit to the Eye the Light that falls on them, after another manner than they did before, and by that means Vary the Colour, so farr forth as it depends upon the Texture or Disposition of the Seen Parts of the Object, which I say, Pyrophilus, that you may not think I would absolutely exclude all other ways of

Modifying the Beams of Light between their Parting from the Lucid Body, and their Reception into the common Sensory.

18. Now there seem to me divers ways, by which we may conceive that Liquors may Nimbly alter the Colour of one another, and of other Bodies, upon which they Act, but my present haste will allow me to mention but some of them, without Insisting so much as upon those I shall name.

19. And first, the Minute Corpuscles that compose a Liquor may early insinuate themselves into those Pores of Bodies, whereto their Size and Figure makes them Congruous, and these Pores they may either exactly Fill, or but Inadequately, and in this latter Case they will for the most part alter the Number and Figure, and always the Bigness of the former Pores. And in what capacity soever these Corpuscles of a Liquor come to be Lodg'd or Harbour'd in the Pores that admit them, the Surface of the Body will for the most part have its Asperity alter'd, and the Incident Light that meets with a Grosser Liquor in the little Cavities that before contain'd nothing but Air, or some yet Subtiler Fluid, will have its Beams either Refracted, or Imbib'd, or else Reflected more or less Interruptedly, than they would be, if the Body had been Unmoistned, as we see, that even fair Water falling on white Paper, or Linnen, and divers other Bodies apt to soak it in, will for some such Reasons as those newly mention'd, immediately alter the Colour of them, and for the most part make it Sadder than that of the Unwetted Parts of the same Bodies. And so you may see, that when in the Summer the High-ways are Dry and Dusty, if there falls store of Rain, they will quickly appear of a much Darker Colour than they did before, and if a Drop of Oyl be let fall upon a Sheet of White Paper, that part of it, which by the Imbibition of the Liquor acquires a greater Continuity, and some Transparency, will appear much Darker than the rest, many of the Incident Beams of Light being now Transmitted, that otherwise would be Reflected towards the Beholders Eyes.

20. Secondly, A Liquor may alter the Colour of a Body by freeing it from those

things that hindred it from appearing in its Genuine Colour; and though this may be said to be rather a Restauration of a Body to its own Colour, or a Retection of its native Colour, than a Change, yet still there Intervenes in it a change of the Colour which the Body appear'd to be of before this Operation. And such a change a Liquor may work, either by Dissolving, or Corroding, or by some such way of carrying off that Matter, which either Veil'd or Disguis'd the Colour that afterwards appears. Thus we restore Old pieces of Dirty Gold to a clean and nitid Yellow, by putting them into the Fire, and into Aqua-fortis, which take off the adventitious Filth that made that pure Metall look of a Dirty Colour. And there is also an easie way to restore Silver Coyns to their due Lustre, by fetching off that which Discolour'd them. And I know a Chymical Liquor, which I employ'd to restore pieces of Cloath spotted with Grease to their proper Colour, by Imbibing the Spotted part with this Liquor, which Incorporating with the Grease, and yet being of a very Volatile Nature, does easily carry it away with it Self. And I have sometimes try'd, that by Rubbing upon a good Touch-stone a certain Metalline mixture so Compounded, that the Impression it left upon the Stone appear'd of a very differing Colour from that of Gold, yet a little of Aqua-fortis would in a Trice make the Golden Colour disclose it self, by Dissolving the other Metalline Corpuscles that conceal'd those of the Gold, which you know that Menstruum will leave Untouch'd.

21. Thirdly, A Liquor may alter the Colour of a Body by making a Comminution of its Parts, and that principally two ways, the first by Disjoyning and Dissipating those Clusters of Particles, if I may so call them, which stuck more Loosely together, being fastned only by some more easily Dissoluble Ciment, which seems to be the Case of some of the following Experiments, where you'l find the Colour of many Corpuscles brought to cohere by having been Precipitated together, Destroy'd by the Affusion of very peircing and incisive Liquors. The other of the two ways I was speaking of, is, by Dividing the Grosser and more Solid Particles into Minute ones, which will be always Lesser, and for the most part otherwise Shap'd than the Entire

Corpuscle so Divided, as it will happen in a piece of Wood reduc'd into Splinters or Chips, or as when a piece of Chrystal heated red Hot and quench'd in Cold water is crack'd into a multitude of little Fragments, which though they fall not asunder, alter the Disposition of the Body of the Chrystal, as to its manner of Reflecting the Light, as we shall have Occasion to shew hereafter.

22. There is a fourth way contrary to the third, whereby a Liquor may change the Colour of another Body, especially of another Fluid, and that is, by procuring the Coalition of several Particles that before lay too Scatter'd and Dispers'd to exhibit the Colour that afterwards appears. Thus sometimes when I have had a Solution of Gold so Dilated, that I doubted whether the Liquor had really Imbib'd any true Gold or no, by pouring in a little Mercury, I have been quickly able to satisfie my Self, that the Liquor contain'd Gold, that Mettall after a little while Cloathing the Surface of the Quick-silver, with a Thin Film of its own Livery. And chiefly, though not only by this way of bringing the Minute parts of Bodies together in such Numbers as to make them become Notorious to the Eye, many of these Colours seem to be Generated which are produc'd by Precipitations, especially by such as are wont to be made with fair Water, as when Resinous Gumms dissolv'd in Spirit of Wine, are let fall again, if the Spirit be Copiously diluted with that weakning Liquor. And so out of the Rectify'd and Transparent Butter of Antimony, by the bare Mixture of fair Water, there will be plentifully Precipitated that Milk-white Substance, which by having its Looser Salts well wash'd off, is turn'd into that Medicine, which Vulgar Chymists are pleas'd to call Mercurius Vitæ.

23. A fifth way, by which a Liquor may change the Colour of a Body, is, by Dislocating the Parts, and putting them out of their former Order into another, and perhaps also altering the Posture of the single Corpuscles as well as their Order or Situation in respect of one another. What certain Kinds of Commotion or Dislocation of the Parts of a Body may do towards the Changing its Colour, is not only evident in the Mutations of Colour observable in Quick-silver, and some other

Concretes long kept by Chymists in a Convenient Heat, though in close Vessels, but in the Obvious Degenerations of Colour, which every Body may take notice of in Bruis'd Cherries, and other Fruit, by comparing after a while the Colour of the Injur'd with that of the Sound part of the same Fruit. And that also such Liquors, as we have been speaking of, may greatly Discompose the Textures of many Bodies, and thereby alter the Disposition of their Superficial parts, the great Commotion made in Metalls, and several other Bodies by Aqua-fortis, Oyl of Vitriol, and other Saline Menstruums, may easily perswade us, and what such Vary'd Situations of Parts may do towards the Diversifying of the manner of their Reflecting the Light, may be Guess'd in some Measure by the Beating of Transparent Glass into a White Powder, but farr better by the Experiments lately Pointed at, and hereafter Deliver'd, as the Producing and Destroying Colours by the means of subtil Saline Liquors, by whose Affusion the Parts of other Liquors are manifestly both Agitated, and likewise Dispos'd after another manner than they were before such Affusion. And in some Chymical Oyls, as particularly that of Lemmon Pills, by barely Shaking the Glass, that holds it, into Bubbles, that Transposition of the Parts which is consequent to the Shaking, will shew you on the Surfaces of the Bubbles exceeding Orient and Lively Colours, which when the Bubbles relapse into the rest of the Oyl, do immediately Vanish.

24. I know not, Pyrophilus, whether I should mention as a Distinct way, because it is of a somewhat more General Nature, that Power, whereby a Liquor may alter the Colour of another Body, by putting the Parts of it into Motion; For though possibly the Motion so produc'd, does, as such, seldome suddenly change the Colour of the Body whose Parts are Agitated, yet this seems to be one of the most General, however not Immediate causes of the Quick change of Colours in Bodies. For the Parts being put into Motion by the adventitious Liquor, divers of them that were before United, may become thereby Disjoyn'd, and when that Motion ceases or decays others of them may stick together, and that in a new Order, by which means

the Motion may sometimes produce Permanent changes of Colours, as in the Experiment you will meet with hereafter, of presently turning a Snowy White Body into a Yellow, by the bare Affusion of fair Water, which probably so Dissolves the Saline Corpuscles that remain'd in the Calx, and sets them at Liberty to Act upon one another, and the Metall, far more Powerfully than the Water without the Assistance of such Saline Corpuscles could do. And though you rubb Blew Vitriol, how Venereal and Unsophisticated soever it be, upon the Whetted Blade of a Knife, it will not impart to the Iron its Latent Colour, but if you moisten the Vitriol with your Spittle, or common Water, the Particles of the Liquor disjoyning those of the Vitriol, and thereby giving them the Various Agitation requisite to Fluid Bodies, the Metalline Corpuscles of the thus Dissolv'd Vitriol will Lodge themselves in Throngs in the Small and Congruous Pores of the Iron they are Rubb'd on, and so give the Surface of it the Genuine Colour of the Copper.

25. There remains yet a way, Pyrophilus to be mention'd, by which a Liquor may alter the Colour of another Body, and this seems the most Important of all, because though it be nam'd but as One, yet it may indeed comprehend Many, and that is, by Associating the Saline Corpuscles, or any other Sort of the more Rigid ones of the Liquor, with the Particles of the Body that it is employ'd to Work upon. For these Adventitious Corpuscles Associating themselves with the Protuberant Particles of the Surface of a Colour'd Body, must necessarily alter their Bigness, and will most commonly alter their Shape. And how much the Colours of Bodies depend upon the Bulk and Figure of their Superficial Particles, you may Guess by this, that eminent antient Philosophers and divers Moderns, have thought that all Colours might in a general way be made out by these two; whose being Diversify'd, will in our Case be attended with these two Circumstances, the One, that the Protuberant Particles being Increas'd in Bulk, they will oftentimes be Vary'd as to the Closness or Laxity of their Order, fewer of them being contain'd within the same Sensible (though Minute) space than before; or else by approaching to one another, they must Straighten the

Pores, and it may be too, they will by their manner of Associating themselves with the Protuberant Particles, intercept new Pores. And this invites me to consider farther, that the Adventitious Corpuscles, I have been speaking of, may likewise produce a great Change as well in the Little Cavities or Pores as in the Protuberances of a Colour'd Body; for besides what we have just now taken notice of, they may by Lodging themselves in those little Cavities, fill them up, and it may well happen, that they may not only fill the Pores they Insinuate themselves into, but likewise have their Upper Parts extant above them; and partly by these new Protuberances, partly by Increasing the Bulk of the former, these Extraneous Corpuscles may much alter the Number and Bigness of the Surfaces Pores, changing the Old and Intercepting new ones. And then 'tis Odds, but the Order of the Little Extancies, and consequently that of the Little Depressions in point of Situation will be alter'd likewise: as if you dissolve Quick-silver in some kind of Aqua-fortis, the Saline Particles of the Menstruum Associating themselves with the Mercurial Corpuscles, will make a Green Solution, which afterwards easily enough Degenerates. And Red Lead or Minium being Dissolv'd in Spirit of Vinegar, yields not a Red, but a Clear Solution, the Redness of the Lead being by the Liquor Destroy'd. But a better Instance may be taken from Copper, for I have try'd, that if upon a Copper-plate you let some Drops of weak Aqua-fortis rest for a while, the Corpuscles of the Menstruum, joyning with those of the Metall, will produce a very sensible Asperity upon the Surface of the Plate, and will Concoagulate that way into very minute Grains of a Pale Blew Vitriol; whereas if upon another part of the same Plate you suffer a little strong Spirit of Urine to rest a competent time, you shall find the Asperated Surface adorn'd with a Deeper and Richer Blew. And the same Aqua-fortis, that will quickly change the Redness of Red Lead into a Darker Colour, will, being put upon Crude Lead, produce a Whitish Substance, as with Copper it did a Blewish. And as with Iron it will produce a Reddish, and on White Quills a Yellowish, so much may the Coalition of the Parts of the same Liquor, with the

differingly Figur'd Particles of Stable Bodies, divers ways Asperate the differingly Dispos'd Surfaces, and to Diversifie the Colour of those Bodies. And you'l easily believe, that in many changes of Colour, that happen upon the Dissolutions of Metalls, and Precipitations made with Oyl of Tartar, and the like Fix'd Salts, there may Intervene a Coalition of Saline Corpuscles with the Particles of the Body Dissolv'd or Precipitated, if you examine how much the Vitriol of a Metall may be Heavier than the Metalline part of it alone, upon the Score of the Saline parts Concoagulated therewith, and, that in Several Precipitations the weight of the Calx does for the same Reason much exceed that of the Metall, when it was first put in to be Dissolv'd.

26. But, Pyrophilus, to consider these Matters more particularly would be to forget that I declar'd against Adventuring, at least for this time, at particular Theories of Colours, and that accordingly you may justly expect from me rather Experiments than Speculations, and therefore I shall Dismiss this Subject of the Forms of Superficial Asperity in Colour'd Bodies, as soon as I shall but have nam'd to you by way of Supplement to what we have hitherto Discours'd in this Section, a Couple of Particulars, (which you'l easily grant me) The one, That there are divers other ways for the speedy Production even of True and Permanent Colours in Bodies, besides those Practicable by the help of Liquors; for proof of which Advertisement, though several Examples might be alleged, yet I shall need but Re-mind you of what I mention'd to you above, touching the change of Colours suddenly made on Temper'd Steel, and on Lead, by the Operation of Heat, without the Intervention of a Liquor. But the other particular I am to observe to you is of more Importance to our present Subject and it is, That though Nature and Art may in some cases so change the Asperity of the Superficial parts of a Body, as to change its Colour by either of the ways I have propos'd Single or Unassisted, yet for the most part 'tis by two or three, or perhaps by more of the fore-mention'd ways Associated together, that the Effect is produc'd, and if you consider how Variously those several ways and some others

Ally'd unto them, which I have left unmention'd, may be Compounded and Apply'd, you will not much wonder that such fruitfull, whether Principles (or Manners of Diversification) should be fitted to Change or Generate no small store of Differing Colours.

27. Hitherto, Pyrophilus, we have in discoursing of the Asperity of Bodies consider'd the little Protuberances of other Superficial particles which make up that Roughness, as if we took it for granted, that they must be perfectly Opacous and Impenetrable by the Beams of Light, and so, must contribute to the Variety of Colours as they terminate more or less Light, and reflect it to the Eye mix'd with more or less of thus or thus mingl'd Shades. But to deal Ingenuously with you, Pyrophilus, before I proceed any further, I must not conceal from you, that I have often thought it worth a Serious Enquiry, whether or no Particles of Matter, each of them sing'y Insensible, and therefore small enough to be capable of being such Minute Particles as the Atomists both of old and of late have (not absurdly) called Corpuscula Coloris, may not yet consist each of them of divers yet Minuter Particles, betwixt which we may conceive little Commissures where they Adhere to one another, and, however, may not be Porous enough to be, at least in some degree, Pervious to the unimaginably subtile Corpuscles that make up the Beams of Light, and consequently to be in such a degree Diaphanous. For, Pyrophilus, that the proposed Enquiry may be of moment to him that searches after the Nature of Colour, you'l easily grant, if you consider, that whereas Perfectly Opacous bodies can but reflect the incident Beams of Light, those that are Diaphanous are qualified to refract them too, and that Refraction has such a stroak in the Production of Colours, as you cannot but have taken notice of, and perhaps admir'd in the Colours generated by the Trajection of Light through Drops of Water that exhibit a Rain-bow, through Prismatical glasses, and through divers other Transparent bodies. But 'tis like, Pyrophilus, you'l more easily allow that about this matter 'tis rather Important to have a Certainty, than that 'tis Rational to entertain a Doubt; wherefore

I must mention to you some of the Reasons that make me think it may need a further Enquiry, for I find that in a Darkned Room, where the Light is permitted to enter but at One hole, the little wandering Particles of Dust, that are commonly called Motes, and, unless in the Sunbeams, are not taken notice of by the unassisted Sight, I have, I say, often observ'd, that these roving Corpuscles being look'd on by an Eye plac'd on one side of the Beams that enter'd the Little hole, and by the Darkness having its Pupill much Enlarg'd, I could discern that these Motes as soon as they came within the compass of the Luminous, whether Cylinder or Inverted Cone, if I may so call it, that was made up by the Unclouded Beams of the Sun, did in certain positions appear adorn'd with very vivid Colours, like those of the Rain-bow, or rather like those of very Minute, but Sparkling fragments of Diamonds; and as soon as the Continuance of their Motion had brought them to an Inconvenient position in reference to the Light and the Eye, they were only visible without Darting any lively Colours as before, which seems to argue that these little Motes, or minute Fragments, of several sorts of bodies reputed Opacous, and only crumbled as to their Exteriour and Looser parts into Dust, did not barely Reflect the Beams that fell upon them, but remit them to the Eye Refracted too. We may also observe, that several Bodies, (as well some of a Vegetable, as others of an Animal nature) which are wont to pass for Opacous, appear in great part Transparent, when they are reduc'd into Thin parts, and held against a powerful Light. This I have not only taken notice of in pieces of Ivory reduc'd but into Thick leaves, as also in divers considerable Thick shells of Fishes, and in shaving of Wood, but I have also found that a piece of Deal, far thicker than one would easily imagine, being purposly interposed betwixt my Eye plac'd in a Room, and the clear Daylight, was not only somewhat Transparent, but (perhaps by reason of its Gummous nature) appear'd quite through of a lovely Red. And in the Darkned Room above mention'd, Bodies held against the hole at which the Light enter'd, appear'd far less Opacous then they would elsewhere have done, insomuch that I could easily and plainly see through the whole Thickness of

my Hand, the Motions of a Body plac'd (at a very near distance indeed, but yet) beyond it. And even in Minerals, the Opacity is not always so great as many think, if the Body be made Thin, for White Marble though of a pretty Thickness, being within a Due distance plac'd betwixt the Eye and a Convenient Light, will Suffer the Motions of ones Finger to be well discern'd through it, and so will pieces, Thick enough, of many common Flints. But above all, that Instance is remarkable, that is afforded us by Muscovie glass, (which some call Selenites, others Lapis Specularis) for though plates of this Mineral, though but of a moderate Thickness, do often appear Opacous, yet if one of these be Dextrously split into the thinnest Leaves 'tis made up of, it will yield such a number of them, as scarce any thing but Experience could have perswaded me, and these Leaves will afford the most Transparent sort of consistent Bodies, that, for ought I have observ'd, are yet known; and a single Leaf or Plate will be so far from being Opacous, that 'twill scarce be so much as Visible. And multitudes of Bodies there are, whose Fragments seem Opacous to the naked Eye, which yet, when I have included them in good Microscopes, appear'd Transparent; but, Pyrophilus, on the other side I am not yet sure that there are no Bodies, whose Minute Particles even in such a Microscope as that of mine, which I was lately mentioning, will not appear Diaphanous. For having consider'd Mercury Precipitated per se, the little Granules that made up the powder, look'd like little fragments of Coral beheld by the naked Eye at a Distance (for very Near at hand Coral will sometimes, especially if it be Good, shew some Transparency.) Filings likewise of Steel and Copper, though in an excellent Microscope, and a fair Day, they show'd like pretty Big Fragments of those Metalls, and had considerable Brightness on some of their Surfaces, yet I was not satisfi'd, that I perceiv'd any Reflection from the Inner parts of any of the Filings. Nay, having look'd in my best Microscope upon the Red Calx of Lead, (commonly call'd Minium) neither I, nor any I shew'd it to, could discern it to be other than Opacous, though the Day were Clear, and the Object strongly Enlightned. And the deeply Red Colour of Vitriol

appear'd in the same Microscope (notwithstanding the great Comminution effected by the Fire) but like Grossy beaten Brick. So that, Pyrophilus, I shall willingly resign you the care of making some further Enquiries into the Subject we have now been considering; for I confess, as I told you before, that I think that the Matter may need a further Scrutiny, nor would I be forward to Determine how far or in what cases the Transparency or Semi-diaphaniety of the Superficial Corpuscles of Bigger Bodies, may have an Interest in the Production of their Colours, especially because that even in divers White bodies, as Beaten Glass, Snow and Froth, where it seems manifest that the Superficial parts are singly Diaphanous, (being either Water, or Air, or Glass) we see not that such Variety of Colours are produc'd as usually are by the Refraction of Light, even in those Bodies, when by their Bigness, Shape, &c. they are conveniently qualify'd to exhibit such Various and Lively Colours as those of the Rain-bow, and of Prismatical Glasses.

28. By what has been hitherto discours'd, Pyrophilus, we may be assisted to judge of that famous Controversie which was of Old disputed betwixt the Epicureans and other Atomists on the one side, and most other Philosophers on the other side. The former Denying Bodies to be Colour'd in the Dark, and the Latter making Colour to be an Inherent quality, as well as Figure, Hardness; Weight, or the like. For though this Controversie be Reviv'd, and hotly Agitated among the Moderns, yet I doubt whether it be not in great part a Nominal dispute, and therefore let us, according to the Doctrine formerly deliver'd, Distinguish the Acceptions of the word Colour, and say, that if it be taken in the Stricter Sense, the Epicureans seem to be in the Right, for if Colour be indeed, though not according to them, but Light Modify'd, how can we conceive that it can Subsist in the Dark, that is, where it must be suppos'd there is no Light; but on the other side, if Colour be consider'd as a certain Constant Disposition of the Superficial parts of the Object to Trouble the Light they Reflect after such and such a Determinate manner, this Constant, and, if I may so speak, Modifying disposition persevering in the Object, whether it be Shin'd upon or no,

there seems no just reason to deny, but that in this Sense, Bodies retain their Colour as well in the Night as Day; or, to Speak a little otherwise, it may be said, that Bodies are Potentially Colour'd in the Dark, and Actually in the Light. But of this Matter discoursing more fully elsewhere, as 'tis a difficulty that concerns Qualities in general, I shall forbear to insist on it here.

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 Greeness of a Leaf ought to pass for Apparent, because, soon Fading into a Yellow, it Scarce lasts at all, in comparison of the Greeness 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.

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'l 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 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 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 Sphærical 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'l 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.

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 Abetters; 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, 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 thesc 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'l find endeavour'd in the Discourse you'l 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 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 Swiftness, 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 comprehensitive 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 Infirmness 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 ef 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.

5. Thirdly. But, Pyrophilus, though this be at present the Hypothesis I preferr, 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 Cælestes, 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 Swiftness 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 Scaliger5, Latet natura hæc, (says he, Speaking of that of Colour) & sicut aliarum rerum species in profundissima caligine inscitiæ humanæ.

Decorative rule

THE EXPERIMENTAL HISTORY OF COLOURS.

PART. II.

Of the Nature of Whiteness and Blackness.

CHAP. I.

1. Illuminated T in Though

Hough 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 explan'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 tantò magis, quantò densior seu collectior fuerit. Deinde aquam non esse quidem coloris ex se candidi & radium tamen ex eâ reflexum versus oculum candicare. Rursus cum plana aquæ 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 Superficiei parte. Ad hæc Spumam ex aqua pura non alia ratione videri candescere & albescerere quam quod sit congeries confertissima minutissimarum bullarum, quarum unaquæque suum radium reflectit, unde continens candor alborve apparet. Denique Nivem nihil aliud videri quam speciem purissimæ spumæ ex bullulis quam minutissimis & confertissimis cohærentis. Sed ridiculam me exhibeam, si tales meas nugas uberius proponem.

3. But though in this passage, that very Ingenous 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 Superficieculæ, that Look some one way, and some another, enough of them Obverted to his Eye, to afford like a broken Looking-glass, a confused Idæa, 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 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 Over-powers 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 Short; for after other things not needfull to be here Transcribed: Iter, says he, Diurnum duo scilicet montana milliaria (quæ 12 Italica sunt) consiciunt. Nocte verò sub splendissima luna, duplatum iter consumunt aut triplatum. Neque id incommodè fit, cum nivium reverberatione lunaris splendoris sublimes & declives campos illustret,

ac etiam montium præcipitia ac noxias feras à lorgè 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.

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 ingenous 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.

7. Thirdly, And the better to shew that White Bodies reflect store of Light, in

comparson 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 Phænomenon, 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.

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.

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, 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 Oyly 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 insteed 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 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 Crystalls purposely reserv'd, some of the Subtile Powder of the same Salt, which will Comparatively exhibit a very considerable degree of Whitishness.

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.

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 suâpte Naturâ nigra constare ex particulis, quarum Superficieculæ scabræ sint, nec facilè lucem extrorsum reflectant. I wish this Ingenious Man had enlarg'd 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 Effluviums, or Minute Particles of some Ætherial 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 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 Sphærical 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.

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 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, 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 (Cæteris 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.

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.

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.

Decorative rule

EXPERIMENT IN CONSORT, Touching Whiteness & Blackness.

EXPERIMENT I.

Illuminated H in Having Aving 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 Præcipitate 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 Cleer, 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 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 throughly 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 Præcipitation 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 Præcipitated 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 Præcipitating liquors that I sometimes employ, afford good store of a Crudled matter, such as I have had in the Præcipitations 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 Præcipitate, 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 dryed 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 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 Crystalls 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.

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 Alablaster, 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 sincerily, 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 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 Oxycæder 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.

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 Magistery 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.

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 Præcipitated 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 Præcipitated 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 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 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 Æquinoctial, 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 Tropick 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, 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 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.

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, 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 Pisos11 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 Æthiopian 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 setled 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 Cole-black as ours, but partly of a Whitish Colour) in spight 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 pipple-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 cleerly

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 Europæan Bodyes. 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 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 Countrey-man Andrew Battel, who being sent Prisoner by the Portugalls to Angola, liv'd there, and in the adjoyning 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 Countrey 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 himself13; Here are (sayes he, speaking of the formerly mention'd Regions) Born in this Countrey 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 Countrey 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 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.

EXPERIMENT XII.

The way, Pyrophilus, of producing Whiteness by Chymical Præcipitations 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 Præcipitated by Oyl of Tartar into White Powders. Thus Silver and Tin separately dissolv'd in Aqua Fortis, will the one Præcipitate it self, and the other be Præcipitated 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 Præcipitated 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 Præcipitated 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 Vitæ, 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 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 Præcipitated 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 Præcipitating 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 Præcipitated Bodyes are White, yet I know some that are not; For Gold Dissolv'd in Aqua Regis, whether you Præcipitate 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 Præcipitated 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 Præcipitate, 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 Præcipitation brought to White Powders, and yet some affording Præcipitates of other Colours, the reason of both the Phænomena may deserve to be enquir'd into.

EXPERIMENT XIII.

Some Learned Modern Writers15 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 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 præexistent 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 spight 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 prædominant Colour, and return to the Reddishness of Copper, I was assur'd of the Affirmative; so that among Mineral Bodyes, 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 Prædominant 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 Æstimate 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.

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.

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 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 Inflamable, and consequenly (according to the Chymists) as Sulphureous a Body as it is, I could not by such a degree of Heat, as brought it 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 Inflamable, 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 throughly 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 then 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 appliable 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 dissappears? 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.

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 Oyly 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 Quæries, 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 Inclin'd 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 Præcipitates of Gold and Mercury) as likewise of Quick-silver and Silver (for I know that make and use of such Precipitates 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.

Decorative rule

THE Experimental History OF COLOURS. Begun.

The Third PART.

Containing Promiscuous Experiments About COLOURS.

EXPERIMENT I.

Illuminated B in Because Ecause that, according to the Conjectures I have above propos'd, one of the most General Causes of the Diversity of Colours in Opacous Bodyes, 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.

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 Bodyes differingly 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 Bodyes 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 Bodyes, 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 Bodyes; 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.

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.

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 Rebounding 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 Tincted, 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.

The Explication of the Scheme.

The Explication of the Scheme.

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

A B & α β Two rays from the Sun falling on the Prism at B β. and thence partly reflected towards C & γ. and partly refracted towards D & δ.

B C & β γ. Those reflected Rays.

B D & β δ. Those refracted Rays which are partly refracted towards E & ε. 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 & ζ.

D F & δ ζ. Those Reflected Rays which are partly refracted towards G & η. colourless, and partly reflected, towards H & θ.

F H & ζ θ. Those reflected Rays which are refracted towards I & ι. 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 througn 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.

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 Bodyes 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 Bodyes 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 Admixtion 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 Peeces would not serve the turn) of deep Blew Glass, and looking upon the Candles flame at a Convenient distance througn 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. 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 conctinu'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.

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 & urinæ difficultates ac arenulas pellendas. Fit autem hac ratione, Lignum assulatim & minutim concisum in limpidissima aqua fontana maceratur, inque ea relinquitur, donec aqua à bibentibus absumpta sit, dimidia hora post injectum lignum aqua cæruleum colorem contrabit, qui sensim intenditur pro temporis diuturnitate, tametsi 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 Cæruleous 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 comming out of the Glass to be perfectly Cæruleous, 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 Phænomena 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 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 Cæruleous one.

These and other Phænomena, 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 Phænomena 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 Modifie 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 Cæruleous, 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 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 Cæruleous 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 Cæruleous 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 Cæruleous 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 Cæruleous; 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 Phænomena 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 Indigenæ Coalle & Tlapazatli vocant, quod etsi experientia hucusque non nisi Cæruleo 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 rarò in molem arboris excrescit, truncus illius eft crassus, enodis, instar piri arboris, folia ciceris foliis, aut rutæ haud absimilia, flores exigui, oblongi, lutei & spicatim digesti; est frigida & humida planta, licet parum recedat à medio temperamento. Hujus itaque descriptæ arboris lignum in poculum efformatum, aquam eidem infusam primo in aquam intense Cæruleam, colore floris Buglossæ; tingit, & quo diutius in eo steterit, tanto intensiorem colorem acquirit. Hanc igitur aquam si Vitreæ Sphæræ infuderis, lucique exposueris, ne ullum quidem Cærulei coloris vestigium apparebit, sed instar aquæ puræ putæ fontanæ limpidam claramque aspicientibus se præbebit. 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 verò vel in vase opaco posita, Cæruleum colorem suum resumet.

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 or Deep; and then, whereas it has been already said, that the Cæruleous 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 Cæruleous 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 Sun-beams 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 Phænomena, 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 Cæruleous 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 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 indiscriminatly 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 Cæruleous, 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 Prædominant 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 Cæruleous 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 recovers its Cæruleous 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 Prædominant in Quick-lime belongs, we have been perswaded to referr it rather to Lixiviate 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 Cæruleous Colour of our Tincture. But whether concerning Liquors, wherein neither Acid nor Alcalisate Salts are Eminently Prædominant, our Tincture will enable us to conjecture any thing more than that such Salts are not Prædominant 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 tasts to the Saline Principle of Bodyes,) have any Remarkable Power either to deprive our Tincture of its Cæruleous 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 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 Phænomena 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 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 imploy any more than White, and Black, and Red, and Blew, and Yellow; these five, Variously 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 differingly 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 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 Increas'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 Rebounding 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.

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.

EXPERIMENT XV.

On this occasion, Pyrophilus, I shall add, that finding the Glass-prism to be the usefullest Instrument Men have yet imploy'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 Phænomena 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 imploy, 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.

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, 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.

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 Præcipitating 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 throughly 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 Phænomena 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, 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 Modifie 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.

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.

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 Sphærical 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, 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 Phænomenon 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, Imprægnated 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 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 Cæruleous Colour be Destroy'd by an Acid Salt, it may be Restor'd by one that is either Volatile, or Lixiviate; 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 Corn18. 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 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.

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 Lixiviate 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 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 setled 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 Cæruleous 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.

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 Metalls, 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 imploy'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, Registred 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 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 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 protrathit 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 à Sale, Qui scire vult Virtutes, is scrutetur arcana Mercurii. Sic nimirum fundamentum hauserit Mysteriorum, in quolibet crescenti indagandorum, prout natura cuilibet speciei ea ingessit. 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.

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 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 Oyly 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, 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 immediately turn'd into a Greenish Colour deep enough, by as much Urinous Spirit into a Colour much of Kin to 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 Lixiviate 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 Lixiviate 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 imploy'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, imploy'd for Binding.

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, it 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 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 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 Modifie 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 it 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 imploy'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 Oyly 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;

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.

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, 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 Shops21. 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, 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.

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.

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 Liqours, into which such Fumes convene, (for though we will not deny, that by skill and care a Reddish Liqour 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 Empyreumatical 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 Liqours 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 differingly 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, 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.

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 imployed 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 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 heightned 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 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 sowr 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 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-stepts 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 droping 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 setling 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.

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 Phænomenon. 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 Lixiviate 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 Phænomena 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 Phænomenon, 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 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 Phænomenon. 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 out 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 undephlegmated Aqua-fortis will not perform the same thing well, yet that which is made exceeding Strong by being carefully Dephlegm'd, 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 imploy'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 Lixiviate Solvents some other Mineral concretions abounding with Sulphureous parts, of which sort is crude Antimony, I concluded it to be easie to Precipitate 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 Filtred 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 Cæruleous Colour to the Tincture of Lignum Nephriticum, and turn that of Syrrup of Violets into Green. Wherefore this XL. Experiment does opportunely supply the deficiency of those. For being sollicitous 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 Lixiviate 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 alwayes 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 cleer 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 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 Cæruleous 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, 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.

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 tincted 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 succceds 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 dryed, 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 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 præcipitatus 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 unneccessary 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, wich 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.

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 swiming 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 swiming 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 tincted 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 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 Phænomena 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 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 Stopple (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.

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 tincted 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 Phænomena 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 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 frighting 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 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 Phænomenon 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 Wormius23 in his late Musæum 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.

EXPERIMENT XLVI.

We have often taken notice, as of a remarkable thing, that Metalls as they appear to the Eye, before they come to be farther alter'd by other Bodyes, 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 Bodyes 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 Metalls 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 Bodyes employ'd to work on them, than by the bare alteration of the parts of the Metalls 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 Metalls. The next such as emerge from the Coalition of Metalline Particles with those of some Menstruum imploy'd to Corrode a Metall or Precipitate it; And the last, The Colours afforded by Metalline Bodyes either Colliquated 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 Metalls, 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.

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 Phænomenon not unfit for you to consider, though I have not now the leisure to discourse upon it. Tin Corroded by Aqua-fortis till the 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 tincted 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 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 Præcipitated 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 concurr 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 imploy'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 prædominant, 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 those which I intimated in the præamble 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 Phænomena 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 Spagyrists 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.

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 imploying, either præcipitating 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 Præcipitated 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 Præcipitated with an Alcaly, it will afford a Yellowish or tawny powder, and if there be no Præcipitation 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 Spagyrists.

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 had occasion among other Tryals to mingle a few grains of Shell-silver (such as is imploy'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 Venerial 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.

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 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 mistion 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-imploy them.

Annotation V.

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.

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.

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 imploy'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 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 imploy'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 simper 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 tincted 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 tincted, 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 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 Moisture25.

Annotation I.

Whereas it is presum'd that the Magistery 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 Magistery, 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 Præcipitate what acid Salts have dissolv'd, I could not but be prone to suspect that the Curdled Matter, which is call'd the Magistery of Vegetables, may have in it no inconsiderable proportion of a stony substance Præcipitated 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 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 Præcipitated 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.

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.

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 alwayes be of the very same Colour with the Vegetable it is made off. For Lixiviate 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.

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 Lucriferous 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'l 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 Præcipitate 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 Præcipitated by this Liquor were usually fair and White.

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 Præcipitate 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 Præcipitate 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 Precipitate 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 Precipitate out of a Dirty Green magistery of Rose-leaves, so by the same Method, you may produce a fair Yellow, and sometimes a Red Liquor, and the like Precipitate, 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 Precipitate,) 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 Precipitate like that formerly mention'd, and turn the Liquor that swam above it, for the most part into a lovely Yellow.

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 Armnoniack,

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 differingly 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 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.

Decorative tiles

LONDON,

Printed for Henry Herringman. 1664

Decorative rule

A COPY OF THE LETTER

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

SIR,

Illuminated T in Though Hough 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 hasted 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 imploy'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 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 Phœnomemon 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 recrute 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 imploy'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 verè asserere ausus fuit, se gemmam noctu lucentem vidisse. Garcias ab Horto proregis Indiæ Medicus, refert se allocutum fuisse, qui se vidisse affirmarent. 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 nullâ gemmâ hastenus deprehensum, licet à quibusdam temerè jactetur. And the recentest Writer I have met with on this Subject, Olaus Wormius, in his Account of his well furnish'd Musæum, 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 naturâ 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.

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 it. I might tell you that Marcus Paulus Venetus28 (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 Catay29, 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 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.

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 marveilous, 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 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 imploy'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 Embassador 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 suspition 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 '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 appeares to be more susceptible of them, than ordinary Diamonds. And I confess to you, that this is not the only odd suspition (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 Affriction 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 Boot31, 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 à 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 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 Wormius33 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 Vetraria34 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 Effluviums 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 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.

Decorative rule

OBSERVATIONS

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

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 Morning37 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.

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

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.

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 near39 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.

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 purposedly 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.

Fifteenthly, Having well excited the Stone, I nimbly plung'd it under Water40, 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.

Sixteenthly, 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

Seventeenthly, 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.

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.

Decorative rule

A Postscript.

Annexed some Hours after the Observations were Written.

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.

FINIS.

Notes.

1 L. Annæ Senecæ Natur. Quest. l. 6. c. 5.

2 He that desires more instances of this kind and matter, that according to this doctrine may much help the Theory of colours, and particularly the force both of Sulphureous and volatile, is likewise of Alcalizate and Acid Salts, and in what particulars, Colours likely depend not in the causation from any Salt at all, may beg his information from M. Boyle who hath some while since honoured me with the sight of his papers concerning this subject, containing many excellent experiments, made by him for the Elucidation of this doctrine, &c Dr. R. Sharrock in his

ingenious and usefull History of the Propagation and Improvement of Vegetables, published in the yeare 1660.

3 See the Discourse of the Nature of Whiteness and Blackness.

4 Since for his eminent Qualities and Loyalty Grac'd, by his Majesty, with the Honour of Knighthood.

5 Exercitat. 325 Parag. 4

6 Album quippe & agrum, hoc quidem asperum esse dicit, hoc vero læve. de Sensu & Sensib. 3. 3.

7 Epist. 2. pag. 45.

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

9 Hist. Anatom. Cent. 3. Hist. 44.

10 Olearius Voyage de Mosco. et de Perse liv. 3.

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

15 See Scaliger Exercit. 325. Sect. 9.

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

17 Kircher. Art. Mag. lucis & umbræ, lib. 1. part. 3.

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

19 Paracelsus de Mineral. tract. 1. pag. m. 243

20 See Parkinson Th. Boran. Trib. 9. cap. 26.

21 Parkinson, Thea. Bot. Trib. 4 cap. 12.

22 Beguinus, Tyr. Chy. Lib. 2º. Cap. 13º.

23 Libr. 2do Cap. 34.

24 See the latter end of the fiftieth Experiment.

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.

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

27 Musæi Wormiani. Cap. 17.

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

29 In the year 1619.

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

31 The Narrative in the Authors own words, is this. Ego (sayes he) sanctè affirmare possum me unam aureo Annulo inclusam perpetuo gestare, cujus facultatem (si gemmæ est) nunquam satis admirari potui. Gestaverat enim ante Triginta annos Hispanus quidam non procula puternis ædibus habitans. Is cum vitâ functus esset, & ipsius suspellex (ut moris apud nos est) venum exposita esset, inter cætera 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 gemmæ habendæ desiderio etiam parens & frater meus, qui antea sæpius 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, inquiens; 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 Gemmâ ornatus gratia, dum gratiam nullam haberet, uti. Paret Sculptor redditque Gemmam, quam gesto pro annulo Signatorio. Vix per mensem gestaram, redit illi pristinus color, sed non ita nitens propter Sculpturam, ac inæqualem superficiem. Miramur omnes gemmam, atque id præcipuè quod color indies pulchrior fieret. Id quià observabam, nunquam fere eam à manu deposui, ita ut nunc adhuc candem gestem.

32 Olaus Wormius, in Musæ. 18º pag. 186.

33 Musæ. Worm. pag. 99.

34 Arte Vetraria, lib. 7 cap. 102.

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.

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.

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.

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.

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.

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.

43 We afterwards, try'd precious Stones, as Diamonds, Rubies, Saphires, 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.

Decorative rule

Transcriber's notes.

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

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 Lixiviate 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 ... is attempted -> where the change (etc.) 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 swimning -> 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 asserere -> nemo nunquam vere asserere (ib.): what is reladed -> what is related Observations: carefulsy drawn -> carefully drawn

- and emended Phœnomenon/a to Phænomenon/a 10 times and Cœruleous etc. -> Cæruleous 20 times

EXPERIMENTS AND CONSIDERATIONS Touching COLOURS.

Firſt occaſionally Written, among ſome other Eſſays, to a Friend; and now ſuffer'd to come abroad as

THE BEGINNING Of An Experimental Hiſtory OF COLOURS.

By the Honourable ROBERT BOYLE, Fellow of the ROYAL SOCIETY.

Non fingendum, aut excogitandum, ſed inveniendum, quid Natura faciat, aut ferat. Bacon.

LONDON.

Printed for Henry Herringman at the Anchor on the Lower walk of the New Exchange. MDCLXIV.

Decorative tile

THE PREFACE.

Illuminated H in Having Aving in convenient places of the following Treatiſe, mention'd the Motives, that induc'd me to write it, and the Scope I propos'd to my ſelf in it; I think it ſuperfluous to entertain the Reader now, with what he will meet with hereafter. And I ſhould judge it needleſs, to trouble others, or my ſelf, with any thing of Preface: were it not that I can ſcarce doubt, but this Book will fall into the hands of ſome Readers, who being unacquainted with the difficulty of attempts of this nature, will think itn ſtrange that I ſhould publiſh any thing about Colours, without a particular Theory of them. But I dare expect that Intelligent and Equitable Readers will conſider on my behalf: That the profeſſed Deſign of this Treatiſe is to deliver things rather Hiſtorical than Dogmatical, and conſequently if I have added divers new ſpeculative Conſiderations and hints, which perhaps may afford no deſpicable Aſſiſtance, towards the framing of a ſolid and comprehenſive Hypotheſis, I have done at least as much as I promis'd, or as the nature of my undertaking exacted. But another thing there is, which if it ſhould be objected, I fear I ſhould not be able ſo eaſily to anſwer it, and that is; That in the following treatiſe (eſpecially in the Third part of it) the Experiments might have been better Marſhall'd, and ſome of them deliver'd in fewer words. For I muſt confeſs that this Eſſay was written to a private Friend, and that too, by ſnatches, at ſeveral times, and places, and (after my manner) in looſe ſheets, of which I oftentimes had not all by me that I had already written, when I was writing more, ſo that it needs be no wonder if all the Experiments be not rang'd to the beſt Advantage, and if ſome connections and

conſecutions of them might eaſily have been mended. Eſpecially ſince having careleſſly laid by the looſe Papers, for ſeveral years after they were written, when I came to put them together to diſpatch them to the Preſs, I found ſome of thoſe I reckon'd upon, to be very unſeaſonably wanting. And to make any great change in the order of the reſt, was more than the Printers importunity, and that, of my own avocations (and perhaps alſo conſiderabler ſolicitations) would permit. But though ſome few preambles of the particular Experiments might have (perchance) been ſpar'd, or ſhorten'd, if I had had all my Papers under my View at once; Yet in the moſt of thoſe Introductory paſſages, the Reader will (I hope) find hints, or Advertiſements, as well as Tranſitions. If I ſometimes ſeem to inſiſt long upon the circumſtances of a Tryall, I hope I ſhall be eaſily excuſed by thoſe that both know, how nice divers experiments of Colours are, and conſider that I was not barely to relate them, but ſo as to teach a young Gentleman to make them. And if I was not ſollicitous, to make a nicer diviſion of the whole Treatiſe, than into three parts, whereof the One contains ſome Conſiderations about Colours in general. The Other exhibits a ſpecimen of an Account of particular Colours, Exemplifi'd in Whiteneſs and Blackneſs. And the Third promiſcuous Experiments about the remaining Colours (eſpecially Red) in order to a Theory of them. If, I ſay, I contented my ſelf with this eaſie Diviſion of my Diſcourſe, it was perhaps becauſe I did not think it ſo neceſſary to be Curious about the Method or Contrivance of a Treatiſe, wherein I do not pretend to preſent my Reader with a compleat Fabrick, or ſo much as Modell; but only to bring in Materials proper for the Building; And if I did not well know how Ingenious the Curioſity and Civility of Friends makes them, to perſwade Men by ſpecious allegations, to gratifie their deſires; I ſhould have been made to believe by perſons very well qualify'd to judge of matters of this nature, that the following Experiments will not need the addition of accurate Method and ſpeculative Notions to procure Acceptance for the Treatiſe that contains them: For it hath been repreſented, That in moſt of them, as the Novelty will make them ſurprizing, and the

Quickneſs of performance, keep them from being tedious; ſo the ſenſible changes, that are effected by them, are ſo manifest, ſo great, and ſo ſudden, that ſcarce any will be diſpleaſed to ſee them, and thoſe that are any thing Curious will ſcarce be able to ſee them, without finding themſelves excited, to make Reflexions upon Them. But though with me, who love to meaſure Phyſical things by their uſe, not their ſtrangeneſs, or prettineſs, the partiality of others prevails not to make me over value theſe, or look upon them in themſelves as other than Trifles: Yet I confeſs, that ever ſince I did divers years ago ſhew ſome of them to a Learned Company of Virtuoſi: ſo many perſons of differing Conditions, and ev'n Sexes, have been Curious to ſee them, and pleas'd not to Diſlike them, that I cannot Deſpair, but that by complying with thoſe that urge the Publication of them, I may both gratifie and excite the Curious, and lay perhaps a Foundation whereon either others or my ſelf may in time ſuperſtruct a ſubſtantial theory of Colours. And if Ariſtotle, after his Maſter Plato, have rightly obſerv'd Admiration to be the Parent of Philoſophy, the wonder, ſome of theſe Trifles have been wont to produce in all ſorts of Beholders, and the acceſs they have ſometimes gain'd ev'n to the Cloſets of Ladies, ſeem to promiſe, that ſince the ſubject is ſo pleaſing, that the Speculation appears as Delightful! as Difficult, ſuch eaſie and recreative Experiments, which require but little time, or charge, or trouble in the making, and when made are ſenſible and ſurprizing enough, may contribute more than others, (far more important but as much more difficult) to recommend thoſe parts of Learning (Chymistry and Corpuſcular Philoſophy) by which they have been produc'd, and to which they give Teſtimony ev'n to ſuch kind of perſons, as value a pretty Trick more than a true Notion, and would ſcarce admit Philoſophy, if it approach'd them in another Dreſs: without the ſtrangeneſs or endearments of pleaſantneſs to recommend it. I know that I do but ill conſult my own Advantage in the conſenting to the Publication of the following Treatiſe: For thoſe things, which, whilſt men knew not how they were perform'd, appear'd ſo ſtrange, will, when the way of making them, and the Grounds on which I devis'd them, ſhall be Publick,

quickly loſe all that their being Rarityes, and their being thought Myſteries, contributed to recommend them. But 'tis fitter for Mountebancks than Naturalis to deſire to have their diſcoverys rather admir'd than underſtood, and for my part I had much rather deſerve the thanks of the Ingenious, than enjoy the Applauſe of the Ignorant. And if I can ſo farr contribute to the diſcovery of the nature of Colours, as to help the Curious to it, I ſhall have reach'd my End, and ſav'd my ſelf ſome Labour which elſe I may chance be tempted to undergo in proſecuting that ſubect, and Adding to this Treatiſe, which I therefore call a History, becauſe it chiefly contains matters of fact, and which Hiſtory the Title declares me to look upon but as Begun: Becauſe though that above a hundred, not to ſay a hundred and fifty Experiments, (ſome looſe, and others interwoven amongſt the diſcourſes themſelves) may ſuffice to give a Beginning to a Hiſtory not hitherto, that I know, begun, by any; yet the ſubject is ſo fruitfull, and ſo worthy, that thoſe that are Curious of theſe Matters will be farr more wanting to themſelves than I can ſuſpect, if what I now publiſh prove any more than a Beginning. For, as I hope my Endeavours may afford them ſome aſſistance towards this work, ſo thoſe Endeavours are much too Vnfiniſh'd to give them any diſcouragement, as if there were little left for others to do towards the Hiſtory of Colours.

For (firſt) I have been willing to leave unmention'd the moſt part of thoſe Phænomena of Colours, that Nature preſents us of her own accord, (that is, without being guided or over-ruld by man) ſuch as the different Colours that ſeveral ſorts of Fruites paſs through before they are perfectly ripe, and thoſe that appear upon the fading of flowers and leaves, and the putrifaction (and its ſeveral degrees) of fruits, &c. together with a thouſand other obvious Instances of the changes of colours. Nor have I much medled with thoſe familiar Phænomena wherein man is not an Idle ſpectator; ſuch as the Greenneſs produc'd by ſalt in Beef much powder'd, and the Redneſs produc'd in the ſhells of Lobſters upon the boyling of thoſe fiſhes; For I was willing to leave the gathering of Obſervations to thoſe that have not the Opportunity

to make Experiments. And for the ſame Reaſons, among others, I did purpoſly omit the Lucriferous practiſe of Trades-men about colours; as the ways of making Pigments, of Bleanching wax, of dying Scarlet, &c. though to divers of them I be not a stranger, and of ſome I have myſelf made Tryall.

Next; I did purpoſely paſs by divers Experiments of other Writers that I had made Tryall of (and that not without regiſtring ſome of their Events) unleſs I could ſome way or other improve them, becauſe I wanted leaſure to inſert them, and had thoughts of proſecuting the work once begun of laying together thoſe I had examin'd by themſelves in caſe of my not being prevented by others diligence. So that there remains not a little, among the things that are already publiſhed, to imploy thoſe that have a mind to exerciſe themſelves in repeating and examining them. And I will not undertake, that none of the things deliver'd, ev'n in this Treatiſe, though never ſo faithfully ſet down, may not prove to be thus farr of this Sort, as to afford the Curious ſomewhat to add about them. For I remember that I have ſomewhere in the Book it ſelf acknowledged, that having written it by ſnatches, partly in the Counntrey, and partly at unſeaſonable times of the year, when the want of fit Inſtruments, and of a competent variety of flowers, ſalts, Pigments, and other materials made me leave ſome of the following Experiments, (eſpecialy thoſe about Emphatical Colours) far more unfiniſh'd than they ſhould have been, if it had been as eaſie for me to ſupply what was wanting to compleat them, as to diſcern. Thirdly to avoyd diſcouraging the young Gentleman I call Pyrophilus, whom the leſs Familiar, and more Laborious operations of Chymistry would probably have frighted, I purpoſely declin'd in what I writ to him, the ſetting down any Number of ſuch Chymicall Experiments, as, by being very elaborate or tedious, would either require much skill, or exerciſe his patience. And yet that this ſort of Experiments is exceedingly Numerous, and might more than a little inrich the Hiſtory of Colours, thoſe that are vers'd in Chymical proceſſes, will, I preſume, eaſily allow me.

And (Laſtly) for as much as I have occaſion more than once in my ſeveral Writings

to treat either porpoſely or incidentally of matters relating to Colours; I did not, perhaps, conceive my ſelf oblig'd, to deliver in one Treatiſe all that I would ſay concerning that ſubject.

But to conclude, by ſumming up what I would ſay concerning what I have and what I have not done, in the following Papers; I ſhall not (on the one ſide) deny, that conſidering that I pretended not to write an accurate Treatiſe of Colours, but an Occaſional Eſſay to acquaint a private friend with what then occurrd to me of the things I had thought or try'd concerning them; I might preſume I did enough for once, if I did clearly and faithfully ſet down, though not all the Experiments I could, yet at leaſt ſuch a variety of them, that an attentive Reader that ſhall conſider the Grounds on which they have been made, and the hints that are purpoſely (though diſperſedly) couched in them, may eaſily compound them, and otherwiſe vary them, ſo as very much to increaſe their Number. And yet (on the other ſide) I am ſo ſenſible both of how much I have, either out of neceſſity or choice, left undone, and of the fruitfullneſs of the ſubject I have begun to handle; that though I had performed far more then 'tis like many Readers will judge I have, I ſhould yet be very free to let them apply to my Attempts that of Seneca, where having ſpoken of the Study of Natures Myſteries, and Particularly of the Cauſe of Earth-Quakes, he ſubjoins.1 Nulla res conſummata eſt dum incipit. Nec in hac tantum re omnium maxima ac involutiſſimá, in quâ etiam cum multum actum erit, omnis ætas, quod agat inveniet; ſed in omni alio Negotio, longè ſemper à perfecto fuere Principia.

Decorative rule

The Publiſher to the READER.

Friendly Reader,

Illuminated H in HereEre is preſented to thy view one of the Abſtruſeſt as well as the Gentileſt Subjects of Natural Philoſophy, the Experimentall Hiſtory of Colours;

which though the Noble Author be pleaſed to think but Begun, yet I muſt take leave to ſay, that I think it ſo well begun, that the work is more than half diſpatcht. Concerning which I cannot but give this advertiſement to the Reader, that I have heard the Author expreſs himſelf, that it would not ſurpriſe him, if it ſhould happen to be objected, that ſome of theſe Experiments have been already publiſhed, partly by Chymiſts, and partly by two or three very freſh Writers upon other Subjects. And though the number of theſe Experiments be but very ſmall, and though they be none of the conſiderableſt, yet it may on this occaſion be further repreſented, that it is eaſie for our Author to name ſeveral men, (of whoſe number I can truly name my ſelf) who remember either their having ſeen him make, or their having read, his Accounts of the Experiments delivered in the following Tract ſeveral years ſince, and long before the publication of the Books, wherein they are mentioned. Nay in divers paſſages (where he could do it without any great inconvenience) he hath ſtruck out Experiments, which he had tryed many years ago, becauſe he ſince found them divulged by perſons from whom he had not the leaſt hint of them; which yet is not touched, with deſign to reflect upon any Ingenious Man, as if he were a Plagiary: For, though our Generous Author were not reſerved enough in ſhowing his Experiments to thoſe that expreſſed a Curioſity to ſee them (amongſt whom a very Learned Man hath been pleaſed publickly to acknowledge it ſeveral years ago2; yet the ſame thing may be well enough lighted on by perſons that know nothing of one another. And eſpecially Chymical Laboratories may many times afford the ſame Phænomenon about Colours to ſeveral perſons at the ſame or differing times. And as for the few Phænomena mentioned in the ſame Chymical writers, as well as in the following Treatiſe, our Author hath given an account, why he did not decline rejecting them, in the Anotations upon the 47th Experiment of the third part. Not here to mention, what he elſewhere ſaith, to ſhew what uſe may be Juſtifiably made of Experiments not of his own deviſing by a writer of Natural Hiſtory, if, what he employes of others mens, be well examined or verified by himſelf.

In the mean time, this Treatiſe is ſuch, that there needs no other invitation to peruſe it, but that tis compoſed by one of the Deepeſt & Moſt indefatigable ſearchers of Nature, which, I think the World, as far as I know it, affords. For mine own part, I feel a Secret Joy within me, to ſee ſuch beginings upon ſuch Themes, it being demonſtratively true, Mota facilius moveri, which cauſeth me to entertain ſtrong hopes, that this Illuſtrious Virtuoſo and Reſtleſs Inquirer into Nature's Secrets will not ſtop here, but go on and proſper in the Diſquiſition or the other principal Colours, Green, Red, and Yellow. The Reaſoning faculty ſet once afloat, will be carried on, and that with eaſe, eſpecially, when the productions thereof meet, as they do here, with ſo greedy an Entertainment at home and abroad. I am confident, that the ROYAL SOCIETY, lately conſtituted by his MOST EXCELLENT MAJESTY for improving Natural knowledge, will Judge it their intereſt to exhort our Author to the proſecution of this Argument, conſidering, how much it is their deſign and buſineſs to accumulate a good ſtock of ſuch accurate Obſervations and Experiments, as may afford them and their Offpring genuine Matter to raiſe a Maſculine Philoſophy upon, whereby the Mind of Man may be enobled with the Knowledge of ſolid Truths, and the Life of Man benefited with ampler accommodations, than it hath been hitherto.

Our Great Author, one of the Pillars of that Illuſtrious Corporation, is conſtantly furniſhing large Symbola's to this work, and is now falln, as you ſee, upon ſo comprehenſive and important a theme, as will, if inſiſted on and compleated, prove one of the conſiderableſt peeces of that ſtructure. To which, if he ſhall pleaſe to add his Treatiſe of Heat and Flame, as he is ready to publiſh his Experimental Accounts of Cold, I eſteem, the World will be obliged to Him for having ſhewed them both the Right and Left Hand of Nature, and the Operations thereof.

The conſidering Reader will by this very Treatiſe ſee abundant cauſe to ſollicit the Author for more; ſure I am, that of whatever of the Productions of his Ingeny comes into Forein parts (where I am happy in the acquaintance of many intelligent friends) is highly valued; And to my knowledge, there are thoſe among the French, that have

lately begun to learn Engliſh, on purpoſe to enable themſelves to read his Books, being impatient of their Traduction into Latin. If I durſt ſay all, I know of the Elogies received by me from abroad concerning Him, I ſhould perhaps make this Preamble too prolix, and certainly offend the modeſty of our Author.

Wherefore I ſhall leave this, and conclude with deſiring the Reader, that if he meet with other faults beſides thoſe, that the Errata take notice of (as I believe he may) he will pleaſe to conſider both the weakneſs of the Authors eyes, for not reviewing, and the manifold Avocations of the Publiſher for not doing his part; who taketh his leave with inviting thoſe, that have alſo conſidered this Nice ſubject experimentally, to follow the Example of our Noble Author, and impart ſuch and the like performances to the now very inquiſitive world. Farewell.

H. O.

Decorative rule

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Decorative rule

Decorative rule

THE EXPERIMENTAL HISTORY OF COLOURS

BEGUN.

THE FIRST PART.

CHAP. I.

1 Illuminated I

have ſeen you ſo paſſionately addicted, Pyrophilus to the delightful Art of Limning and Painting, that I cannot but think my ſelf obliged to acquaint you with ſome of thoſe things that have occurred to mee concerning the changes of Colours. And I may expect that I ſhall as well ſerve the Virtuoſi in general, as gratifie you in particular, by furniſhing a perſon, who, I hope, will both improve my Communications, and communicate his Improvements, with ſuch Experiments and Obſervations as may both invite you to enquire ſeriouſly into the Nature of Colours, and aſſiſt you in the Inveſtigation of it. This being the principal ſcope of the following Tract, I ſhould do that which might prevent my own deſign, if I ſhould here attempt to deliver you an accurate and particular Theory of Colours; for that were to preſent you with what I deſire to receive from you; and, as farr as in mee lay, to make that ſtudy needleſs, to which I would engage you.

2 Wherefore my preſent work ſhall be but to divert and recreate, as well as excite you by the delivery of matters of fact, ſuch as you may for the moſt part try with much eaſe, and poſſibly not without ſome delight: And leſt you ſhould expect any thing of Elaborate or Methodical in what you will meet with here, I muſt confeſs to you before-hand, that the ſeaſons I was wont to chuſe to deviſe and try Experiments about Colours, were thoſe daies, wherein having taken Phyſick, and finding my ſelf as unfit to ſpeculate, as unwilling to be altogether idle, I choſe this diverſion, as a kind of Mean betwixt the one and the other. And I have the leſs ſcrupled to ſet down

the following Experiments, as ſome of them came to my mind, and as the Notes wherein I had ſet down the reſt, occurr'd to my hands, that by declining a Methodical way of delivering them, I might leave you and my ſelf the greater liberty and convenience to add to them, and tranſpoſe them as ſhall appear expedient.

3 Yea, that you may not think mee too reſerv'd, or look upon an Enquiry made up of meer Narratives, as ſomewhat jejune, am content to premiſe a few conſiderations, that now offer themſelves to my thoughts, which relate in a more general way, either to the Nature of Colours, or to the ſtudy of it. And I ſhall inſert an Eſſay, as well Speculative as Hiſtorical, of the Nature of Whiteneſs and Blackneſs, that you may have a Specimen of the Hiſtory of Colours, I have ſometimes had thoughts of; and if you diſlike not the Method I have made uſe of, I hope, you, and ſome of the Virtuoſi, your friends, may be thereby invited to go thorow with Red, Blew, Yellow, and the reſt of the particular Colours, as I have done with White and Black, but with farr more ſagacity and ſucceſs. And if I can invite Ingenious men to undertake ſuch Tasks, I doubt not but the Curious will quickly obtain a better Account of Colours, than as yet we have, ſince in our Method the Theorical part of the Enquiry being attended, and as it were interwoven with the Hiſtorical, whatever becomes of the diſputable Conjectures, the Philoſophy of Colours will be promoted by the indiſputable Experiments.

CHAP. II.

1 To come then in the firſt place to our more general Conſiderations, I ſhall begin with ſaying ſomething as to the Importance of examining the Colours of Bodies. For there are ſome, eſpecially Chymiſts, who think, that a conſiderable diverſity of Colours does conſtantly argue an equal diverſity of Nature, in the Bodies wherein it is conſpicuous; but I confeſs I am not altogether of their mind; for not to mention changeable Taffaties, the blew and golden necks of Pidgeons, and divers Water-fowl, Rainbows Natural and Artificial, and other Bodies, whoſe Colours the

Philoſophers have been pleaſed to call not Real, but Apparent and Phantaſtical; not to inſiſt on theſe, I ſay, (for fear of needleſly engaging in a Controverſie) we ſee in Parrots, Goldfinches, and divers other Birds, not only that the contiguous feathers which are probably as near in properties as place, are ſome of them Red, and others White, ſome of them Blew, & others Yellow, &c. but that in the ſeveral parts of the ſelf-ſame feather there may often be ſeen the greateſt diſparity of Colours; and ſo in the leaves of Tulips, July-flowers, and ſome other Vegetables the ſeveral leaves, and even the ſeveral parts of the ſame leaf, although no difference have been obſerved in their other properties, are frequently found painted with very different Colours. And ſuch a variety we have much more admired in that lovely plant which is commonly, and not unjuſtly call'd the Marvayl of Peru; for of divers ſcores of fine Flowers, which in its ſeaſon that gaudy Plant does almoſt daily produce, I have ſcarce taken notice of any two that were dyed perfectly alike. But though Pyro: ſuch things as theſe, among others, keep mee from daring to affirm, that the Diverſity and change of Colours does alwaies argue any great difference or alteration, betwixt, or in, the Bodies, wherein it is to be diſcerned, yet that oftentimes the Alteration of Colours does ſignifie conſiderable Alterations in the diſpoſition of parts of Bodies, may appear in the Extraction of Tinctures, and divers other Chymical Operations, wherein the change of Colours is the chief, and ſometimes the only thing, by which the Artiſt regulates his proceeding, and is taught to know when 'tis ſeaſonable for him to leave off. Inſtances of this ſort are more obvious in divers ſorts of fruits, as Cherries, Plums, &c. wherein, according as the Vegetable ſap is ſweetned, or otherwiſe ripened, by paſſing from one degree to another of Maturation, the external part of the fruit paſſes likewiſe from one to another Colour. But one of the nobleſt Inſtances I have met with of this kind, is not ſo obvious; and that is the way of tempering Steel to make Gravers, Drills, Springs, and other Mechanical Inſtruments, which we have divers times both made Artificers practiſe in our preſence, and tryed our ſelves, after the following manner, Firſt, the ſlender Steel to be tempered is to be

hardened by heating as much of it as is requiſite among glowing Coals, till it be glowing hot, but it muſt not be quenched aſſoon as it is taken from the fire (for that would make it too brittle, and ſpoil it) but muſt be held over a baſon of water, till it deſcend from a White heat to a Red one, which aſſoon as ever you perceive, you muſt immediately quench as much as you deſire to harden in the cold water. The Steel thus hardened, will, if it be good, look ſomewhat White and muſt be made bright at the end, that its change of Colours may be there conſpicuous; and then holding it ſo in the flame of a Candle, that the bright end may be, for about half an inch, or more, out of the flame, that the ſmoak do not ſtain or ſully the brightneſs of it, you ſhall after a while ſee that clean end, which is almoſt contiguous to the flame, paſs very nimbly from one Colour to another, as from a brighter Yellow, to a deeper and reddiſh Yellow, which Artificers call a ſanguine, and from that to a fainter firſt, and then a a deeper Blew. And to bring home this Experiment to our preſent purpoſe, it is found by daily Experience, that each of theſe ſucceeding Colours argue ſuch a change made in the texture of the Steel, that if it be taken from the flame, and immediately quenched in the tallow (whereby it is ſetled in whatever temper it had before) when it is Yellow, it is of ſuch a hardneſs as makes it fit for Gravers Drills, and ſuch like tools; but if it be kept a few minutes longer in the flame till it grow Blew, it becomes much ſofter, and unfit to make Gravers for Metalls, but fit to make Springs for Watches, and ſuch like Inſtruments, which are therefore commonly of that Colour; and if the Steel be kept in the flame, after that this deep Blew hath diſcloſed it ſelf, it will grow ſo ſoft, as to need to be new hardened again, before it can be brought to a temper, fit for Drills or Penknives. And I confeſs Pyro. I have taken much pleaſure to ſee the Colours run along from the parts of the Steel contiguous to the flame, to the end of the Inſtrument, and ſucceed one another ſo faſt, that if a man be not vigilant, to thruſt the Steel into the tallow at the very nick of time, at which it has attain'd its due Colour, he ſhall miſs of giving his tool the right temper. But becauſe the flame of a Candle is offenſive to my weak eyes, and becauſe

it is apt to either black or ſully the contiguous part of the Steel which is held in it, and thereby hinder the change of Colours from being ſo long and clearly diſcern'd, I have ſometimes made this Experiment by laying the Steel to be tempered upon a heated bar of Iron, which we finde alſo to be employ'd by ſome Artificers in the tempering of ſuch great Inſtruments, as are too big to be ſoon heated ſufficiently by the flame of a Candle. And you may eaſily ſatisfie your ſelf Pyro: of the differing hardneſs and toughneſs, which is aſcribed to Steel temper'd at different Colours, if you break but ſome ſlender wires of Steel ſo temper'd, and obſerve how they differ in brittleneſs, and if with a file you alſo make tryal of their various degrees of hardneſs.

2 But Pyrophilus, I muſt not at preſent any further proſecute the Conſideration of the importance of Experiments about Colours, not only becauſe you will in the following papers finde ſome inſtances, that would here be preſented you out of their due place, of the uſe that may be made of ſuch Experiments, in diſcovering in divers bodies, what kind the ſalt is, that is predominant in them; but alſo becauſe a ſpeculative Naturaliſt might juſtly enough allege, that as Light is ſo pleaſing an object, as to be well worth our looking on, though it diſcover'd to us nothing but its ſelf; ſo modifi'd Light called Colour, were worth our contemplation, though by underſtanding its Nature we ſhould be taught nothing elſe. And however, I need not make either you or my ſelf excuſes for entertaining you on the ſubject I am now about to treat of, ſince the pleaſure Pyro: takes in mixing and laying on of Colours, will I preſume keep him, and will (I am ſure) keep mee from thinking it troubleſome to ſet down, eſpecially after the tedious proceſſes (about other matters) wherewith I fear I may have tyr'd him, ſome eaſie, and not unpleaſant Experiments relating to that ſubject.

3 But, before we deſcend to the more particular conſiderations, we are to preſent you concerning Colours, I preſume it will be ſeaſonable to propoſe at the very entrance a Diſtinction; the ignorance or neglect of which, ſeems to mee to have frequently enough occaſioned either miſtakes or confuſion in the Writings of divers Modern

Philoſophers; for Colour may be conſidered, either as it is a quality reſiding in the body that is ſaid to be coloured, or to modifie the light after ſuch or ſuch a manner; or elſe as the Light it ſelf, which ſo modifi'd, ſtrikes upon the organ of ſight, and ſo cauſes that Senſation which we call Colour; and that this latter may be look'd upon as the more proper, though not the uſual acception of the word Colour, will be made probable by divers paſſages in the inſuing part of our diſcourſe; and indeed it is the Light it ſelf, which after a certain manner, either mingled with ſhades, or ſome other waies troubled, ſtrikes our eyes, that does more immediately produce that motion in the organ, upon whoſe account men ſay they ſee ſuch or ſuch a Colour in the object; yet, becauſe there is in the body that is ſaid to be coloured, a certain diſpoſition of the ſuperficial particles, whereby it ſends the Light reflected, or refracted, to our eyes thus and thus alter'd, and not otherwiſe, it may alſo in ſome ſenſe be ſaid, that Colour depends upon the viſible body; and therefore we ſhall not be againſt that way of ſpeaking of Colours that is moſt uſed among the Modern Naturaliſts, provided we be allowed to have recourſe when occaſion ſhall require to the premis'd diſtinction, and to take the more immediate cauſe of Colour to be the modifi'd Light it ſelf, as it affects the Senſory; though the diſpoſition alſo of the colour'd body, as that modifies the Light, may be call'd by that name Metonimically (to borrow a School term) or Efficiently, that is in regard of its turning the Light, that rebounds from it, or paſſes thorow it, into this or that particular Colour.

4 I know not whether I may not on this occaſion add, that Colour is ſo far from being an Inherent quality of the object in the ſenſe that is wont to be declar'd by the Schools, or even in the ſenſe of ſome Modern Atomiſts, that, if we conſider the matter more attentively, we ſhall ſee cauſe to ſuſpect, if not to conclude, that though Light do more immediately affect the organ of ſight, than do the bodies that ſend it thither, yet Light it ſelf produces the ſenſation of a Colour, but as it produces ſuch a determinate kind of local motion in ſome part of the brain; which, though it happen moſt commonly from the motion whereinto the ſlender ſtrings of the Retina are put,

by the appulſe of Light, yet if the like motion happen to be produc'd by any other cauſe, wherein the Light concurrs not at all, a man ſhall think he ſees the ſame Colour. For proof of this, I might put you in mind, that 'tis uſual for dreaming men to think they ſee the Images that appear to them in their ſleep, adorn'd ſome with this, and ſome with that lively Colour, whilſt yet, both the curtains of their bed, and thoſe of their eyes are cloſe drawn. And I might add the confidence with which diſtracted perſons do oftentimes, when they are awake, think, they ſee black fiends in places, where there is no black object in ſight without them. But I will rather obſerve, that not only when a man receives a great ſtroak upon his eye, or a very great one upon ſome other part of his head, he is wont to ſee, as it were, flaſhes of lightning, and little vivid, but vaniſhing flames, though perhaps his eyes be ſhut: But the like apparitions may happen, when the motion proceeds not from ſomething without, but from ſomething within the body, provided the unwonted fumes that wander up and down in the head, or the propagated concuſſion of any internal part in the body, do cauſe about the inward extremities of the Optick Nerve, ſuch a motion as is wont to be there produc'd, when the ſtroak of the Light upon the Retina makes us conclude, that we ſee either Light, or ſuch and ſuch a Colour: This the moſt ingenious Des Cartes hath very well obſerv'd, but becauſe he ſeems not to have exemplifi'd it by any unobvious or peculiar obſervation, I ſhall indeavour to illuſtrate this doctrine by a few Inſtances.

5 And firſt, I remember, that having, through Gods goodneſs, been free for ſeveral years, from troubleſome Coughs, being afterwards, by an accident, ſuddenly caſt into a violent one, I did often, when I was awaked in the night by my diſtempers, obſerve, that upon coughing ſtrongly, it would ſeem to mee, that I ſaw very vivid, but immediately diſappearing flames, which I took particular notice of, becauſe of the conjecture I am now mentioning.

6 An excellent and very diſcreet perſon, very near ally'd both to you and mee, was relating to mee, that ſome time ſince, whilſt ſhe was talking with ſome other Ladies,

upon a ſudden, all the objects, ſhe looked upon, appeared to her dyed with unuſual Colours, ſome of one kind, and ſome of another, but all ſo bright and vivid, that ſhe ſhould have been as much delighted, as ſurpriz'd with them, but that finding the apparition to continue, ſhe fear'd it portended ſome very great alteration as to her health: As indeed the day after ſhe was aſſaulted with ſuch violence by Hyſterical and Hypocondrical Diſtempers, as both made her rave for ſome daies, and gave her, during that time, a Baſtard Palſey.

7 Being a while ſince in a Town, where the Plague had made great havock, and inquiring of an ingenious man, that was ſo bold, as without much ſcruple to viſit thoſe that were ſick of it, about the odd ſymptomes of a Diſeaſe that had ſwept away ſo many there; he told mee, among other things, that he was able to tell divers Patients, to whom he was called, before they took their beds, or had any evident ſymptomes of the Plague, that they were indeed infected upon peculiar obſervations, that being asked, they would tell him that the neighbouring objects, and particularly his cloths, appear'd to them beautifi'd with moſt glorious Colours, like thoſe of the Rainbow, oftentimes ſucceeding one another; and this he affirm'd to be one of the moſt uſual, as well as the moſt early ſymptomes, by which this odd Peſtilence diſclos'd it ſelf: And when I asked how long the Patients were wont to be thus affected, he anſwered, that it was moſt commonly for about a day; and when I further inquired whether or no Vomits, which in that Peſtilence were uſually given, did not remove this ſymptome (For ſome uſed the taking of a Vomit, when they came aſhore, to cure themſelves of the obſtinate and troubleſome giddineſs caus'd by the motion of the ſhip) reply'd, that generally, upon the evacuation made by the Vomit, that ſtrange apparition of Colours ceaſed, though the other ſymptomes were not ſo ſoon abated, yet he added (to take notice of that upon the by, becauſe the obſervation may perchance do good) that an excellent Phyſician, in whoſe company he was wont to viſit the ſick, did give to almoſt all thoſe to whom he was called, in the beginning before Nature was much weakened, a pretty odd Vomit conſiſting of

eight or ten dramms of Infuſion of Crocus Metallorum, and about half a dramm, or much more, of White Vitriol, with ſuch ſucceſs, that ſcarce one of ten to whom it was ſeaſonably adminiſtred, miſcarried.

8 But to return to the conſideration of Colours: As an apparition of them may be produced by motions from within, without the aſſiſtance of an outward object, ſo I have obſerved, that 'tis ſometimes poſſible that the Colour that would otherwiſe be produced by an outward object, may be chang'd by ſome motion, or new texture already produced in the Senſory, as long as that unuſual motion, or new diſpoſition laſts; for I have divers times try'd, that after I have through a Teleſcope look'd upon the Sun, though thorow a thick, red, or blew glaſs, to make its ſplendor ſupportable to the eye, the impreſſion upon the Retina, would be not only ſo vivid, but ſo permanent, that if afterwards I turned my eye towards a flame, it would appear to mee of a Colour very differing from its uſual one. And if I did divers times ſucceſſively ſhut and open the ſame eye, I ſhould ſee the adventitious Colour, (if I may ſo call it) changed or impair'd by degrees, till at length (for this unuſual motion of the eye would not preſently ceaſe) the flame would appear to mee, of the ſame hew that it did to other beholders; a not unlike effect I found by looking upon the Moon, when ſhe was near full, thorow an excellent Teleſcope, without colour'd Glaſs to ſcreen my eye with; But that which I deſire may be taken notice of, becauſe we may elſewhere have occaſion to reflect upon it, and becauſe it ſeems not agreeable to what Anatomiſts and Optical Writers deliver, touching the relation of the two eyes to each other, is this circumſtance, that though my Right eye, with which I looked thorow the Teleſcope, were thus affected by the over-ſtrong impreſſion of the light, yet when the flame of a Candle, or ſome other bright object appear'd to me of a very unuſual Colour, whilſt look'd upon with the Diſcompos'd Eye, or (though not ſo notably) with both eyes at once; yet if I ſhut that Eye, and looked upon the ſame object with the other, it would appear with no other than its uſual Colour, though if I again opened, and made uſe of the Dazled eye, the vivid adventitious Colour would

again appear. And on this occaſion I muſt not pretermit an Obſervation which may perſwade us, that an over-vehement ſtroak upon the Senſory, eſpecially if it be naturally of a weak conſtitution, may make a more laſting impreſſion than one would imagine, which impreſſion may in ſome caſes, as it were, mingle with, and vitiate the action of vivid objects for a long time after.

For I know a Lady of unqueſtionable Veracity, who having lately, by a deſperate fall, receiv'd ſeveral hurts, and particularly a conſiderable one upon a part of her face near her Eye, had her ſight ſo troubl'd and diſorder'd, that, as ſhe hath more than once related to me, not only when the next morning one of her ſervants came to her bed ſide, to ask how ſhe did, his cloaths appear'd adorn'd with ſuch variety of dazling Colours, that ſhe was fain preſently to command him to withdraw, but the Images in her Hangings, did, for many daies after, appear to her, if the Room were not extraordinarily darken'd, embelliſh'd with ſeveral offenſively vivid Colours, which no body elſe could ſee in them; And when I enquir'd whether or no White Objects did not appear to her adorn'd with more luminous Colours than others, and whether ſhe ſaw not ſome which ſhe could not now well deſcribe to any, whoſe eyes had never been diſtemper'd, ſhe anſwer'd mee, that ſometimes ſhe thought ſhe ſaw Colours ſo new and glorious, that they were of a peculiar kind, and ſuch as ſhe could not deſcribe by their likeneſs to any ſhe had beheld either before or ſince, and that White Objects did ſo much diſorder her ſight, that if ſeveral daies after her fall, ſhe look'd upon the inſide of a Book, ſhe fanci'd ſhe ſaw there Colours like thoſe of the Rain-bow, and even when ſhe thought her ſelf pretty well recover'd, and made bold to leave her Chamber, the coming into a place where the Walls and Ceeling were whited over, made thoſe Objects appear to her cloath'd with ſuch glorious and dazling Colours, as much offended her ſight, and made her repent her venturouſneſs, and ſhe added, that this Diſtemper of her Eyes laſted no leſs than five or ſix weeks, though, ſince that, ſhe hath been able to read and write much without finding the leaſt Inconvenience in doing ſo. I would gladly have known, whether if ſhe had ſhut

the Injur'd Eye, the Phænomena would have been the ſame, when ſhe employ'd only the other, but I heard not of this accident early enough to ſatisfie that Enquiry.

9 Wherefore, I ſhall now add, that ſome years before, a perſon exceedingly eminent for his profound Skil in almoſt all kinds of Philological Learning, coming to adviſe with mee about a Diſtemper in his Eyes, told me, among other Circumſtances of it, that, having upon a time looked too fixedly upon the Sun, thorow a Teleſcope, without any coloured Glaſs, to take off from the dazling ſplendour of the Object, the exceſs of Light did ſo ſtrongly affect his Eye, that ever ſince, when he turns it towards a Window, or any White Object, he fancies, he ſeeth a Globe of Light, of about the bigneſs the Sun then appeared of to him, to paſs before his Eyes: And having Inquir'd of him, how long he had been troubled with this Indiſpoſition, he reply'd, that it was already nine or ten years, ſince the Accident, that occaſioned it, firſt befel him.

I could here ſubjoyn, Pyrophilus, ſome memorable Relations that I have met with in the Account given us by the experienc'd Epiphanius Ferdinandus, of the Symptomes he obſerv'd to be incident to thoſe that are bitten with the Tarantula, by which (Relations) I could probably ſhew, that without any change in the Object, a change in the Inſtruments of Viſion may for a great while make ſome Colours appear Charming, and make others Provoking, and both to a high degree, though neither of them produc'd any ſuch Effects before. Theſe things, I ſay, I could here ſubjoyn in confirmation of what I have been ſaying, to ſhew, that the Diſpoſition of the Organ is of great Importance in the Dijudications we make of Colours, were it not that theſe ſtrange Stories belonging more properly to another Diſcourſe, I had rather, (contenting my ſelf to have given you an Intimation of them here) that you ſhould meet with them fully deliver'd there.

CHAP. III.

But, Pyrophilus, I would not by all that I have hitherto diſcours'd, be thought to have

forgotten the Diſtinction (of Colour) that I mentioned to you about the beginning of the third Section of the former Chapter; and therefore, after all I have ſaid of Colour, as it is modifi'd Light, and immediately affects the Senſory, I ſhall now re-mind you, that I did not deny, but that Colour might in ſome ſenſe be conſider'd as a Quality reſiding in the body that is ſaid to be Colour'd, and indeed the greateſt part of the following Experiments referr to Colour principally under that Notion, for there is in the bodyes we call Colour'd, and chiefly in their Superficial parts, a certain diſpoſition, whereby they do ſo trouble the Light that comes from them to our Eye, as that it there makes that diſtinct Impreſſion, upon whoſe Account we ſay, that the Seen body is either White or Black, or Red or Yellow, or of any one determinate Colour. But becauſe we ſhall (God permiting) by the Experiments that are to follow ſome Pages hence, more fully and particularly ſhew, that the Changes, and conſequently in divers places the Production and the appearance of Colours depends upon the continuing or alter'd Texture of the Object, we ſhall in this place intimate (and that too but as by the way) two or three things about this Matter.

2. And firſt it is not without ſome Reaſon, that I aſcribe Colour (in the ſenſe formerly explan'd) chiefly to the Superficial parts of Bodies, for not to queſtion how much Opacous Corpuſcles may abound even in thoſe Bodies we call Diaphanous, it ſeems plain that of Opacous bodies we do indeed ſee little elſe than the Superficies, for if we found the beams of Light that rebound from the Object to the Eye, to peirce deep into the Colour'd body, we ſhould not judge it Opacous, but either Tranſlucid, or at leaſt Semi-diaphanous, and though the Schools ſeem to teach us that Colour is a Penetrative Quality, that reaches to the Innermoſt parts of the Object, as if a piece of Sealing-wax be broken into never ſo many pieces, the Internal fragments will be as Red as the External ſurface did appear, yet that is but a Particular Example that will not overthrow the Reaſon lately offer'd, eſpecially ſince I can alleage other Examples of a contrary Import, and two or three Negative Inſtances are ſufficient to overthrow the Generality of a Poſitive Rule, eſpecially if that be built but upon One or a Few

Examples. Not (then) to mention Cherries, Plums, and I know not how many other Bodies, wherein the skin is of one Colour, and what it hides of another, I ſhall name a couple of Inſtances drawn from the Colours of Durable bodies that are thought far more Homogeneous, and have not parts that are either Organical, or of a Nature approaching thereunto.

3 To give you the firſt Inſtance, I ſhall need but to remind you of what I told you a little after the beginning of this Eſſay, touching the Blew and Red and Yellow, that may be produc'd upon a piece of temper'd Steel, for theſe Colours though they be very Vivid, yet if you break the Steel they adorn, they will appear to be but Superficial; not only the innermoſt parts of the Metall, but thoſe that are within a hairs breadth of the Superficies, having not any of theſe Colours, but retaining that of the Steel it ſelf. Beſides that, we may as well confirm this Obſervation, as ſome other particulars we elſewhere deliver concerning Colours, by the following Experiment which we purpoſely made.

4 We took a good quantity of clean Lead, and melted it with a ſtrong Fire, and then immediately pouring it out into a clean Veſſel of a convenient ſhape and matter, (we us'd one of Iron, that the great and ſudden Heat might not injure it) and then carefully and nimbly taking off the Scum that floated on the top, we perceiv'd, as we expected, the ſmooth and gloſſie Surface of the melted matter, to be adorn'd with a very glorious Colour, which being as Tranſitory as Delightfull, did almoſt immediately give place to another vivid Colour, and that was as quickly ſucceeded by a third, and this as it were chas'd away by a fourth, and ſo theſe wonderfully vivid Colours ſucceſſively appear'd and vaniſh'd, (yet the ſame now and then appearing the ſecond time) till the Metall ceaſing to be hot enough to afford any longer this pleaſing Spectacle, the Colours that chanc'd to adorn the Surface, when the Lead thus began to cool, remain'd upon it; but were ſo Superficial, that how little ſoever we ſcrap'd off the Surface of the Lead, we did in ſuch places ſcrape off all the Colour, and diſcover only that which is natural to the Metall it ſelf, which receiving

its adventitious Colours, only when the heat was very Intenſe, and in that part which was expos'd to the comparatively very cold Air, (which by other Experiments ſeems to abound with ſubtil Saline parts, perhaps not uncapable of working upon Lead ſo diſpos'd:) Theſe things I ſay, together with my obſerving that whatever parts of the ſo ſtrongly melted Lead were expos'd a while to the Air, turn'd into a kind of Scum or Litharge, how bright and clean ſoever they appear'd before, ſuggeſted to me ſome Thoughts or Ravings, which I have not now time to acquaint You with. One that did not know me, Pyrophilus, would perchance think I endeavour'd to impoſe upon You by relating this Experiment, which I have ſeveral times try'd, but the Reaſon why the Phænomena mention'd have not been taken notice of, may be, that unleſs Lead be brought to a much higher degree of Fuſion or Fluidity than is uſual, or than is indeed requiſite to make it melt, the Phænomena I mention'd will ſcarce at all diſcloſe themſelves; And we have alſo obſerv'd that this ſucceſſive appearing and vaniſhing of vivid Colours, was wont to be impair'd or determin'd whilſt the Metal expos'd to the Air remain'd yet hotter than one would readily ſuſpect. And one thing I muſt further Note, of which I leave You to ſearch after the Reaſon, namely, that the ſame Colours did not always and regularly ſucceed one another, as is uſually in Steel, but in the diverſify'd Order mention'd in this following Note, which I was ſcarce able to write down, the ſucceſſion of the Colours was ſo very quick, whether that proceeded from the differing degrees of Heat in the Lead expos'd to the cool Air, or from ſome other Reaſon, I leave you to examine.

[Blew, Yellow, Purple, Blew; Green, Purple, Blew, Yellow, Red; Purple, Blew, Yellow and Blew, Yellow, Blew, Purple, Green mixt, Yellow, Red, Blew, Green, Yellow, Red, Purple, Green.]

5. The Atomiſts of Old, and ſome Learned men of late, have attempted to explicate the variety of Colours in Opacous bodies from the various Figures of their Superficial parts; the attempt is Ingenious, and the Doctrine ſeems partly True, but I confeſs I think there are divers other things that muſt be taken in as concurrent to

produce thoſe differing forms of Aſperity, whereon the Colours of Opacous bodies ſeem to depend. To declare this a little, we muſt aſſume, that the Surfaces of all ſuch Bodies how Smooth or polite ſoever they may appear to our Dull Sight and Touch, are exactly ſmooth only in a popular, or at moſt in a Phyſical ſenſe, but not in a ſtrict and rigid ſenſe.

6. This, excellent Microſcopes ſhew us in many Bodies, that ſeem Smooth to our naked Eyes; and this not only as to the little Hillocks or Protuberancies that ſwell above that which may be conceiv'd to be the Plain or Level of the conſider'd Surface, for it is obvious enough to thoſe that are any thing converſant with ſuch Glaſſes, but as to numerous Depreſſions beneath that Level, of which ſort of Cavities by the help of a Microſcope, which the greateſt Artificer that makes them, judges to be the greateſt Magnifying Glaſs in Europe, except one that equals it, we have on the Surface of a thin piece of Cork that appear'd ſmooth to the Eye, obſerv'd about ſixty in a Row, within the length of leſs then an 31 and 32 part of an Inch, (for the Glaſs takes in no longer a ſpace at one view) and theſe Cavities (which made that little piece of Cork look almoſt like an empty Honey-comb) were not only very diſtinct, and figur'd like one another, but of a conſiderable bigneſs, and a ſcarce credible depth; inſomuch that their diſtinct ſhadows as well as ſides were plainly diſcern'd and eaſiy to be reckon'd, and might have been well diſtinguiſh'd, though they had been ten times leſſer than they were; which I thought it not amiſs to mention to you Pyrophilus upon the by, that you may thence make ſome Eſtimate, what a ſtrange Inequality, and what a multitude of little Shades, there may really be, in a ſcarce ſenſible part of the Phyſical ſuperficies, though the naked Eye ſees no ſuch matter. And as Excellent Microſcopes ſhew us this Ruggedneſs in many Bodies that paſs for Smooth, ſo there are divers Experiments, though we muſt not now ſtay to urge them, which ſeem to perſwade us of the ſame thing as to the reſt of ſuch Bodies as we are now treating off; So, that there is no ſenſible part of an Opacous body, that may not be conceiv'd to be made up of a multitude of ſingly inſenſible Corpuſcles, but in the

giving theſe ſurfaces that diſpoſition, which makes them alter the Light that reflects thence to the Eye after the manner requiſite to make the Object appear Green, Blew, &c. the Figures of theſe Particles have a great, but not the only ſtroak. 'Tis true indeed that the protuberant Particles may be of very great variety of Figures, Sphærical, Elliptical, Conical, Cylindrical, Polyedrical, and ſome very irregular, and that according to the Nature of theſe, and the ſituation of the Lucid body, the Light muſt be variouſly affected, after one manner from Surfaces (I now ſpeak of Phyſical Surfaces) conſiſting of Sphaerical, and in another from thoſe that are made up of Conical or Cylindrical Corpuſcles; ſome being fitted to reflect more of the incident Beams of Light, others leſs, and ſome towards one part, others towards another. But beſides this difference of Shape, there may be divers other things that may eminently concurr to vary the forms of Aſperity that Colours ſo much depend on. For, willingly allowing the Figure of the Particles in the firſt place, I conſider ſecondly, that the ſuperficial Corpuſcles, if I may ſo call them, may be bigger in one Body, and leſs in another, and conſequently fitted to allay the Light falling on them with greater ſhades. Next, the protuberant Particles may be ſet more or leſs cloſe together, that is, there may be a greater or a ſmaller number of them within the compaſs of one, than within the compaſs of another ſmall part of the Surface of the ſame Extent, and how much theſe Qualities may ſerve to produce Colour may be ſomewhat gueſs'd at, by that which happens in the Agitation of Water; for if the Bubbles that are thereby made be Great, and but Few, the Water will ſcarce acquire a ſenſible Colour, but if it be reduc'd to a Froth, conſiſting of Bubbles, which being very Minute and Contiguous to each other, are a multitude of them crowded into a narrow Room, the Water (turned to Froth) does then exhibit a very manifeſt White Colour,3 (to which theſe laſt nam'd Conditions of the Bubbles do as well as their Convex figure contribute) and that for Reaſons to be mention'd anon. Beſides, it is not neceſſary that the Superficial particles that exhibit one Colour, ſhould be all of them Round, or all Conical, or all of any one Shape, but Corpuſcles of differing Figures may be mingled

on the Surface of the Opacous Body, as when the Corpuſcles that make a Blew colour, and thoſe that make a Yellow, come to be Accurately and Skilfully mix'd, they make up a Green, which though it ſeem one ſimple Colour, yet in this caſe appears to be made by Corpuſcles of very differing Kinds, duely commix'd. Moreover the Figure and Bigneſs of the little Depreſſions, Cavities, Furrows or Pores intercepted betwixt theſe protuberant Corpuſcles, are as well to be conſider'd as the Sizes and Shapes of the Corpuſcles themſelves: For we may conceive the Phyſical ſuperficies of a Body, where (as we ſaid) its Colour does as it were reſide, to be cut Tranſverſly by a Mathematical plain, which you know is conceiv'd to be without any Depth or Thickneſs at all, and then as ſome parts of the Phyſical Superficies will be Protuberant; or ſwell above this laſt plain, ſo others may be depreſs'd beneath it; as (to explane my ſelf by a groſs Compariſon) in divers places of the Surface of the Earth, there are not only Neighbouring Hills, Trees, &c. that are rais'd above the Horizontal Level of the Valley, but Rivers, Wells, Pits and other Cavities that are depreſs'd beneath it, and that ſuch Protuberant and Concave parts of a Surface may remit the Light ſo differingly, as much to vary a Colour, ſome examples and other things, that we ſhall hereafter have occaſion to take notice off in this Tract, will ſufficiently declare, till when, it may ſuffice to put you in mind, that of two Flat-ſides of the ſame piece of, for example, red Marble, the one being diligently Poliſhed, and the other left to its former Roughneſs, the differing degrees or ſorts of Aſperity, for the ſide that is ſmooth to the Touch wants not its Roughneſs, will ſo diverſifie the Light reflected from the ſeveral Plains to the Eye, that a Painter would employ two differing Colours to repreſent them.

7. And I hope, Pyrophilus, you will not think it ſtrange or impertinent, that I employ in divers paſſages of theſe Papers, examples drawn from Bodies and Shadows far more Groſs, than thoſe minute Protuberances and ſhady Pores on which in moſt caſes the Colour of a Body as 'tis an Inherent Quality or Diſpoſition of its Surface, ſeems to depend. For ſometimes I employ ſuch Examples, rather to declare my Meaning,

than prove my Conjecture; things, whom their Smallneſs makes Inſenſible, being better repreſented to the Imagination by ſuch familiar Objects, as being like them enough in other reſpects, are of a Viſible bulk. And next, though the Beams of Light are ſuch ſubtil Bodies, that in reſpect of them, even Surfaces that are ſenſibly Smooth, are not exactly ſo, but have their own degree of Roughneſs, conſiſting of little Protuberances and Depreſſions; and though conſequently ſuch Inequalities may ſuffice to give Bodies differing Colours, as we ſee in Marble that appears White or Black, or Red or Blew, even when the moſt carefully Poliſh'd, yet 'tis plain by the late Inſtance of Red Marble, and many others, that even bigger Protuberances and greater Shades may likewiſe ſo Diverſifie the Roughneſs of a Bodies Superficies, as manifeſtly to concurr to the varying of its Colour, whereby ſuch Examples appear to be proper enough to be employ'd in ſuch a Subject as we have now in hand. And having hinted thus much on this Occaſion, I now proceed.

8. The Situation alſo of the Superficial particles is conſiderable, which I diſtinguiſh into the Poſture of the ſingle Corpuſcles, in reſpect of the Light, and of the Eye, and the Order of them in reference alſo to one another; for a Body may otherwiſe reflect the Light, when its Superficial particles are more erected upon the Plain that may be conceiv'd to paſs along their Baſis, and when the Points or Extremes of ſuch Particles are Obverted to the Eye, than when thoſe Particles are ſo Inclin'd, that their Sides are in great part Diſcernable, as the Colour of Pluſh or Velvet will appear Vary'd to you, if you carefully ſtroak part of it one way, and part of it another, the poſture of the particular Thrids, in reference to the Light, or the Eye, becoming thereby different. And you may obſerve in a Field of ripe Corn blown upon by the Wind, that there will appear as it were Waves of a Colour (at leaſt Gradually) differing from that of the reſt of the Field, the Wind by Depreſſing ſome of the Ears, and not at the ſame time others, making the one Reflect more from the Lateral and Strawy parts, than do the reſt. And ſo, when Doggs are ſo angry, as to Erect the Hairs upon their Necks, and upon ſome other parts of their Bodies, thoſe Parts ſeem to acquire a Colour

vary'd from that which the ſame Hairs made, when in their uſual Poſture they did farr more ſtoop. And that the Order wherein the Superficial Corpuſcles are Rang'd is not to be neglected, we may gueſs by turning of Water into Froth, the beating of Glaſs, and the ſcraping of Horns, in which caſes the Corpuſcles that were before ſo marſhall'd as to be Perſpicuous, do by the troubling of that Order become Diſpos'd to terminate and reflect more Light, and thereby to appear Whitiſh. And there are other ways in which the Order of the Protuberant parts, in reference to the Eye, may much contribute to the appearing of a particular Colour, for I have often obſerv'd, that when Peaſe are Planted, or Set in Parallel Lines, and are Shot up about half a Foot above the Surface of the Ground, by looking on the Field or Plot of Ground from that part towards which the Parallel Lines tended, the greater part of the Ground by farr would appear of its own dirty Colour, but if I look'd upon it Tranſverſly, the Plot would appear very Green, the upper parts of the Peaſe hindering the intercepted parts of the Ground, which as I ſaid retain'd their wonted Colour, from being diſcover'd by the Eye. And I know not, Pyrophilus, whether I might not add, that even the Motion of the Small Parts of a Viſible Object may in ſome caſes contribute, though it be not ſo eaſie to ſay how, to the Producing or the Varying of a Colour; for I have ſeveral times made a Liquor, which when it has well ſettled in a cloſe Vial, is Tranſparent and Colourleſs, but as ſoon as the Glaſs is unſtopp'd, begins to fly away very plentifully in a White and Opacous fume; and there are other Bodies, whoſe Fumes, when they fill a Receiver, would make one ſuſpect it contains Milk, and yet when theſe Fumes ſettle into a Liquor, that Liquor is not White, but Tranſparent; And ſuch White Fumes I have ſeen afforded by unſtopping a Liquor I know, which yet is it ſelf Diaphanous and Red; Nor are theſe the only Inſtances of this Kind, that our Tryals can ſupply us with. And if the Superficial Corpuſcles be of the Groſſer ſort, and be ſo Framed, that their differing Sides or Faces may exhibit differing Colours, then the Motion or Reſt of thoſe Corpuſcles may be conſiderable, as to the Colour of the Superficies they compoſe, upon this account, that ſometimes more, ſometimes fewer

of the Sides diſpos'd to exhibit ſuch a Colour may by this means become or continue more Obverted to the Eye than the reſt, and compoſe a Phyſical Surface, that will be more or leſs ſenſibly interrupted; As, to explane my meaning, by propoſing a groſs Example, I remember, that in ſome ſorts of Leavy Plants thick ſet by one another, the two ſides of whoſe Leaves were of ſomewhat differing Colours, there would be a notable Diſparity as to Colour, if you look'd upon them both when the Leaves being at Reſt had their upper and commonly expos'd ſides Obverted to the Eye, and when a breath of Wind paſſing thorow them, made great Numbers of the uſually Hidden ſides of the Leaves become conſpicuous. And though the Little Bodies, we were lately ſpeaking of, may Singly and Apart ſeem almoſt Colourleſs, yet when Many of them are plac'd by one another, ſo near, that the Eye does not eaſily diſcern an Interruption, within a ſenſible ſpace, they may exhibit a Colour; as we ſee, that though a Slendereſt Thrid of Dy'd Silk do's, whilſt look'd on Single, ſeem almoſt quite Devoyd of Redneſs, (for inſtance) yet when numbers of theſe Thrids are brought together into one Skein, their Colour becomes notorious.

9. But the ſame Occaſion that invited me to ſay what I have mention'd concerning the Leaves of Trees, invites me alſo to give you ſome account of what happens in Changeable Taffities, where we ſee differing Colours, as it were, Emerge and Vaniſh upon the Ruffling of the ſame piece of Silk: As I have divers times with Pleaſure obſerv'd, by the help of ſuch a Microſcope, as, though it do not very much Magnifie the Object, has in recompence this great Conveniency, that you may eaſily, as faſt as you pleaſe, remove it from one part to another of a Large Object, of which the Glaſs taking a great part at once, you may thereby preſently Survey the Whole. Now by the help of ſuch a Microſcope I could eaſily (as I began to ſay) diſcern, that in a piece of Changeable Taffity, (that appear'd, for Inſtance, ſometimes Red, and ſometimes Green) the Stuff was compos'd of Red thrids and Green, paſſing under and over each other, and croſſing one another in almoſt innumerable points; and if I look'd through the Glaſs upon any conſiderable portion of the Stuff, that (for example ſake) to the

naked Eye appear'd to be Red, I could plainly ſee, that in that Poſition, the Red thrids were Conſpicuous, and reflected a vivid Light; and though I could alſo perceive, that there were Green ones, yet by reaſon of their diſadvantagious Poſition in the Phyſical Surface of the Taffity, they were in part hid by the more Protuberant Thrids of the other Colour; and for the ſame cauſe, the Reflection from as much of the Green as was diſcover'd, was comparatively but Dim and Faint. And if, on the contrary, I look'd through the Microſcope upon any part that appear'd Green, I could plainly ſee that the Red thrids were leſs fully expos'd to the Eye, and obſcur'd by the Green ones, which therefore made up the Predominant Colour. And by obſerving the Texture of the Silken Stuff, I could eaſily ſo expoſe the Thrids either of the one Colour or of the other to my Eye, as at pleaſure to exhibit an apparition of Red or Green, or make thoſe Colours ſucceed one another: So that, when I obſerv'd their Succeſſion by the help of the Glaſs, I could mark how the Predominant Colour did as it were ſtart out, when the Thrids that exhibited it came to be advanagiouſly plac'd; And by making little Folds in the Stuff after a certain manner, the Sides that met and terminated in thoſe Folds, would appear to the naked Eye, one of them Red, and the other Green. When Thrids of more than two differing Colours chance to be Interwoven, the reſulting changeableneſs of the Taffity may be alſo ſomewhat different. But I chooſe to give an Inſtance in the Stuff I have been ſpeaking off, becauſe the mixture being more Simple, the way whereby the Changeableneſs is produc'd, may be the more eaſily apprehended: and though Reaſon alone might readily enough lead a conſidering Man to gueſs at the Explication, in caſe he knew how Changeable Taffities are made: yet I thought it not impertinent to mention it, becauſe both Scholars and Gentlemen are wont to look upon the Inquiry into Manufactures, as a Mechanick imployment, and conſequently below Them; and becauſe alſo with ſuch a Microſcope as I have been mentioning, the diſcovery is as well Pleaſant as Satisfactory, and may afford Hints of the Solution of other Phænomena of Colours. And it were not amiſs, that ſome diligent Inquiry were

made, whether the Microſcope would give us an account of the Variableneſs of Colour, that is ſo Conſpicuous and ſo Delightfull in Mother of Pearl, in Opalls, and ſome other reſembling Bodies: For though I remember I did formerly attempt ſomething of that Kind (fruitleſly enough) upon Mother of Pearl, yet not having then the advantage of my beſt Microſcope, nor ſome Conveniences that might have been wiſh'd, I leave it to you, who have better Eyes, to try what you can do further; ſince 'twill be Some diſcovery to find, that, in this caſe, the beſt Eyes and Microſcopes themſelves can make None.

10. I confeſs, Pyrophilus, that a great part of what I have deliver'd, (or propos'd rather) concerning the differing forms of Aſperity in Bodies, by which Differences the incident Light either comes to be Reflected with more or leſs of Shade, and with that Shade more or leſs Interrupted, or elſe happens to be alſo otherwiſe Modify'd or Troubl'd, is but Conjectural. But I am not ſure, that if it were not for the Dullneſs of our Senſes, either theſe or ſome other Notions of Kin to them, might be better Countenanc'd; for I am apt to ſuſpect, that if we were Sharp ſighted enough, or had ſuch perfect Microſcopes, as I fear are more to be wiſh'd than hop'd for, our promoted Senſe might diſcern in the Phyſical Surfaces of Bodies, both a great many latent Ruggidneſſes, and the particular Sizes, Shapes, and Situations of the extremely little Bodies that cauſe them, and perhaps might perceive among other Varieties that we now can but imagine, how thoſe little Protuberances and Cavities do Interrupt and Dilate the Light, by mingling with it a multitude of little and ſingly undiſcernable Shades, though ſome of them more, and ſome of them leſs Minute, ſome leſs, and ſome more Numerous; according to the Nature and Degree of the particular Colour we attribute to the Viſible Object; as we ſee, that in the Moon we can with Excellent Teleſcopes diſcern many Hills and Vallies, and as it were Pits and other Parts, whereof ſome are more, and ſome leſs Vividly illuſtrated, and others have a fainter, others a deeper Shade, though the naked Eye can diſcern no ſuch matter in that Planet. And with an Excellent Microſcope, where the Naked Eye did

ſee but a Green powder, the Aſſisted Eye as we noted above, could diſcern particular Granules, ſome of them of a Blew, and ſome of them of a Yellow colour, which Corpuſcles we had beforehand caus'd to be exquiſitly mix'd to compound the Green.

11. And, Pyrophilus, that you may not think me altogether extravagant in what I have ſaid of the Poſſibility, (for I ſpeak of no more) of diſcerning the differing forms of Aſperity in the Surfaces of Bodies of ſeveral Colours, I'l here ſet down a Memorable particular that chanc'd to come to my Knowledge, ſince I writ a good part of this Eſſay; and it is this. Meeting caſually the other Day with the deſervedly Famous4 Dr. J. Finch, Extraordinary Anatomiſt to that Great Patron of the Virtuoſi, the now Great Duke of Toſcany, and enquiring of this Ingenious Perſon, what might be the chief Rarity he had ſeen in his late return out of Italy into England, he told me, it was a Man at Maeſtricht in the Low-Countrys, who at certain times can diſcern and diſtinguiſh Colours by the Touch with his Fingers. You'l eaſily Conclude, that this is farr more ſtrange, than what I propos'd but as not Impoſſible; ſince the Senſe of the Retina ſeeming to be much more Tender and quick than that of thoſe Groſſer Filaments, Nerves or Membranes of our Fingers, wherewith we uſe to handle Groſs and Hard Bodies, it ſeems ſcarce credible, that any Accuſtomance, or Diet, or peculiarity of Conſtitution, ſhould enable a Man to diſtinguiſh with ſuch Groſs and Unſuitable Organs, ſuch Nice and Subtile Differences as thoſe of the forms of Aſperity, that belong to differing Colours, to receive whoſe Languid and Delicate Impreſſions by the Intervention of Light, Nature ſeems to have appointed and contexed into the Retina the tender and delicate Pith of the Optick Nerve. Wherefore I confeſs, I propos'd divers Scruples, and particularly whether the Doctor had taken care to bind a Napkin or Hankerchief over his Eyes ſo carefully, as to be ſure he could make no uſe of his Sight, though he had but Counterfeited the want of it, to which I added divers other Queſtions, to ſatisfie my Self, whether there were any Likelihood of Colluſion or other Tricks. But I found that the Judicious Doctor having gone farr out of his way, purpoſely to ſatisfie Himſelf and his Learned Prince

about this Wonder, had been very Watchfull and Circumſpect to keep Himſelf from being Impos'd upon. And that he might not through any miſtake in point of Memory mis-inform Me, he did me the Favour at my Requeſt, to look out the Notes he had Written for his Own and his Princes Information, the ſumm of which Memorials, as far as we ſhall mention them here, was this, That the Doctor having been inform'd at Utrecht, that there Lived one at ſome Miles diſtance from Maestricht, who could diſtinguiſh Colours by the Touch, when he came to the laſt nam'd Town, he ſent a Meſſenger for him, and having Examin'd him, was told upon Enquiry theſe Particulars:

That the Man's name was John Vermaaſen, at that time about 33 Years of Age; that when he was but two years Old, he had the Small Pox, which rendred him abſolutely Blind: That at this preſent he is an Organiſt, and ſerves that Office in a publick Quire.

That the Doctor diſcourſing with him over Night, the Blind man affirm'd, that he could diſtinguiſh Colours by the Touch, but that he could not do it, unleſs he were Faſting; Any quantity of Drink taking from him that Exquiſitneſs of Touch, which is requiſite to ſo Nice a Senſation.

That hereupon the Doctor provided againſt the next Morning ſeven pieces of Ribbon, of theſe ſeven Colours, Black, White, Red, Blew, Green, Yellow, and Gray, but as for mingled Colours, this Vermaaſen would not undertake to diſcern them, though if offer'd, he would tell that they were Mix'd.

That to diſcern the Colour of the Ribbon, he places it betwixt the Thumb and the Fore-finger, but his moſt exquiſite perception was in his Thumb, and much better in the right Thumb than in the left.

That after the Blind man had four or five times told the Doctor the ſeveral Colours, (though Blinded with a Napkin for fear he might have ſome Sight) the Doctor found he was twice miſtaken, for he call'd the White Black, and the Red Blew, but ſtill, he,

before his Errour, would lay them by in Pairs, ſaying, that though he could eaſily diſtinguiſh them from all others, yet thoſe two Pairs were not eaſily diſtinguiſh'd amongſt themſelves, whereupon the Doctor deſir'd to be told by him what kind of Diſcrimination he had of Colours by his Touch, to which he gave a reply, for whoſe ſake chiefly I inſert all this Narrative in this place, namely, That all the difference was more or leſs Aſperity, for ſays he, (I give you the Doctor's own words) Black feels as if you were feeling Needles points, or ſome harſh Sand, and Red feels very Smooth.

That the Doctor having deſir'd him to tell in Order the difference of Colours to his Touch, he did as follows;

Black and White are the moſt aſperous or unequal of all Colours, and ſo like, that 'tis very hard to diſtinguiſh them, but Black is the moſt Rough of the two, Green is next in Aſperity, Gray next to Green in Aſperity, Yellow is the fifth in degree of Aſperity, Red and Blew are ſo like, that they are as hard to diſtinguiſh as Black and White, but Red is ſomewhat more Aſperous than Blew, ſo that Red has the ſixth place, and Blew the ſeventh in Aſperity.

12. To theſe Informations the Obliging Doctor was pleas'd to add the welcome preſent of three of thoſe very pieces of Ribbon, whoſe Colours in his preſence the Blind man had diſtinguiſhed, pronouncing the one Gray, the other Red, and the third Green, which I keep by me as Rarities, and the rather, becauſe he fear'd the reſt were miſcarry'd.

13. Before I ſaw the Notes that afforded me the precedent Narrative, I confeſs I ſuſpected this man might have thus diſcriminated Colours, rather by the Smell than by the Touch; for ſome of the Ingredients imployed by Dyers to Colour things, have Sents, that are not ſo Languid, nor ſo near of Kin, but that I thought it not impoſſible that a very Critical Noſe might diſtinguiſh them, and this I the rather ſuſpected, becauſe he requir'd, that the Ribbons, whoſe Colours he was to Name, ſhould be

offer'd him Faſting in the morning; for I have obſerv'd in Setting Doggs, that the feeding of them (especially with ſome ſorts of Aliments) does very much impair the exquiſite ſent of their Noſes. And though ſome of the foregoing particulars would have prevented that Conjecture, yet I confeſs to you (Pyrophilus) that I would gladly have had the Opportunity of Examining this Man my ſelf, and of Queſtioning him about divers particulars which I do not find to have been yet thought upon. And though it be not incredible to me, that ſince the Liquors that Dyers imploy to tinge, are qualifi'd to do ſo by multitudes of little Corpuſcles of the Pigment or Dying ſtuff, which are diſſolved and extracted by the Liquor, and ſwim to and fro in it, thoſe Corpuſcles of Colour (as the Atomiſts call them) inſinuating themſelves into, and filling all the Pores of the Body to be Dyed, may Aſperate its Superficies more or leſs according to the Bigneſs and Texture of the Corpuſcles of the Pigment; yet I can ſcarce believe, that our Blind man could diſtinguiſh all the Colours he did, meerly by the Ribbons having more or leſs of Aſperity, ſo that I cannot but think, notwithſtanding this Hiſtory, that the Blind man diſtinguiſh'd Colours not only by the Degrees of Aſperity in the Bodies offer'd to him, but by Forms of it, though this (latter) would perhaps have been very difficult for him to make an Intelligible mention of, becauſe thoſe Minute diſparities having not been taken notice of by men for want of touch as Exquiſite as our Blind Mans, are things he could not have Intelligibly expreſs'd, which will eaſily ſeem Probable, if you conſider, that under the name of Sharp, and Sweet, and Sour, there are abundance of, as it were, immediate peculiar Reliſhes or Taſts in differing ſorts of Wine, which though Critical and Experienc'd Palats can eaſily diſcern themſelves cannot make them be underſtood by others, ſuch Minute differences not having hitherto any Diſtinct names aſſign'd them. And it ſeems that there was ſomthing in the Forms of Aſperity that was requiſite to the Diſtinction of Colours, beſides the Degree of it, ſince he found it ſo difficult to diſtinguſh Black and White from one another, though not from other Colours. For I might urge, that he ſeems not conſonant to himſelf about the Red, which as you have

ſeen in one place, he repreſents as ſomewhat more Aſperous than the Blew; and in another, very Smooth: But becauſe he ſpeaks of this Smoothneſs in that place, where he mentions the Roughneſs of Black, we may favourably preſume that he might mean but a comparative Smoothneſs; and therefore I ſhall not Inſiſt on this, but rather Countenance my Conjecture by this, that he found it ſo Difficult, not only, to Diſcriminate Red and Blew, (though the firſt of our promiſcuous Experiments will inform you, that the Red reflects by great Odds more Light than the other) but alſo to diſtinguiſh Black and White from one another, though not from other Colours. And indeed, though in the Ribbonds that were offer'd him, they might be almoſt equally Rough, yet in ſuch ſlender Corpuſcles as thoſe of Colour, there may eaſily enough be Conceiv'd, not only a greater Cloſeneſs of Parts, or elſe Paucity of Protuberant Corpuſcles, and the little extant Particles may be otherwiſe Figur'd, and Rang'd in the White than in the Black, but the Cavities may be much Deeper in the one than the other.

14. And perhaps, (Pyrophilus) it may prove ſome Illuſtration of what I mean, and help you to conceive how this may be, if I Repreſent, that where the Particles are ſo exceeding Slender, we may allow the Parts expos'd to the Sight and Touch to be a little Convex in compariſon of the Erected Particle of Black Bodies, as if there were Wyres I know not how many times Slenderer than a Hair: whether you ſuppoſe them to be Figur'd like Needles, or Cylindrically, like the Hairs of a Bruſh, with Hemiſphærical (or at leaſt Convex) Tops, they will be ſo very Slender, and conſequently the Points both of the one ſort and the other ſo very Sharp, that even an exquiſite Touch will be able to diſtinguiſh no greater Difference between them, than that which our Blind man allow'd, when comparing Black and White Bodies, he ſaid, that the latter was the leſs Rough of the two. Nor is every Kind of Roughneſs, though Senſible enough, Inconſiſtent with Whiteneſs, there being Caſes, wherein the Phyſical Superficies of a Body is made by the ſame Operation both Rough and white, as when the Level Surface of clear Water being by agitation Aſperated with a

multitude of Unequal Bubbles, do's thereby acquire a Whiteneſs; and as a Smooth piece of Glaſs, by being Scratch'd with a Diamond, do's in the Aſperated part of its Surface diſcloſe the ſame Colour. But more (perchance) of this elſewhere.

15. And therefore, we ſhall here paſs by the Queſtion, whether any thing might be conſider'd about the Opacity of the Corpuſcles of Black Pigments, and the Comparative Diaphaneity of thoſe of many White Bodies, apply'd to our preſent Caſe; and proceed, to repreſent, That the newly mention'd Exiguity and Shape of the extant Particles being ſuppos'd, it will then be conſiderable what we lately but Hinted, (and therefore muſt now ſomewhat Explane) That the Depth of the little Cavities, intercepted between the extant Particles, without being ſo much greater in Black Bodies than in White ones, as to be perceptibly ſo to the Groſs Organs of Touch, may be very much greater in reference to their Diſpoſition of Reflecting the imaginary ſubtile Beams of Light. For in Black Bodies, thoſe Little intercepted Cavities, and other Depreſſions, may be ſo Figur'd, ſo Narrow and ſo Deep, that the incident Beams of Light, which the more extant Parts of the Phyſical Superficies are diſpos'd to Reflect inwards, may be Detain'd there, and prove unable to Emerge; whilſt in a White Body, the Slender Particles may not only by their Figure be fitted to Reflect the Light copiouſly outwards, but the intercepted Cavities being not Deep, nor perhaps very Narrow, the Bottoms of them may be ſo Conſtituted, as to be fit to Reflect outwards much of the Light that falls even upon Them; as you may poſſibly better apprehend, when we ſhall come to treat of Whiteneſs and Blackneſs. In the mean time it may ſuffice, that you take Notice with me, that the Blind mans Relations import no neceſſity of Concluding, that, though, becauſe, according to the Judgment of his Touch, Black was the Rougheſt, as it is the Darkeſt of Colours, therefore White, which (according to us) is the Lighteſt, ſhould be alſo the Smootheſt: ſince I obſerve, that he makes Yellow to be two Degrees more Aſperous than Blew, and as much leſs Aſperous than Green; whereas indeed, Yellow do's not only appear to the Eye a Lighter Colour than Blew, but (by our firſt Experiment

hereafter to be mention'd) it will appear, that Yellow reflected much more Light than Blew, and manifeſtly more than Green, (which we need not much wonder at, ſince in this Colour and the two others (Blew and Yellow) 'tis not only the Reflected Light that is to be conſidered, ſince to produce both theſe, Refraction ſeems to Intervene, which by its Varieties may much alter the Caſe:) which both ſeems to ſtrengthen the Conjecture I was formerly propoſing, that there was ſomething elſe in the Kinds of Aſperity, as well as in the Degrees of it, which enabled our Blind man to Diſcriminate Colours, and do's at leaſt ſhow, that we cannot in all Caſes from the bare Difference in the Degrees of Aſperity betwixt Colours, ſafely conclude, that the Rougher of any two always Reflects the leaſt Light.

16. But this notwithſtanding, (Pyrophilus) and what ever Curioſity I may have had to move ſome Queſtions to our Sagacious Blind man, yet thus much I think you will admit us to have gain'd by his Teſtimony, that ſince many Colours may be felt with the Circumſtances above related, the Surfaces of ſuch Coloured Bodies muſt certainly have differing Degrees, and in all probability have differing Forms or Kinds of Aſperity belonging to them, which is all the Uſe that my preſent attempt obliges me to make of the Hiſtory above deliver'd, that being ſufficient to prove, that Colour do's much depend upon the Diſpoſition of the Superficial parts of Bodies, and to ſhew in general, wherein 'tis probable that ſuch a Diſpoſition do's (principally at leaſt) conſiſt.

17. But to return to what I was ſaying before I began to make mention of our Blind Organiſt, what we have deliver'd touching the cauſes of the ſeveral Forms or Aſperity that may Diverſifie the Surfaces of Colour'd Bodies, may perchance ſomewhat aſſiſt us to make ſome Conjectures in the general, at ſeveral of the ways whereby 'tis poſſible for the Experiments hereafter to be mention'd, to produce the ſuddain changes of Colours that are wont to be Conſequent upon them; for moſt of theſe Phænomena being produc'd by the Intervention of Liquors, and theſe for the moſt part abounding with very Minute, Active, and Variouſly Figur'd Saline Corpuſcles,

Liquors ſo Qualify'd may well enough very Nimbly after the Texture of the Body they are imploy'd to Work upon, and ſo may change the form of Aſperity, and thereby make them Remit to the Eye the Light that falls on them, after another manner than they did before, and by that means Vary the Colour, ſo farr forth as it depends upon the Texture or Diſpoſition of the Seen Parts of the Object, which I ſay, Pyrophilus, that you may not think I would abſolutely exclude all other ways of Modifying the Beams of Light between their Parting from the Lucid Body, and their Reception into the common Senſory.

18. Now there ſeem to me divers ways, by which we may conceive that Liquors may Nimbly alter the Colour of one another, and of other Bodies, upon which they Act, but my preſent haſte will allow me to mention but ſome of them, without Inſiſting ſo much as upon thoſe I ſhall name.

19. And firſt, the Minute Corpuſcles that compoſe a Liquor may early inſinuate themſelves into thoſe Pores of Bodies, whereto their Size and Figure makes them Congruous, and theſe Pores they may either exactly Fill, or but Inadequately, and in this latter Caſe they will for the moſt part alter the Number and Figure, and always the Bigneſs of the former Pores. And in what capacity ſoever theſe Corpuſcles of a Liquor come to be Lodg'd or Harbour'd in the Pores that admit them, the Surface of the Body will for the moſt part have its Aſperity alter'd, and the Incident Light that meets with a Groſſer Liquor in the little Cavities that before contain'd nothing but Air, or ſome yet Subtiler Fluid, will have its Beams either Refracted, or Imbib'd, or elſe Reflected more or leſs Interruptedly, than they would be, if the Body had been Unmoiſtned, as we ſee, that even fair Water falling on white Paper, or Linnen, and divers other Bodies apt to ſoak it in, will for ſome ſuch Reaſons as thoſe newly mention'd, immediately alter the Colour of them, and for the moſt part make it Sadder than that of the Unwetted Parts of the ſame Bodies. And ſo you may ſee, that when in the Summer the High-ways are Dry and Duſty, if there falls ſtore of Rain, they will quickly appear of a much Darker Colour than they did before, and if a

Drop of Oyl be let fall upon a Sheet of White Paper, that part of it, which by the Imbibition of the Liquor acquires a greater Continuity, and ſome Tranſparency, will appear much Darker than the reſt, many of the Incident Beams of Light being now Tranſmitted, that otherwiſe would be Reflected towards the Beholders Eyes.

20. Secondly, A Liquor may alter the Colour of a Body by freeing it from thoſe things that hindred it from appearing in its Genuine Colour; and though this may be ſaid to be rather a Reſtauration of a Body to its own Colour, or a Retection of its native Colour, than a Change, yet ſtill there Intervenes in it a change of the Colour which the Body appear'd to be of before this Operation. And ſuch a change a Liquor may work, either by Diſſolving, or Corroding, or by ſome ſuch way of carrying off that Matter, which either Veil'd or Diſguis'd the Colour that afterwards appears. Thus we reſtore Old pieces of Dirty Gold to a clean and nitid Yellow, by putting them into the Fire, and into Aqua-fortis, which take off the adventitious Filth that made that pure Metall look of a Dirty Colour. And there is alſo an eaſie way to reſtore Silver Coyns to their due Luſtre, by fetching off that which Diſcolour'd them. And I know a Chymical Liquor, which I employ'd to reſtore pieces of Cloath ſpotted with Greaſe to their proper Colour, by Imbibing the Spotted part with this Liquor, which Incorporating with the Greaſe, and yet being of a very Volatile Nature, does eaſily carry it away with it Self. And I have ſometimes try'd, that by Rubbing upon a good Touch-ſtone a certain Metalline mixture ſo Compounded, that the Impreſſion it left upon the Stone appear'd of a very differing Colour from that of Gold, yet a little of Aqua-fortis would in a Trice make the Golden Colour diſcloſe it ſelf, by Diſſolving the other Metalline Corpuſcles that conceal'd thoſe of the Gold, which you know that Menstruum will leave Untouch'd.

21. Thirdly, A Liquor may alter the Colour of a Body by making a Comminution of its Parts, and that principally two ways, the firſt by Diſjoyning and Diſſipating thoſe Cluſters of Particles, if I may ſo call them, which ſtuck more Looſely together, being faſtned only by ſome more eaſily Diſſoluble Ciment, which ſeems to be the Caſe of

ſome of the following Experiments, where you'l find the Colour of many Corpuſcles brought to cohere by having been Precipitated together, Deſtroy'd by the Affuſion of very peircing and inciſive Liquors. The other of the two ways I was ſpeaking of, is, by Dividing the Groſſer and more Solid Particles into Minute ones, which will be always Leſſer, and for the moſt part otherwiſe Shap'd than the Entire Corpuſcle ſo Divided, as it will happen in a piece of Wood reduc'd into Splinters or Chips, or as when a piece of Chryſtal heated red Hot and quench'd in Cold water is crack'd into a multitude of little Fragments, which though they fall not aſunder, alter the Diſpoſition of the Body of the Chryſtal, as to its manner of Reflecting the Light, as we ſhall have Occaſion to ſhew hereafter.

22. There is a fourth way contrary to the third, whereby a Liquor may change the Colour of another Body, eſpecially of another Fluid, and that is, by procuring the Coalition of ſeveral Particles that before lay too Scatter'd and Diſpers'd to exhibit the Colour that afterwards appears. Thus ſometimes when I have had a Solution of Gold ſo Dilated, that I doubted whether the Liquor had really Imbib'd any true Gold or no, by pouring in a little Mercury, I have been quickly able to ſatisfie my Self, that the Liquor contain'd Gold, that Mettall after a little while Cloathing the Surface of the Quick-ſilver, with a Thin Film of its own Livery. And chiefly, though not only by this way of bringing the Minute parts of Bodies together in ſuch Numbers as to make them become Notorious to the Eye, many of theſe Colours ſeem to be Generated which are produc'd by Precipitations, eſpecially by ſuch as are wont to be made with fair Water, as when Reſinous Gumms diſſolv'd in Spirit of Wine, are let fall again, if the Spirit be Copiouſly diluted with that weakning Liquor. And ſo out of the Rectify'd and Tranſparent Butter of Antimony, by the bare Mixture of fair Water, there will be plentifully Precipitated that Milk-white Subſtance, which by having its Looſer Salts well waſh'd off, is turn'd into that Medicine, which Vulgar Chymiſts are pleas'd to call Mercurius Vitæ.

23. A fifth way, by which a Liquor may change the Colour of a Body, is, by

Diſlocating the Parts, and putting them out of their former Order into another, and perhaps alſo altering the Poſture of the ſingle Corpuſcles as well as their Order or Situation in reſpect of one another. What certain Kinds of Commotion or Diſlocation of the Parts of a Body may do towards the Changing its Colour, is not only evident in the Mutations of Colour obſervable in Quick-ſilver, and ſome other Concretes long kept by Chymiſts in a Convenient Heat, though in cloſe Veſſels, but in the Obvious Degenerations of Colour, which every Body may take notice of in Bruis'd Cherries, and other Fruit, by comparing after a while the Colour of the Injur'd with that of the Sound part of the ſame Fruit. And that alſo ſuch Liquors, as we have been ſpeaking of, may greatly Diſcompoſe the Textures of many Bodies, and thereby alter the Diſpoſition of their Superficial parts, the great Commotion made in Metalls, and ſeveral other Bodies by Aqua-fortis, Oyl of Vitriol, and other Saline Menſtruums, may eaſily perſwade us, and what ſuch Vary'd Situations of Parts may do towards the Diverſifying of the manner of their Reflecting the Light, may be Gueſs'd in ſome Meaſure by the Beating of Tranſparent Glaſs into a White Powder, but farr better by the Experiments lately Pointed at, and hereafter Deliver'd, as the Producing and Deſtroying Colours by the means of ſubtil Saline Liquors, by whoſe Affuſion the Parts of other Liquors are manifeſtly both Agitated, and likewiſe Diſpos'd after another manner than they were before ſuch Affuſion. And in ſome Chymical Oyls, as particularly that of Lemmon Pills, by barely Shaking the Glaſs, that holds it, into Bubbles, that Tranſpoſition of the Parts which is conſequent to the Shaking, will ſhew you on the Surfaces of the Bubbles exceeding Orient and Lively Colours, which when the Bubbles relapſe into the reſt of the Oyl, do immediately Vaniſh.

24. I know not, Pyrophilus, whether I ſhould mention as a Diſtinct way, becauſe it is of a ſomewhat more General Nature, that Power, whereby a Liquor may alter the Colour of another Body, by putting the Parts of it into Motion; For though poſſibly the Motion ſo produc'd, does, as ſuch, ſeldome ſuddenly change the Colour of the Body whoſe Parts are Agitated, yet this ſeems to be one of the moſt General,

however not Immediate cauſes of the Quick change of Colours in Bodies. For the Parts being put into Motion by the adventitious Liquor, divers of them that were before United, may become thereby Diſjoyn'd, and when that Motion ceaſes or decays others of them may ſtick together, and that in a new Order, by which means the Motion may ſometimes produce Permanent changes of Colours, as in the Experiment you will meet with hereafter, of preſently turning a Snowy White Body into a Yellow, by the bare Affuſion of fair Water, which probably ſo Diſſolves the Saline Corpuſcles that remain'd in the Calx, and ſets them at Liberty to Act upon one another, and the Metall, far more Powerfully than the Water without the Aſſiſtance of ſuch Saline Corpuſcles could do. And though you rubb Blew Vitriol, how Venereal and Unſophiſticated ſoever it be, upon the Whetted Blade of a Knife, it will not impart to the Iron its Latent Colour, but if you moiſten the Vitriol with your Spittle, or common Water, the Particles of the Liquor diſjoyning thoſe of the Vitriol, and thereby giving them the Various Agitation requiſite to Fluid Bodies, the Metalline Corpuſcles of the thus Diſſolv'd Vitriol will Lodge themſelves in Throngs in the Small and Congruous Pores of the Iron they are Rubb'd on, and ſo give the Surface of it the Genuine Colour of the Copper.

25. There remains yet a way, Pyrophilus to be mention'd, by which a Liquor may alter the Colour of another Body, and this ſeems the moſt Important of all, becauſe though it be nam'd but as One, yet it may indeed comprehend Many, and that is, by Aſſociating the Saline Corpuſcles, or any other Sort of the more Rigid ones of the Liquor, with the Particles of the Body that it is employ'd to Work upon. For theſe Adventitious Corpuſcles Aſſociating themſelves with the Protuberant Particles of the Surface of a Colour'd Body, muſt neceſſarily alter their Bigneſs, and will moſt commonly alter their Shape. And how much the Colours of Bodies depend upon the Bulk and Figure of their Superficial Particles, you may Gueſs by this, that eminent antient Philoſophers and divers Moderns, have thought that all Colours might in a general way be made out by theſe two; whoſe being Diverſify'd, will in our Caſe be

attended with theſe two Circumſtances, the One, that the Protuberant Particles being Increas'd in Bulk, they will oftentimes be Vary'd as to the Cloſneſs or Laxity of their Order, fewer of them being contain'd within the ſame Senſible (though Minute) ſpace than before; or elſe by approaching to one another, they muſt Straighten the Pores, and it may be too, they will by their manner of Aſſociating themſelves with the Protuberant Particles, intercept new Pores. And this invites me to conſider farther, that the Adventitious Corpuſcles, I have been ſpeaking of, may likewiſe produce a great Change as well in the Little Cavities or Pores as in the Protuberances of a Colour'd Body; for beſides what we have juſt now taken notice of, they may by Lodging themſelves in thoſe little Cavities, fill them up, and it may well happen, that they may not only fill the Pores they Inſinuate themſelves into, but likewiſe have their Upper Parts extant above them; and partly by theſe new Protuberances, partly by Increaſing the Bulk of the former, theſe Extraneous Corpuſcles may much alter the Number and Bigneſs of the Surfaces Pores, changing the Old and Intercepting new ones. And then 'tis Odds, but the Order of the Little Extancies, and conſequently that of the Little Depreſſions in point of Situation will be alter'd likewiſe: as if you diſſolve Quick-ſilver in ſome kind of Aqua-fortis, the Saline Particles of the Menstruum Aſſociating themſelves with the Mercurial Corpuſcles, will make a Green Solution, which afterwards eaſily enough Degenerates. And Red Lead or Minium being Diſſolv'd in Spirit of Vinegar, yields not a Red, but a Clear Solution, the Redneſs of the Lead being by the Liquor Deſtroy'd. But a better Inſtance may be taken from Copper, for I have try'd, that if upon a Copper-plate you let ſome Drops of weak Aqua-fortis reſt for a while, the Corpuſcles of the Menſtruum, joyning with thoſe of the Metall, will produce a very ſenſible Aſperity upon the Surface of the Plate, and will Concoagulate that way into very minute Grains of a Pale Blew Vitriol; whereas if upon another part of the ſame Plate you ſuffer a little ſtrong Spirit of Urine to reſt a competent time, you ſhall find the Aſperated Surface adorn'd with a Deeper and Richer Blew. And the ſame Aqua-fortis, that will quickly change the

Redneſs of Red Lead into a Darker Colour, will, being put upon Crude Lead, produce a Whitiſh Subſtance, as with Copper it did a Blewiſh. And as with Iron it will produce a Reddiſh, and on White Quills a Yellowiſh, ſo much may the Coalition of the Parts of the ſame Liquor, with the differingly Figur'd Particles of Stable Bodies, divers ways Aſperate the differingly Diſpos'd Surfaces, and to Diverſifie the Colour of thoſe Bodies. And you'l eaſily believe, that in many changes of Colour, that happen upon the Diſſolutions of Metalls, and Precipitations made with Oyl of Tartar, and the like Fix'd Salts, there may Intervene a Coalition of Saline Corpuſcles with the Particles of the Body Diſſolv'd or Precipitated, if you examine how much the Vitriol of a Metall may be Heavier than the Metalline part of it alone, upon the Score of the Saline parts Concoagulated therewith, and, that in Several Precipitations the weight of the Calx does for the ſame Reaſon much exceed that of the Metall, when it was firſt put in to be Diſſolv'd.

26. But, Pyrophilus, to conſider theſe Matters more particularly would be to forget that I declar'd againſt Adventuring, at leaſt for this time, at particular Theories of Colours, and that accordingly you may juſtly expect from me rather Experiments than Speculations, and therefore I ſhall Diſmiſs this Subject of the Forms of Superficial Aſperity in Colour'd Bodies, as ſoon as I ſhall but have nam'd to you by way of Supplement to what we have hitherto Diſcours'd in this Section, a Couple of Particulars, (which you'l eaſily grant me) The one, That there are divers other ways for the ſpeedy Production even of True and Permanent Colours in Bodies, beſides thoſe Practicable by the help of Liquors; for proof of which Advertiſement, though ſeveral Examples might be alleged, yet I ſhall need but Re-mind you of what I mention'd to you above, touching the change of Colours ſuddenly made on Temper'd Steel, and on Lead, by the Operation of Heat, without the Intervention of a Liquor. But the other particular I am to obſerve to you is of more Importance to our preſent Subject and it is, That though Nature and Art may in ſome caſes ſo change the Aſperity of the Superficial parts of a Body, as to change its Colour by either of the

ways I have propos'd Single or Unaſſiſted, yet for the moſt part 'tis by two or three, or perhaps by more of the fore-mention'd ways Aſſociated together, that the Effect is produc'd, and if you conſider how Variouſly thoſe ſeveral ways and ſome others Ally'd unto them, which I have left unmention'd, may be Compounded and Apply'd, you will not much wonder that ſuch fruitfull, whether Principles (or Manners of Diverſification) ſhould be fitted to Change or Generate no ſmall ſtore of Differing Colours.

27. Hitherto, Pyrophilus, we have in diſcourſing of the Aſperity of Bodies conſider'd the little Protuberances of other Superficial particles which make up that Roughneſs, as if we took it for granted, that they muſt be perfectly Opacous and Impenetrable by the Beams of Light, and ſo, muſt contribute to the Variety of Colours as they terminate more or leſs Light, and reflect it to the Eye mix'd with more or leſs of thus or thus mingl'd Shades. But to deal Ingenuouſly with you, Pyrophilus, before I proceed any further, I muſt not conceal from you, that I have often thought it worth a Serious Enquiry, whether or no Particles of Matter, each of them ſing'y Inſenſible, and therefore ſmall enough to be capable of being ſuch Minute Particles as the Atomiſts both of old and of late have (not abſurdly) called Corpuſcula Coloris, may not yet conſiſt each of them of divers yet Minuter Particles, betwixt which we may conceive little Commiſſures where they Adhere to one another, and, however, may not be Porous enough to be, at leaſt in ſome degree, Pervious to the unimaginably ſubtile Corpuſcles that make up the Beams of Light, and conſequently to be in ſuch a degree Diaphanous. For, Pyrophilus, that the propoſed Enquiry may be of moment to him that ſearches after the Nature of Colour, you'l eaſily grant, if you conſider, that whereas Perfectly Opacous bodies can but reflect the incident Beams of Light, thoſe that are Diaphanous are qualified to refract them too, and that Refraction has ſuch a ſtroak in the Production of Colours, as you cannot but have taken notice of, and perhaps admir'd in the Colours generated by the Trajection of Light through Drops of Water that exhibit a Rain-bow, through Priſmatical glaſſes, and through divers

other Tranſparent bodies. But 'tis like, Pyrophilus, you'l more eaſily allow that about this matter 'tis rather Important to have a Certainty, than that 'tis Rational to entertain a Doubt; wherefore I muſt mention to you ſome of the Reaſons that make me think it may need a further Enquiry, for I find that in a Darkned Room, where the Light is permitted to enter but at One hole, the little wandering Particles of Duſt, that are commonly called Motes, and, unleſs in the Sunbeams, are not taken notice of by the unaſſiſted Sight, I have, I ſay, often obſerv'd, that theſe roving Corpuſcles being look'd on by an Eye plac'd on one ſide of the Beams that enter'd the Little hole, and by the Darkneſs having its Pupill much Enlarg'd, I could diſcern that theſe Motes as ſoon as they came within the compaſs of the Luminous, whether Cylinder or Inverted Cone, if I may ſo call it, that was made up by the Unclouded Beams of the Sun, did in certain poſitions appear adorn'd with very vivid Colours, like thoſe of the Rain-bow, or rather like thoſe of very Minute, but Sparkling fragments of Diamonds; and as ſoon as the Continuance of their Motion had brought them to an Inconvenient poſition in reference to the Light and the Eye, they were only viſible without Darting any lively Colours as before, which ſeems to argue that theſe little Motes, or minute Fragments, of ſeveral ſorts of bodies reputed Opacous, and only crumbled as to their Exteriour and Looſer parts into Duſt, did not barely Reflect the Beams that fell upon them, but remit them to the Eye Refracted too. We may alſo obſerve, that ſeveral Bodies, (as well ſome of a Vegetable, as others of an Animal nature) which are wont to paſs for Opacous, appear in great part Tranſparent, when they are reduc'd into Thin parts, and held againſt a powerful Light. This I have not only taken notice of in pieces of Ivory reduc'd but into Thick leaves, as alſo in divers conſiderable Thick ſhells of Fiſhes, and in ſhaving of Wood, but I have alſo found that a piece of Deal, far thicker than one would eaſily imagine, being purpoſly interpoſed betwixt my Eye plac'd in a Room, and the clear Daylight, was not only ſomewhat Tranſparent, but (perhaps by reaſon of its Gummous nature) appear'd quite through of a lovely Red. And in the Darkned Room above mention'd, Bodies held againſt the hole at which

the Light enter'd, appear'd far leſs Opacous then they would elſewhere have done, inſomuch that I could eaſily and plainly ſee through the whole Thickneſs of my Hand, the Motions of a Body plac'd (at a very near diſtance indeed, but yet) beyond it. And even in Minerals, the Opacity is not always ſo great as many think, if the Body be made Thin, for White Marble though of a pretty Thickneſs, being within a Due diſtance plac'd betwixt the Eye and a Convenient Light, will Suffer the Motions of ones Finger to be well diſcern'd through it, and ſo will pieces, Thick enough, of many common Flints. But above all, that Inſtance is remarkable, that is afforded us by Muſcovie glaſs, (which ſome call Selenites, others Lapis Specularis) for though plates of this Mineral, though but of a moderate Thickneſs, do often appear Opacous, yet if one of theſe be Dextrouſly ſplit into the thinneſt Leaves 'tis made up of, it will yield ſuch a number of them, as ſcarce any thing but Experience could have perſwaded me, and theſe Leaves will afford the moſt Tranſparent ſort of conſiſtent Bodies, that, for ought I have obſerv'd, are yet known; and a ſingle Leaf or Plate will be ſo far from being Opacous, that 'twill ſcarce be ſo much as Viſible. And multitudes of Bodies there are, whoſe Fragments ſeem Opacous to the naked Eye, which yet, when I have included them in good Microſcopes, appear'd Tranſparent; but, Pyrophilus, on the other ſide I am not yet ſure that there are no Bodies, whoſe Minute Particles even in ſuch a Microſcope as that of mine, which I was lately mentioning, will not appear Diaphanous. For having conſider'd Mercury Precipitated per ſe, the little Granules that made up the powder, look'd like little fragments of Coral beheld by the naked Eye at a Diſtance (for very Near at hand Coral will ſometimes, eſpecially if it be Good, ſhew ſome Tranſparency.) Filings likewiſe of Steel and Copper, though in an excellent Microſcope, and a fair Day, they ſhow'd like pretty Big Fragments of thoſe Metalls, and had conſiderable Brightneſs on ſome of their Surfaces, yet I was not ſatisfi'd, that I perceiv'd any Reflection from the Inner parts of any of the Filings. Nay, having look'd in my beſt Microſcope upon the Red Calx of Lead, (commonly call'd Minium) neither I, nor any I ſhew'd it to, could

diſcern it to be other than Opacous, though the Day were Clear, and the Object ſtrongly Enlightned. And the deeply Red Colour of Vitriol appear'd in the ſame Microſcope (notwithſtanding the great Comminution effected by the Fire) but like Groſſy beaten Brick. So that, Pyrophilus, I ſhall willingly reſign you the care of making ſome further Enquiries into the Subject we have now been conſidering; for I confeſs, as I told you before, that I think that the Matter may need a further Scrutiny, nor would I be forward to Determine how far or in what caſes the Tranſparency or Semi-diaphaniety of the Superficial Corpuſcles of Bigger Bodies, may have an Intereſt in the Production of their Colours, eſpecially becauſe that even in divers White bodies, as Beaten Glaſs, Snow and Froth, where it ſeems manifeſt that the Superficial parts are ſingly Diaphanous, (being either Water, or Air, or Glaſs) we ſee not that ſuch Variety of Colours are produc'd as uſually are by the Refraction of Light, even in thoſe Bodies, when by their Bigneſs, Shape, &c. they are conveniently qualify'd to exhibit ſuch Various and Lively Colours as thoſe of the Rain-bow, and of Priſmatical Glaſſes.

28. By what has been hitherto diſcours'd, Pyrophilus, we may be aſſiſted to judge of that famous Controverſie which was of Old diſputed betwixt the Epicureans and other Atomiſts on the one ſide, and moſt other Philoſophers on the other ſide. The former Denying Bodies to be Colour'd in the Dark, and the Latter making Colour to be an Inherent quality, as well as Figure, Hardneſs; Weight, or the like. For though this Controverſie be Reviv'd, and hotly Agitated among the Moderns, yet I doubt whether it be not in great part a Nominal diſpute, and therefore let us, according to the Doctrine formerly deliver'd, Diſtinguiſh the Acceptions of the word Colour, and ſay, that if it be taken in the Stricter Senſe, the Epicureans ſeem to be in the Right, for if Colour be indeed, though not according to them, but Light Modify'd, how can we conceive that it can Subſiſt in the Dark, that is, where it muſt be ſuppos'd there is no Light; but on the other ſide, if Colour be conſider'd as a certain Conſtant Diſpoſition of the Superficial parts of the Object to Trouble the Light they Reflect

after ſuch and ſuch a Determinate manner, this Conſtant, and, if I may ſo ſpeak, Modifying diſpoſition perſevering in the Object, whether it be Shin'd upon or no, there ſeems no juſt reaſon to deny, but that in this Senſe, Bodies retain their Colour as well in the Night as Day; or, to Speak a little otherwiſe, it may be ſaid, that Bodies are Potentially Colour'd in the Dark, and Actually in the Light. But of this Matter diſcourſing more fully elſewhere, as 'tis a difficulty that concerns Qualities in general, I ſhall forbear to inſiſt on it here.

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 Greeneſs of a Leaf ought to paſs for Apparent, becauſe, ſoon Fading into a Yellow, it Scarce laſts at all, in compariſon of the Greeneſs 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.

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'l 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 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 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 Sphærical 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'l 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.

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 Abetters; 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, 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 theſc 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'l find endeavour'd in the Diſcourſe you'l 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

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 Swiftneſs, 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 comprehenſitive 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 Infirmneſs 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 ef 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.

5. Thirdly. But, Pyrophilus, though this be at preſent the Hypotheſis I preferr, 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 Cæleſtes, 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 Swiftneſs 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 Scaliger5, Latet natura hæc, (ſays he, Speaking of that of Colour) & ſicut aliarum rerum ſpecies in profundiſſima caligine inſcitiæ humanæ.

Decorative rule

THE EXPERIMENTAL HISTORY OF COLOURS.

PART. II.

Of the Nature of Whiteneſs and Blackneſs.

CHAP. I.

1. Illuminated T in Though

Hough 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 explan'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 tantò magis, quantò denſior ſeu collectior fuerit. Deinde aquam non eſſe quidem coloris ex ſe candidi &

radium tamen ex eâ reflexum verſus oculum candicare. Rurſus cum plana aquæ 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 Superficiei parte. Ad hæc Spumam ex aqua pura non alia ratione videri candeſcere & albeſcerere quam quod ſit congeries confertiſſima minutiſſimarum bullarum, quarum unaquæque ſuum radium reflectit, unde continens candor alborve apparet. Denique Nivem nihil aliud videri quam ſpeciem puriſſimæ ſpumæ ex bullulis quam minutiſſimis & confertiſſimis cohærentis. Sed ridiculam me exhibeam, ſi tales meas nugas uberius proponem.

3. But though in this paſſage, that very Ingenous 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 Superficieculæ, that Look ſome one way, and ſome another, enough of them Obverted to his Eye, to afford like a broken Looking-glaſs, a confuſed Idæa, 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 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 Over-powers 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 Short; for after other things not needfull to be here Tranſcribed: Iter, ſays he, Diurnum duo ſcilicet montana milliaria (quæ 12 Italica ſunt) conſiciunt. Nocte verò ſub ſplendiſſima luna, duplatum iter conſumunt aut triplatum. Neque id incommodè fit, cum nivium reverberatione

lunaris ſplendoris ſublimes & declives campos illuſtret, ac etiam montium præcipitia ac noxias feras à lorgè 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.

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 ingenous 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.

7. Thirdly, And the better to ſhew that White Bodies reflect ſtore of Light, in comparſon 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 Phænomenon, 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.

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.

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, 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 Oyly 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 inſteed 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 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 Cryſtalls purpoſely reſerv'd, ſome of the Subtile Powder of the ſame Salt, which will Comparatively exhibit a very conſiderable degree of Whitiſhneſs.

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.

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 ſuâpte Naturâ nigra constare ex particulis, quarum Superficieculæ ſcabræ ſint, nec facilè lucem extrorſum reflectant. I wiſh this Ingenious Man had enlarg'd 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 Effluviums, or Minute Particles of ſome Ætherial 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 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 Sphærical 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.

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 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, 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 (Cæteris 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.

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.

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.

Decorative rule

EXPERIMENT IN CONSORT, Touching Whiteneſs & Blackneſs.

EXPERIMENT I.

Illuminated H in Having Aving 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

Præcipitate 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 Cleer, 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 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 throughly 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 Præcipitation 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 Præcipitated 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 Præcipitating liquors that I ſometimes employ, afford good ſtore of a Crudled matter, ſuch as I have had in the Præcipitations 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 Præcipitate, 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 dryed 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 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 Cryſtalls 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.

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 Alablaſter, 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 ſincerily, 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 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 Oxycæder 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.

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 Magiſtery 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.

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 Præcipitated 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 Præcipitated 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 Glorioufly (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 Corpuſcles 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 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 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 Æquinoctial, 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 Tropick 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, 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 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.

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, 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 Piſos11 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 Æthiopian 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 ſetled 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 Cole-black as ours, but partly of a Whitiſh Colour) in ſpight 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 pipple-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 cleerly 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 Europæan Bodyes. 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 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 Countrey-man Andrew Battel, who being ſent Priſoner by the Portugalls to Angola, liv'd there, and in the adjoyning 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 Countrey 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 himſelf13; Here are (ſayes he, ſpeaking of the formerly mention'd Regions) Born in this Countrey 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 Countrey 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 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.

EXPERIMENT XII.

The way, Pyrophilus, of producing Whiteneſs by Chymical Præcipitations 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 Præcipitated by Oyl of Tartar into White Powders. Thus Silver and Tin ſeparately diſſolv'd in Aqua Fortis, will the one Præcipitate it ſelf, and the other be Præcipitated 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 Præcipitated 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 Præcipitated 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 Vitæ, 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 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 Præcipitated 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 Præcipitating 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 Præcipitated Bodyes are White, yet I know ſome that are not; For Gold Diſſolv'd in Aqua Regis, whether you Præcipitate 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 Præcipitated 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 Præcipitate, 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 Præcipitation brought to White Powders, and yet ſome affording Præcipitates of other Colours, the reaſon of both the Phænomena may deſerve to be enquir'd into.

EXPERIMENT XIII.

Some Learned Modern Writers15 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 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 præexiſtent 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 ſpight 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 prædominant Colour, and return to the Reddiſhneſs of Copper, I was aſſur'd of the Affirmative; ſo that among Mineral Bodyes, 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 Prædominant 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 Æſtimate 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.

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.

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 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

Inflamable, and conſequenly (according to the Chymiſts) as Sulphureous a Body as it is, I could not by ſuch a degree of Heat, as brought it 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 Inflamable, 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 throughly 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 then 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 appliable 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

diſſappears? 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.

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 Oyly 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 Quæries, 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 Inclin'd 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 Præcipitates of Gold and Mercury) as likewiſe of Quick-ſilver and Silver (for I know that make and uſe of ſuch Precipitates 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.

Decorative rule

THE Experimental Hiſtory OF COLOURS. Begun.

The Third PART.

Containing Promiſcuous Experiments About COLOURS.

EXPERIMENT I.

Illuminated B in Because Ecauſe that, according to the Conjectures I have above propos'd, one of the moſt General Cauſes of the Diverſity of Colours in Opacous Bodyes, 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.

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 Bodyes differingly 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 Bodyes 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 Bodyes, 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 Bodyes; 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.

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.

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 Rebounding 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 Tincted, 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.

The Explication of the Scheme.

The Explication of the Scheme.

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

A B & α β Two rays from the Sun falling on the Priſm at B β. and thence partly reflected towards C & γ. and partly refracted towards D & δ.

B C & β γ. Thoſe reflected Rays.

B D & β δ. Thoſe refracted Rays which are partly refracted towards E & ε. 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 & ζ.

D F & δ ζ. Thoſe Reflected Rays which are partly refracted towards G & η. colourleſs, and partly reflected, towards H & θ.

F H & ζ θ. Thoſe reflected Rays which are refracted towards I & ι. 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 througn 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.

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 Bodyes 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 Bodyes 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 Admixtion 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 Peeces would not ſerve the turn) of deep Blew Glaſs, and looking upon the Candles flame at a Convenient diſtance througn 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. 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 conctinu'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.

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 & urinæ difficultates ac arenulas pellendas. Fit autem hac ratione, Lignum aſſulatim & minutim conciſum in limpidiſſima aqua fontana maceratur, inque ea relinquitur, donec aqua à bibentibus abſumpta ſit, dimidia hora post injectum lignum aqua cæruleum colorem contrabit, qui ſenſim intenditur pro temporis diuturnitate, tametſi 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 Cæruleous 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 comming out of the Glaſs to be perfectly

Cæruleous, 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 Phænomena 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 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 Cæruleous one.

Theſe and other Phænomena, 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 Phænomena 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 Modifie 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 Cæruleous, 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 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 Cæruleous 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 Cæruleous 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 Cæruleous 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 Cæruleous; 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 Phænomena 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 Indigenæ Coalle & Tlapazatli vocant, quod etſi experientia hucuſque non niſi Cæruleo 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 rarò in molem arboris excreſcit, truncus illius eſt craſſus, enodis, inſtar piri arboris, folia ciceris foliis, aut rutæ haud abſimilia, flores exigui, oblongi, lutei & ſpicatim digeſti; eſt frigida & humida planta, licet parum recedat à medio temperamento. Hujus itaque deſcriptæ arboris lignum in poculum efformatum, aquam eidem infuſam primo in aquam intenſe Cæruleam, colore floris Bugloſſæ; tingit, & quo diutius in eo ſteterit, tanto intenſiorem colorem acquirit. Hanc igitur aquam si Vitreæ Sphæræ infuderis, lucique expoſueris, ne ullum quidem Cærulei coloris veſtigium apparebit, ſed inſtar aquæ puræ putæ fontanæ limpidam claramque aspicientibus ſe præbebit. 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 verò vel in vaſe opaco poſita, Cæruleum colorem ſuum reſumet.

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 or Deep; and then, whereas it has been already ſaid, that the Cæruleous 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 Cæruleous 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 Sun-beams 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 Phænomena, 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 Cæruleous 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 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 indiſcriminatly 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 Cæruleous, 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 Prædominant 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 Cæruleous 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

recovers its Cæruleous 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 Prædominant in Quick-lime belongs, we have been perſwaded to referr it rather to Lixiviate 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 Cæruleous Colour of our Tincture. But whether concerning Liquors, wherein neither Acid nor Alcaliſate Salts are Eminently Prædominant, our Tincture will enable us to conjecture any thing more than that ſuch Salts are not Prædominant 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 taſts to the Saline Principle of Bodyes,) have any Remarkable Power either to deprive our Tincture of its Cæruleous 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 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 Phænomena 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 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 imploy any more than White, and Black, and Red, and Blew, and Yellow; theſe five, Variouſly 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 differingly 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 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 Increas'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 Rebounding 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.

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.

EXPERIMENT XV.

On this occaſion, Pyrophilus, I ſhall add, that finding the Glaſs-priſm to be the uſefulleſt Inſtrument Men have yet imploy'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 Phænomena 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 imploy, 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.

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, 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.

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 Præcipitating 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 throughly 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 Phænomena 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, 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 Modifie 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.

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.

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 Sphærical 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, 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 Phænomenon 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, Impræ̀gnated 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 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 Cæruleous Colour be Deſtroy'd by an Acid Salt, it may be Restor'd by one that is either Volatile, or Lixiviate; 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 Corn18. 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 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.

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 Lixiviate 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 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 ſetled 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 Cæruleous 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.

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 Metalls, 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 imploy'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, Regiſtred 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 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 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 protrathit 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 à Sale, Qui ſcire vult Virtutes, is ſcrutetur arcana Mercurii. Sic nimirum fundamentum hauſerit Myſteriorum, in quolibet creſcenti indagandorum, prout natura cuilibet ſpeciei ea ingeſſit. 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.

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 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 Oyly 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, 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 a dark Reddiſh Colour, full of little Black Specks; and that this Juice by a drop of a ſtrong Lixivium, was immediately turn'd into a Greeniſh Colour deep enough, by as much Urinous Spirit into a Colour much of Kin to 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 Lixiviate 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 Lixiviate 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 imploy'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 receneſt 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, imploy'd for Binding.

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, it 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 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 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 Modifie 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 it 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 imploy'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 Oyly 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;

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.

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, 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 Shops21. 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, 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.

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.

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 Liqours, into which ſuch Fumes convene, (for though we will not deny, that by skill and care a Reddiſh Liqour 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 Empyreumatical 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 Liqours 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 differingly 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, 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.

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 imployed 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 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 heightned 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 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 ſowr 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 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 droping 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 ſetling 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.

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 Phænomenon. 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 Lixiviate 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 Phænomena 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 Phænomenon, 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 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 Phænomenon. 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 out 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 undephlegmated Aqua-fortis will not perform the ſame thing well, yet that which is made exceeding Strong by being carefully Dephlegm'd, 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 imploy'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 Lixiviate Solvents ſome other Mineral concretions abounding with Sulphureous parts, of which ſort is crude Antimony, I concluded it to be eaſie to Precipitate 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 Filtred 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 Cæruleous Colour to the Tincture of Lignum Nephriticum, and turn that of Syrrup of Violets into Green. Wherefore this XL. Experiment does opportunely ſupply the deficiency of thoſe. For being

ſollicitous 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 Lixiviate 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 alwayes 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 cleer 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 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 Cæruleous 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, 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.

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 tincted 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 ſuccceds 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 dryed, 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 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 præcipitatus 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, wich 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.

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 ſwiming 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 ſwiming 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 tincted 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 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 Phænomena 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 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 Stopple (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.

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 tincted 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 Phænomena 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 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 frighting 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 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 Phænomenon 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 Wormius23 in his late Musæum 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.

EXPERIMENT XLVI.

We have often taken notice, as of a remarkable thing, that Metalls as they appear to the Eye, before they come to be farther alter'd by other Bodyes, 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 Bodyes 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 Metalls 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 Bodyes employ'd to work on them, than by the bare alteration of the parts of the Metalls 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 Metalls. The next ſuch as emerge from the Coalition of Metalline Particles with thoſe of ſome Menstruum imploy'd to Corrode a Metall or Precipitate it; And the laſt, The Colours afforded by Metalline Bodyes either Colliquated 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 Metalls, 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.

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 Phænomenon not unfit for you to conſider, though I have not now the leiſure to diſcourſe upon it. Tin Corroded by Aqua-fortis till the 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 tincted 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 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 Præcipitated 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 concurr 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 imploy'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 prædominant, 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 those which I intimated in the præamble 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 Phænomena 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 Spagyriſts 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.

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 imploying, either præcipitating 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

Præcipitated 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 Præcipitated with an Alcaly, it will afford a Yellowiſh or tawny powder, and if there be no Præcipitation 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 Spagyriſts.

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 had occaſion among other Tryals to mingle a few grains of Shell-ſilver (ſuch as is imploy'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 Venerial 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.

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 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 miſtion 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-imploy them.

Annotation V.

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.

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.

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 imploy'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 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 imploy'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 ſimper 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 tincted 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 tincted, 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 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 Moiſture25.

Annotation I.

Whereas it is preſum'd that the Magiſtery 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 Magiſtery, 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 Præcipitate what acid Salts have diſſolv'd, I could not but be prone to ſuſpect that the Curdled Matter, which is call'd the Magiſtery of Vegetables, may have in it no inconſiderable proportion of a ſtony ſubſtance Præcipitated 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 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 Præcipitated 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.

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.

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 alwayes be of the very ſame Colour with the Vegetable it is made off. For Lixiviate 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.

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 Lucriferous 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'l 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 Præcipitate 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 Præcipitated by this Liquor were uſually fair and White.

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 Præcipitate 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 Præcipitate 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 Precipitate 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 Precipitate out of a Dirty Green magiſtery of Roſe-leaves, ſo by the ſame Method, you may produce a fair Yellow, and ſometimes a Red Liquor, and the like Precipitate, 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 Precipitate,) 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 Precipitate like that formerly mention'd, and turn the Liquor that ſwam above it, for the moſt part into a lovely Yellow.

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 Armnoniack, 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 differingly 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 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.

Decorative tiles

LONDON,
Printed for Henry Herringman. 1664

Decorative rule

A COPY OF THE LETTER

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

SIR,

Illuminated T in Though Hough 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 haſted 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

imploy'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 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 Phœnomemon 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 recrute 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 imploy'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 verè aſſerere auſus fuit, ſe gemmam noctu lucentem vidiſſe. Garcias ab Horto proregis Indiæ Medicus, refert ſe allocutum fuiſſe, qui ſe vidiſſe affirmarent. 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 nullâ gemmâ hastenus deprehenſum, licet à quibuſdam temerè jactetur. And

the recenteſt Writer I have met with on this Subject, Olaus Wormius, in his Account of his well furniſh'd Musæum, 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 naturâ 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.

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 Glorioufly 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 it. I might tell you that Marcus Paulus Venetus28 (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 Catay29, 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 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.

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 marveilous, 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 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 imploy'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 Embaſſador 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 ſuſpition 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 '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 appeares to be more ſuſceptible of them, than ordinary Diamonds. And I confeſs to you, that this is not the only odd ſuſpition (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 Affriction 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 Boot31, 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 à 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 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 Wormius33 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 Vetraria34 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 Effluviums 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 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.

Decorative rule

OBSERVATIONS

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

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 Morning37 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.

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

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.

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 near39 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.

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 purpoſedly 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.

Fifteenthly, Having well excited the Stone, I nimbly plung'd it under Water40, 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.

Sixteenthly, 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

Seventeenthly, 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.

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.

Decorative rule

A Poſtſcript.

Annexed ſome Hours after the Obſervations were Written.

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.

FINIS.

Notes.

1 L. Annæ Senecæ Natur. Queſt. l. 6. c. 5.

2 He that deſires more inſtances of this kind and matter, that according to this doctrine may much help the Theory of colours, and particularly the force both of Sulphureous and volatile, is likewiſe of Alcalizate and Acid Salts, and in what particulars, Colours likely depend not in the cauſation from any Salt at all, may beg his information from M. Boyle who hath ſome while ſince honoured me with the ſight of his papers concerning this ſubject, containing many excellent experiments, made by him for the Elucidation of this doctrine, &c Dr. R. Sharrock in his ingenious and uſefull Hiſtory of the Propagation and Improvement of Vegetables, publiſhed in the yeare 1660.

3 See the Diſcourſe of the Nature of Whiteneſs and Blackneſs.

4 Since for his eminent Qualities and Loyalty Grac'd, by his Majeſty, with the Honour of Knighthood.

5 Exercitat. 325 Parag. 4

6 Album quippe & agrum, hoc quidem aſperum eſſe dicit, hoc vero læve. de Senſu & Senſib. 3. 3.

7 Epist. 2. pag. 45.

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

9 Hiſt. Anatom. Cent. 3. Hiſt. 44.

10 Olearius Voyage de Moſco. et de Perſe liv. 3.

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

15 See Scaliger Exercit. 325. Sect. 9.

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

17 Kircher. Art. Mag. lucis & umbræ, lib. 1. part. 3.

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

19 Paracelſus de Mineral. tract. 1. pag. m. 243

20 See Parkinſon Th. Boran. Trib. 9. cap. 26.

21 Parkinſon, Thea. Bot. Trib. 4 cap. 12.

22 Beguinus, Tyr. Chy. Lib. 2º. Cap. 13º.

23 Libr. 2do Cap. 34.

24 See the latter end of the fiftieth Experiment.

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.

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

27 Musæi Wormiani. Cap. 17.

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

29 In the year 1619.

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

31 The Narrative in the Authors own words, is this. Ego (ſayes he) ſanctè affirmare poſſum me unam aureo Annulo incluſam perpetuo geſtare, cujus facultatem (ſi gemmæ eſt) nunquam ſatis admirari potui. Geſtaverat enim ante Triginta annos Hiſpanus quidam non procula puternis ædibus habitans. Is cum vitâ functus eſſet, & ipſius ſuſpellex (ut moris apud nos eſt) venum expoſita eſſet, inter cætera 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 gemmæ habendæ deſiderio etiam parens &

frater meus, qui antea sæpius 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, inquiens; 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 Gemmâ ornatus gratia, dum gratiam nullam haberet, uti. Paret Sculptor redditque Gemmam, quam geſto pro annulo Signatorio. Vix per menſem geſtaram, redit illi priſtinus color, ſed non ita nitens propter Sculpturam, ac inæqualem ſuperficiem. Miramur omnes gemmam, atque id præcipuè quod color indies pulchrior fieret. Id quià obſervabam, nunquam fere eam à manu depoſui, ita ut nunc adhuc candem geſtem.

32 Olaus Wormius, in Musæ. 18º pag. 186.

33 Musæ. Worm. pag. 99.

34 Arte Vetraria, lib. 7 cap. 102.

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.

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.

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.

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.

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.

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.

43 We afterwards, try'd precious Stones, as Diamonds, Rubies, Saphires, 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.

Decorative rule

Transcriber's notes.

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

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 Lixiviate 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 ... is attempted -> where the change (etc.) 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 swimning -> 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 asserere -> nemo nunquam vere asserere (ib.): what is reladed -> what is related Observations: carefulsy drawn -> carefully drawn

- and emended Phœnomenon/a to Phænomenon/a 10 times and Cœruleous etc. -> Cæruleous 20 times

*** END OF THE PROJECT GUTENBERG EBOOK EXPERIMENTS AND CONSIDERATIONS TOUCHING COLOURS (1664) ***

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