CHROMATICS.

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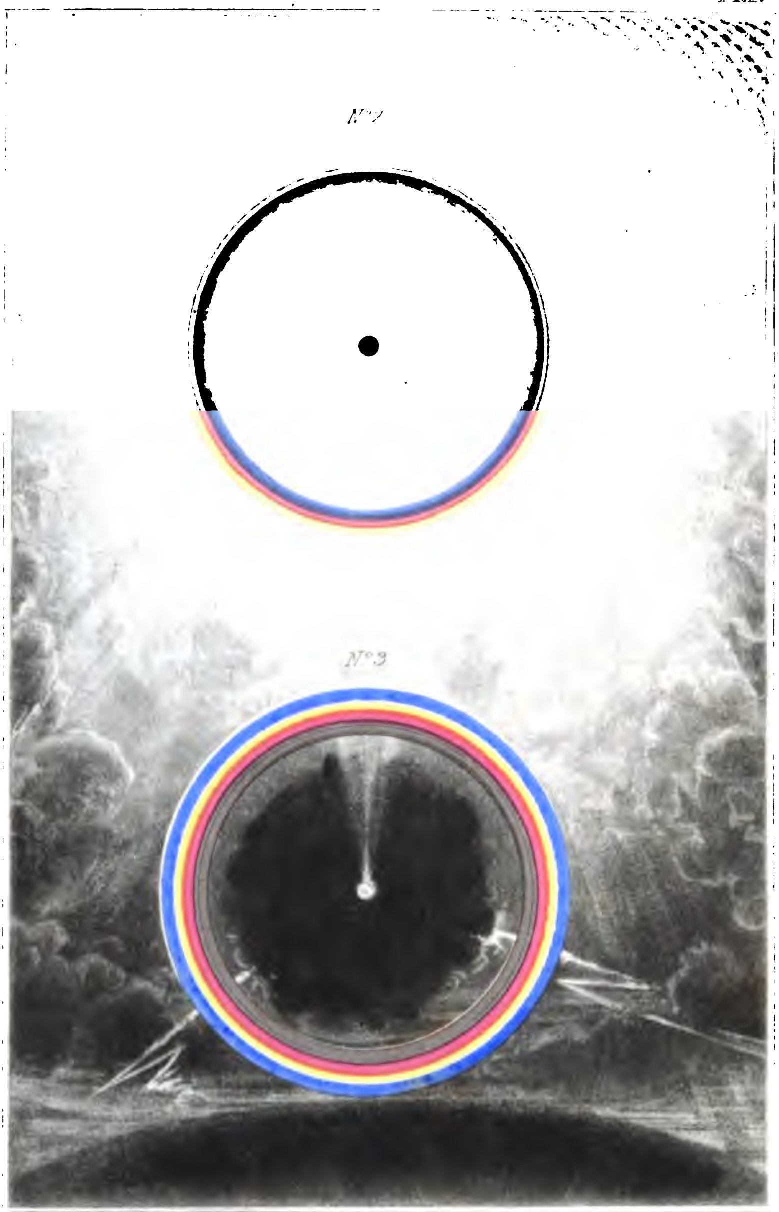
Pl. I.



Drawn by Geo. Field. Engraved by David Lucas.

CHROMATICS;

OR, THE

ANALOGY, HARMONY, AND PHILOSOPHY

OF

COLOURS.

By GEORGE FIELD,

AUTHOR OF "CHROMATOGRAPHY, OR A TREATISE ON COLOURS AND PIGMENTS, AND OF THEIR POWERS IN PAINTING;" "OUTLINES OF ANALOGICAL PHILOSOPHY," ETC.

A NEW EDITION, AUGMENTED.

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ERRATA.

Page 30, line 12, *for* visions tell, *read* vision tells.
— , — 28, *for* Hamilta, *read* Humilta.
— 44, — 1, *for* Chapter VI. *read* Chapter V.
— 45, — 23, *for* Example, *read* Experiment.
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— 125, — 22, *for* far, *read* fair.
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PREFACE

TO

THE FIRST EDITION.

THE following essay was designed to form part of a treatise on the nature, preparation, and relations of colours. The time necessary, however, to so arduous an undertaking, the want of an elementary book on the relations of colours, and the advice and approbation of several distinguished artists, have induced the author to publish it as a separate work.

The principle or plan of developement pursued therein belongs to *a universal archetype ;* * for all analogy is founded on universal relation, or the universe would not be a system of order and wisdom, but a chaos of confusion and folly, without unity, harmony, or design. Of such universal relation, the coincidences of music and chromatics,

* See an Essay entitled 'Tritogenia,' in the "Pamphleteer," No. XVII., 1816.

hereinafter adduced, are indicative,—coincidences which pervade all the *sensible sciences;* thence extending on the one hand to the *natural or material,* and, on the other, to the *moral or intellectual sciences,* in universal harmonious relation.

That the system before us is conformable to nature, is ocularly demonstrated by the immediate exhibition of its objects, an advantage peculiar to chromatics; and that it is consonant to universal reason is evident, because greater simplicity, or greater variety comprehended under such simplicity, cannot be conceived in any system; this attempt, therefore, addresses itself to reason and common sense, and requires but few preliminaries.

It may be expected, notwithstanding, that some account should be given of the doctrines delivered by preceding authors upon light and colours, yet such an attempt would conduct far beyond the proper limits of an elementary treatise, at the same time that literature contributes very little to the purpose of the present essay. Some works of a similar kind were, however, recently put into the author's hands by the late worthy and lamented Dr. Taylor, of the Society of Arts, &c., whose information concerning colours was not less extensive than his urbanity.

The earliest of these was the tractate of Le Blon, entitled "Coloritto, or the Harmony of

Colouring," in which he recognises the title of the ancient Greeks to an *Ars Chromatica* unknown to the moderns,—distinguishes the qualities *inherent* and *transient* in colours, by the terms material and impalpable, and divides them into primary and secondary. White he describes as a compound of the primitive impalpable colours, and black as a like compound of the palpable. True painting, he says, represents *light* by white, and *shade* by black, —reflections by *yellow*, and turnings-off or roundings of objects by *blue*. Such is the outline of the brief and perspicuous theory of Le Blon, which, however deficient or defective, verges upon the truth and simplicity of nature.

Le Blon was followed by Harris in a similar tract, entitled "The Natural System of Colours," in which he taught nearly the same doctrine. He distinguished colour into *prismatic* and *compound*, the first of which he subdivided into *grand primitives* and *mediates*, and these he defines by comparison with the tints of flowers. He denominated his *compound primitives*, olive, slate, and brown, —bore testimony to the composition of black by his *grand primitives*, and the consequent neutralising power of colours,—and, finally, illustrated his system by two diagrams, on Newton's plan, in which the above relations are exhibited in thirty-six sections, subdivided into 660 tints; this distribution is, however, arbitrary, the hues, shades, and tints of colours being unlimited.

To the above succeeded some other publications of a like design; but since they added nothing of importance to the foregoing, they may be passed over; the union of brevity, with perspicuity, being ever most conducive to science.*

* The increased interest which the subject has attained since the author first published this work, is apparent from the many elegant books which have appeared in relation to colouring, especially those of Messrs. Fielding, Burnet, Owen Jones, Gruner, Hay, Harding, Goëthe, Mérimée, &c., and, recently, the admirable version and commentary on the "Symbolic Colours of Frederic Portal," by W. S. Inman, Esq. published by Weale.

PREFACE

TO THE

PRESENT EDITION.

This work, as printed twenty-eight years ago, was part of a general treatise on colours, and an abstract of the first principles of chromatic science, constituting one division of a universal system of "Analogical Philosophy." As it was well received by the artists, and the truth and practicability of its theory continue to be acknowledged, and as we hold the science to be that which, from its middle station, the simplicity, breadth, and perspicuity of its relations, the beauty of its representations, and its easy reference to nature, is best adapted to illustrate the universal analogy of science, we have been induced to republish the work under a wider developement, extending the sphere of its application throughout art.

Our plan has been adopted according to a rule whereby every science should spring from its own especial principles, under a regulation subject to the general relations of science; and chromatics being strictly a sensible science, we have commenced with the elementary principles of light, shade, and colour, which are those of vision,—then unfolded their æsthetical relations, and finally adduced their philosophical, or, more properly, physiological elements and phenomena, whereby the science is confirmed upon its physical or natural foundation experimentally.

Every science is appropriately of universal relations; and the present science, being especially æsthetical or sensible, is intimately connected with fine art, and more remotely so on the one hand with physics, and, on the other, with ethical nature; hence the relation of chromatics with painting being immediate, they have been held in continual reference throughout. Add to which the laws of harmonious colouring, as exercised in the latter art, are precisely coincident in every other art, and, therefore, painting best illustrates the rules of good taste in all other uses of colouring.

The remarkable coincidences of this science with harmonics have induced us to expatiate that part of our original plan whereby we have illustrated the science of colours by that of sounds, and brought them both through natural analogy into connexion with universal science.

Hence, also, the fundamental relations of the science of *figures* or forms, which are elementary in drawing and geometry, are allied with this science in nature and painting not less exactly than harmonics are, but are more intimately and essentially connected therewith by practice and the laws of perspective and space. We have, therefore, adduced the coincidences of the science of figures, or plastics, with that of colours, in confirmation of the identity of relation by which these sciences are regulated and connected, whereby they may be reciprocally illustrated and advanced.

With regard to the diagrams of colours and figures given as examples, we have preferred the symmetrical regularities of science to the picturesque representations of art, which, however flattering to the eye, would be inadequate symbols of a theory addressed to the understanding.

The second part of our work, in which we have principally treated of the sciences coincident and allied with chromatics, we have distinguished by the term *æsthetical,* which, in its original meaning, denoted the whole science of *sense,* but which has been limited by recent usage to that of *taste,* which is but a form or effect of sentiment or sense, with a design, no doubt, to render permanent a subject hitherto vague. We have, nevertheless, employed the term in its original signification generically, and, according to analogy, whereby *æsthetics* denote all the sensible sciences, as *physics* do the material, and *ethics* the moral.

The narrow and devious views in which the æsthetical subject of *taste* and *beauty* has been regarded, have left it ambiguous and obscure; and although that which pleases one imagination disgusts another, the discordance of sentiments is not in the object, which is one only, but in the various minds and senses which are pleased or displeased, and which, while it accounts for the variety of sentiment concerning beauty, by no means alters its nature and laws, any more than similar discordances in the judgments of men concerning reason, truth, and good, can invalidate the foundation of reason, truth, or goodness, or annul the expediency for inquiry.

Whatever is beautiful pleases, whatever pleases is harmonious, whatever is harmonious is subordinated, and, therefore, *whatever is subordinated, harmonious, and pleasant, is beautiful*, and whatever is capable of pleasing and harmonious in subordination, is capable of beauty; and since whatever is harmonious is subordinated, and whatever pleases is so far harmonious, *the harmonious and the beautiful are the same. Beauty* is, therefore, to be sought for in harmony.

Now as *harmony* is the attribute of *music*, which depends upon pleasing subordination of sounds, and takes its name from the *muses*, who are figurative of all *inquiries* or *sciences* which extend to all things through subordination and system, so is there beauty through subordination and harmony in all things; and thus *beauty is universal*, and cannot be fully unfolded nor understood through partial inquiries; to which we attribute the insufficiency of all essays on the beautiful, and the necessity to investigate it universally.

Beauty is, therefore, as various as the universe, and the variety of beauty is coincident with the variety of pleasing subordination throughout the universe, and extends to all objects of sentiment and sense, by which it is properly limited; whatever, therefore, produces harmony in the objects of sense and sentiment, produces also beauty, and effects coincident pleasure.

To shew the conditions upon which subordination and harmony depend in the senses and their objects, is, therefore, to determine the universal conditions of beauty, and its fundamental laws and regulation. In an essay whose chief objects are harmony and beauty, we have, therefore, attempted to exhibit this regulation in the most important sciences of sense; namely, in the chromatic, musical, and plastic sciences principally, which are those of vision, hearing, and feeling, and have shewn that the conditions of harmony and beauty therein, and the natural laws by which they are governed and connected, are analogous, systematic, and universal.

To carry out this principle fully, would, however, be to unfold a universe, and our present aim has been accomplished if we have indicated the elements, or helped to lay the foundation of beauty for all art, while developing its chromatic relations, emulating therein the philosophic breadth of principle which distinguished the practice of the arts in ancient Greece.*

The Greeks, to whom every art and science has been indebted, have celebrated, with exquisite taste and imagination, the sisterhood of Music, Painting, and Poetry, a relation which we have attempted to trace to its real and natural source. Having first, therefore, demonstrated the intimate analogy of painting with harmonics, both in its chromatic and graphic departments, it required

* See a further investigation of this subject in our "Outlines of Analogical Philosophy," Vol. II. Outline vi. and Part IV., in which we have briefly treated on the principles, relations, and purposes of ART. We have also a work in forwardness especially dedicated to this inquiry.

only to completeness that we should establish the relation of poetical expression with chromatics and harmonics; and this attempt accordingly concludes our second part.

With regard to the third, or *physical* and final part of this treatise, our design not being literary, but doctrinal and practical, we have not treated its subject historically, nor with the usual detail of amusing experiments, however incidentally such may have arisen, our chief intention therein being to confirm the principles of our science on the foundation of nature and experimental induction.

Should it be asked whether all this science is essential to good colouring, we reply, not *absolutely essential*, but, for the most part, *expedient;* for the artist may colour well by force of nature and a cultivated eye, with practice, and no one can colour well without them; just as many persons sing or play on an instrument agreeably by similar means, without knowledge of music; but, in each case, will attainment be facilitated, and the faculties of the performer and the scope of his practice, become elevated, extended, and refined by its science. Should, nevertheless, any individual choose to follow the art, unstudied in science and uninstructed by nature, there remains no better course for him than to follow in the wake of an Etty, a Leslie, a Turner, a Mulready, or others of rising eminence in the fine school of colouring to which they belong, steering clear, at the same time, from such arbitrary and meretricious models as are founded neither on truth of nature nor science, both of which are essential to the perfecting of a school, and, wanting which, painting becomes plastic, art resorts to models, and invariably declines.

In thus widely regarding our humble science, we have not disregarded the paramount claims of science as a whole; for although we have through expedience assumed for it the precedence, and subordinated other sciences to our view, it has been only as every thing in harmony is, subordinated to a key. We will not, therefore, apologise for trespassing on other departments of knowledge, not doubting that the time will arrive when the sciences will comport with a simplicity, grace, and unity, not hitherto contemplated even by their professors, to the incalculable advancement of human intelligence and power, and, what is of infinitely higher concern, to voluntary virtue and happiness, the fruition of true wisdom.

1844.

CHROMATICS;

OR,

THE ANALOGY AND HARMONY OF COLOURS,

&c.

CHAPTER I.

ELEMENTARY RELATIONS OF COLOURS.

1. THE term CHROMATICS denotes the science of the relations of *Light, Shade,* and *Colours.*

2. Light, shade, and colours, are the sole immediate objects to the eye; for although figure, number, motion, &c., become objects of vision, they do so only by the agency or mediation of *light, shade, and colours; which are, accordingly, the sole primary and peculiar objects of sight, and the elementary principles of chromatic science;* they are sensible representations of material objects to the mind, and thereon the art of Painting is founded.

3. Light and shade are, then, the generating principles or elements of all visual effects, of which

light is the *agent, or active element,* and shade the *patient, or re-active element;* they are, therefore, correlative, coessential, and concurrent. Accordingly, the light of day, and the sunbeam itself, are compounds of light and shade; nor is either pure light, or pure shade, in any case an object of vision. Hence no eye can endure the sun's pure rays; and if the darkness of night, with closed eyes, is in any respect visible, it is only so because the organ itself secretes and emits light.

4. Light and shade are either *Achromatic* or colourless, or they are *Chromatic* or coloured. They are, also, either *inherent or immanent,* as in pigments and solid substances, or they are *transient,* as in the sunbeam and rainbow; and also in prismic, specular, and ocular spectra, &c., made apparent by transmission, refraction, or reflection.

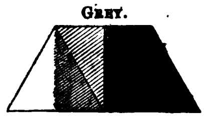
5. Inherent light and shade are called *white and black,* and in their transient state they are denominated *light and dark.*

6. It follows from the above that the elements of Light and Shade have three states, or modes of concurrence, which are convertible; one *sensible, achromatic, and mechanical,* as above [5]; another *latent, chromatic and chemical* [part III. ch. 12]; and a third, in which the *sensible and latent are conjoined,* as they are in the colours of pigments, &c.; in which these elements concur latently in their hues, and are variously participated sensibly

in the variety of their light and shade, or depth and brilliancy.

7. The elements of light and shade, in their sensible, inherent, achromic state, have two extremes and a mean, which are denominated *White, Black,* and *Grey,* the intermedia, or degrees of which, are indefinite or infinite, and are called *shades,* as the intermedia of colours are called *hues.*

EXAMPLE I.



8. Upon the right management of these, alone or in conjunction with colours and figures, depend all the powers of light and shade, technically called *chiaroscuro* in painting, as will fully appear in the sequel. But the term chiaroscuro, though commonly extended to all the attributes of light and shade, is more properly confined to the effects produced by their union and contrast. Black, white, and grey, have a double office, affecting both shade and colours, and are, among the chromatic means of the art, the most important, both as to their use and their abuse.* Milton's con-

* Of the especial powers of black, white, and grey, we have treated in our "Chromatography" under each term.

ception of the relations of light and shade was at once poetical and philosophical:—

> "From that high mount of God whence *light* and *shade*
> Spring forth, the face of brightest heaven had chang'd
> To grateful *twilight*."

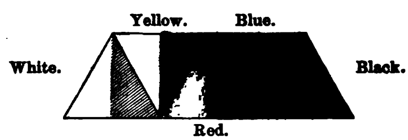
9. By the latent concurrence of *Light* and *Shade* they become chromatic, and *colours* are generated or produced [6]; and as the various states of these elements are relative and convertible, we may deduce our proof of this position variously from them. Thus a *white spot* upon a black ground, or a *black spot* upon a white ground, or a *grey spot* upon either ground, viewed through a Lensic Prism,* will be converted by refraction into an iris of three colours, as instanced in the two halos which surround the black and white spots upon the white and black grounds of plate I. in front of this work. The same may be demonstrated of coloured spots and grounds.

10. This experiment may be regarded as the *chromatic Canon*—the rule and foundation of the entire science of colouring, as the rainbow was by some early artists; and as the colours thereof, *Blue*, *Red*, and *Yellow*, however produced, are not further decomposible, they are *primary*; and in every case the blue will accompany the passive or dark element, the yellow will follow the active

* Respecting this instrument, see chap. xiii.

or light element, and the red will be intermediate. Accordingly where, in latent occurrence, the *photogenic element,** or principle of white and light, predominates, it determines the colour to be YELLOW; where the *sciogenic element,* or principle of black and shade predominates, it determines the colour to be BLUE; and where these elements concur with intermediate subordination, they determine the colour to be RED, according to the following:—

EXAMPLE II.



11. The colours thus elicited from black and white, being PRIMARY COLOURS, are called *colours of the first order.* These and their compounds are also denominated, more or less, *positive colours,* in distinction from those of their elements, black, white, and greys, which are called neutral, or *negative colours;* but the above primaries are also alone called *entire colours;* all their compounds and sub-compounds being denominated, more or less, *broken colours.*

12. As the primary positive colours are evolved by analysis from the negatives, black and white, or light and shade, so by synthesis, or composition,

* See chap. xii.

those positive colours reunite or resolve into those negatives or their elements, by an inversion of the foregoing iridal experiments [9]* through a transition from the latent to the sensible state of these elements.

13. Accordingly, by a due mixture of the three primary colours, in pigments or otherwise, the neutrals, black, &c., may be composed; and each primary alternately neutralises the other two primaries in the same respect; upon which law depend all the powers of their compounds, and also the variety of contrasts and accordances, or complementary equivalence and compensation of colours, upon which harmony of colouring depends, as will be rendered apparent.

14. This negation, or neutralisation of positive colours, by no means, however, arises from their arbitrary mixture or intimate composition, but is subject to a natural invariable Law of proportions, which requires them, when of equal intensities, to be to each other proximately as *three* yellow, *five* red, and *eight* blue, as we have demonstrated by the Metrochrome.† Thus Light and Shade are to colours what Acute and Grave are to sounds, and the relations here adduced of the primary colours are analogous to the relations of the common chord, or primary triad, whereon the musical scale is

* Plate I.

† Described chap. XIV.

established; and upon their Law, under a similar regulation and analogy, depends the entire regimen and science of harmony in colours.

15. As the primary colours are thus generated from a *spot*, so are the primary figures generated in like variety from a geometrical *point*; and as those colours are all comprehended in shade, so are these figures included in the sphere. As, again, all figures are generated of the primary lines, right, angular, and curve, so are all colours generated of the primaries, blue, red, and yellow; and as these partake of the various degrees of black, white, and grey, between the extremes of light and shade, so do the various primary and compound figures partake of the variety of dimensions, *linear*, *superficial*, and *solid*, between the extremes of the point and sphere; an admirable analogy of two distinct natures united in painting, well deserving the considerate attention of the artist in the composition of forms, of the one correlate, as the coinciding relations of colours are in the toning and harmony of the other; and especially so since the important purposes of relief, effect, and expression, are dependent on the adaptation and masses of colours and forms united, the whole of which will become more evident hereafter.

16. It is entirely agreeable to this analogy that the various modes of gradation, and contrast of light and shade in natural and artificial objects, are referable to the primary solids, as *plane*,

angular, and *curved;* and all their variety is dependent on, and determined by, the compounding of these primary forms on polyhedric and irregular or broken figures; and upon the management of this relation depend the chief effects and variety of chiaroscuro, we mean, as properly defined in the painter's sense, to be the unity with gradation and contrast of light and shade.

17. Accordingly, this principle of chiaroscuro completes itself on the most perfect or entire of forms, the globe or *sphere*, as carried out in pictural effect, according to the analogy of Correggio's bunch of grapes, and in some of Rembrandt's compositions; but it extends also to the *plane* aerial gradations and breadth of space in the pictures of Claude and Wilson, and also to the picturesque, rugged, and *angular* effects of Salvator Rosa, Caravaggio, &c., and is variously compounded in other works of art, and more diversely so in those of nature.

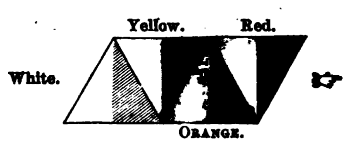
CHAPTER II.

DEFINITE RELATIONS, COMPOSITION, AND MELODY OF COLOURS.

18. It appears from the foregoing that the *Primary Colours* resulting from the analysis, or concurring in the synthesis, of their colourless elements united in light and shade, are *three;* the lowest number capable of uniting in variety, harmony, or system, and therefore their variety of union can be only three; and they constitute, in pairs, *colours of a second order,* thence called Secondary Colours, less positive than the former, or one degree nearer the achromatic or neutral state of their elements, in manner following:—

19. First, from the mixture or union of the two primaries, *Yellow* and *Red,* proceeds the secondary Orange, on the warm advancing white and *light* extreme of their elements, to which yellow is in nearest relation, in the following order:—

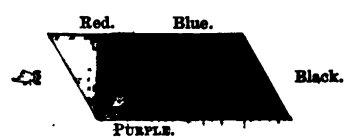
Example III.



and as in the neutrality of the elements of colours, Yellow holds the proportion of *three*, and Red the proportion of *five*; Orange, their compound, reckons in the scale of equivalents,* or neutralising proportionals, as *eight;* the use of which will presently appear, and it follows that Red is the ruling power of the compound.

20. Secondly, from a like mixture or union of *Red* and *Blue* proceeds the secondary *Purple*, on the cool retiring black and *dark* extreme, to which Blue is in nearest relation, according to the order following:—

EXAMPLE IV.



and as in the scale of equivalent proportions, Red reckons as *five* and Blue as *eight*, it follows that Purple, their compound, is represented in the scale of equivalents by the number *thirteen*, and that Blue is the ruling colour in Purple.

21. And, thirdly, from a similar union or composition of Yellow and Blue, proceeds the medial secondary *Green*, in equal relation to the extremes

* Plate II.

of warm and cool, advance and retirement, white and black, and light and shade, as follows:—

EXAMPLE V.

of which, again, Yellow being as *three*, and Blue as *eight* in the scale, Green, their compound, reckons thereon as *eleven*, and Blue is the ruling or predominating power in Green.

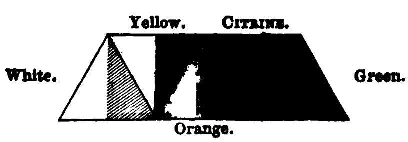
22. Here, then, it should be remarked that, as in the achromatic constitution of the neutral elements of colours, Yellow is effective as *three*, Red as *five*, and Blue as *eight*, it follows that either of their above compounds or secondary colours, according to their proportional number, will neutralise, or render achromatic, the remaining primary colour alternately. Thus *thirteen of Purple* will neutralise, or extinguish, and will be neutralised, or extinguished by, *three of Yellow; eleven of Green* will neutralise, and be neutralised by, *five of Red;* and *eight of each*, or equal quantities of *Orange and Blue*, will neutralise each other reciprocally; the colours employed in every case being of equal intensities.

23. It follows, of course, that the above pri-

mary and secondary colours contrast or oppose each other most effectively according to the same law, and the proportionals which govern their neutralisation or mutual extinction; and as the secondary colours are produced from the union of two primary colours alternately, in like manner from the concurrence of any two sounds of the primary musical triad, or common chord, there results a secondary, harmonic, or accordant sound.

24. Again, it is apparent that the SECONDARY COLOURS are subject to the same regulation and variety of union as their primaries, with like relations to their elements; affording *colours of a third order*, or TERTIARY COLOURS. Accordingly, from the pairing and compounding of the secondary colours, *Orange* and *Green*, proceeds the tertiary CITRINE, on the warm advancing white and *light* extreme, in proximate relations to the colours *Orange*, *Yellow*, and *White*, as follows:—

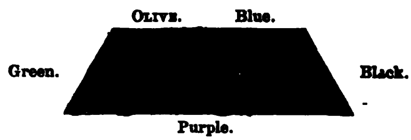
EXAMPLE VI.



25. Secondly, from the compounding of the secondary colours, *Green* and *Purple*, proceeds the tertiary colour OLIVE, on the cold, retiring

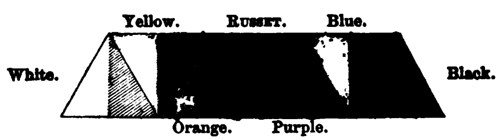
black and *dark* extreme, in proximity to the colours Purple, Blue, and Black, in order following:—

EXAMPLE VII.



26. And, finally, from the compounding of the secondaries, *Orange* and *Purple*, proceeds the tertiary RUSSET, in equal and intermediate relation to the extremes of warmth and coldness, advancement and retirement, White and Black, and *light and shade*, in the following order:—

EXAMPLE VIII.



27. Thus, of the TERTIARY COLOURS, Yellow predominates in, and gives its relations to, the *Citrine*, as Blue does to the *Olive*, and Red to the *Russet;* whence it follows that the tertiaries have the same relations and proportions to the secondary colours, with reference to *shade* retiring, that the primaries have to the same secondary colours with respect to light advancing: that is,

that Citrine is to Dark-purple as Yellow is to bright or Light-purple; that Russet is to Dark-Green as Red is to Light-Green; and that Olive is to Dark-Orange as Blue is to Bright-Orange.

28. As each of the secondary colours is composed of two primary colours, so in each of the tertiaries the three primary colours are variously compounded; it follows hence that no new generic distinction can proceed from the interchanged combinations of the tertiary colours, and hence their equal compounds all receive the indefinite term *Brown*, though better denominated and distinguished as Russet-Olive, Olive-Citrine, &c. [Example XIV.] The Browns may, however, be compounded upon the same triple relation in infinite progress and approach to the neutral *Grey*, the extremes of which are Black and White, from which we set out [7].

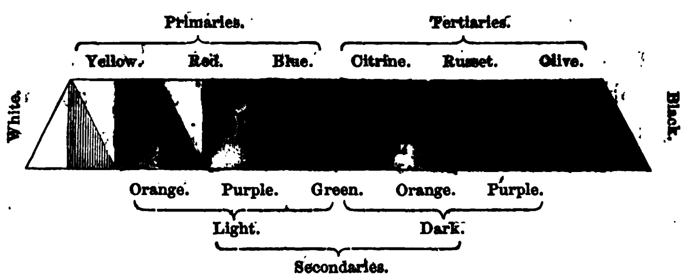
29. There remain, nevertheless, the collateral or indirect relations of colours; as, first, of a primary with a secondary colour; secondly, of a primary colour with a tertiary; and, finally, of a secondary with a tertiary colour; but these may for the present be passed over, since, although they afford orders and variations of colours, they do not afford distinctions of genera or species. To these may, however, be added an anomalous system of *Semineutral Colours*, arising from the combinations of all colours with the neutral *Black*; the

whole of which, though of practical consideration,* is of little theoretical importance.

30. We may now, therefore, terminate the series of colours thus deduced from their elementary principles, in one united definitive scale as they arise, in the natural order and relation in which the secondary colours spring from the primaries, and the tertiary colours follow from the secondaries in regular succession from Light to Shade.

EXAMPLE IX.

Definitive Scale of Colours.



31. Such are the distinctions, relations, and gradations of colours, as determined by the various predominance of their elements, through an orderly and infinite procession to the neutral or achromatic state, the position at which all predominance terminates; and the equilibrium of their elementary principles is re-established in

* See "Chromatography," Chap. XVIII.

unity, according to a naturally perfect and universal system.

32. From the various mixture of any colour with the inherent active element of all colour, *White*, an infinity of combinations may be produced, technically called TINTS; from the like combination of any tint or colour with any other colour may be produced an infinite variety of HUES; and from the like combination of hues and tints of colour, with their inherent passive element *Black*, may be produced the whole infinite variety of SHADES and *Semineutrals*.

33. A correct system of the relations of colours to light and shade, is of such importance in painting that, although by the force of natural colouring in objects, and a good eye, the artist may colour well, locally and individually, yet if there be a fundamental error in his theory, he cannot escape failure in the more essential accomplishments of general colouring, arrangement, and chiaroscuro.

34. Such a fundamental error has been that of regarding *Red as the prime power* and next to light, which vitiated the colouring of the Roman school, as it cannot fail to do that of every artist who shall follow it, and will in the end corrupt his eye, unless fortunately the perfection of his sense overcome his theory; and these effects of a false system are remarkable in the works of a master no less celebrated than Raphael, which have rebuffed the sensible eye of the most judicious

critics on a first inspection.* Even those works of Titian in which he deferred to the practice of the Roman school, evince these effects of false relations. Such practice posites yellow as a retiring power after orange, and throws the entire scale into confusion.

35. Another fundamental error of the Italian schools has been the regarding of *Black as the instrument of power* or depth in colour, instead of realising force by a combination of powers, according to the true relations of composition and contrast in colours; whence the smoky hues and murky colouring, often observable in the works of the Florentine and Roman masters, and all the vices that arise in practice from *confounding shades with hues*. Black, White, Red, and Green, of the particular powers of which we have spoken elsewhere, are, when improperly placed and employed, the dæmons of colouring, against whose evil doings the orthodox colourist will take due precaution to exorcise himself.

36. We have thus particularised these systematic errors because they continue, through pictures, or other authorities, to influence the practice of many artists, to the detriment of good colouring, and have been publicly taught by a late eminent historical painter and President of the Royal Academy, whose taste and practice had been corrupted in the Roman

* Malone's "Life of Reynolds."

and Florentine schools, whom we have heard contend strenuously for the above false theory, and who pursued it to the injury of his reputation as an artist.* The same failure has commonly attended the Roman students from this country, who have, with few exceptions, returned bad colourists, to unlearn the false acquirements of their Italian studies, and to retrieve, in their own pure school of colouring, those principles and that practice which produced a Reynolds and a Wilson, as they had in other natural schools a Rubens, a Rembrandt, a Tintoretto, and a Paulo Veronese, &c. And some among us, who have evinced a good eye and refined taste in their earlier works, have imbibed and carried into practice those fallacious principles, wherein prejudice has prevailed over the authority of nature; and as their learning increases, and their sense declines, will endanger their final reputation as colourists.

37. Upon a right understanding and strict comparison of the order and relations of the preceding *Definitive Scale of Colours* with the Fundamental Scale or *Gamut of the Musician*, it is impossible

* In speaking thus of the amiable West, we would, by no means, detract from his just reputation in other departments of painting, to whom the English historic school owes a Hilton and other eminent disciples; we object only against his authority in colouring; in which, nevertheless, borne by the current of the English school, and his own natural feeling, he has left us some pleasing examples, in spite of a false theory.

not to be struck with the entire resemblance and complete analogy of the two scales; nor will the philosophic mind of the artist find it difficult to carry these relations into figures and the forms of science universally. And as the acuteness, tone, and gravity of musical notes, blend or run into each other through an infinite series in the musical scale, imparting *melody* to musical composition, so do the like infinite sequences of the tints, hues, and shades of colours, impart mellowness, or melody, to colours and colouring. Upon these gradations and successions depend the sweetest effects of colours in nature and painting, so analogous to the melody of musical sounds, that we have not hesitated to call them *the melody of colours.*

> "Methinks, e'en now, I view some free design
> Where breathing nature lives in every line:
> *Chaste and subdued the modest tints decay,*
> *Steal into shades, and mildly melt away.*"

38. In like manner the anomalous compounds of broken colours [28, 29, &c.], which belong to no regular scale, but are expressive, in a high degree, in the representations of natural objects, are strictly analogous to sounds irregular in concord and interval, and thence less individually pleasing and harmonic, yet affording vocal tones which, although not strictly musical, are infinitely expressive as broken or compound, and capable of musical relations in the manner of broken, irregular, and

semineutral colours, and their achromatic shades in picturesque effects and representations.

39. The various simple accordances of two colours in the foregoing examples, by which third colours are produced, coincide with those consonances of two sounds which coalesce in third sounds, and are termed *concords*, as the contrary, in each case, are *discords;* and these may be either successive or simultaneous ; but *harmony*, properly distinguished, both with the musician and colourist, signifies the complex accordances of three or more sounds or colours in consonance, opposition, or contrast: to the consideration of which we proceed.

CHAPTER III.

EQUIVALENT RELATIONS, CONTRASTS, AND CONSONANCES OF COLOURS.

40. Having deduced the definitive or fundamental scale of colours from their elements, and shewn their successive relations, in which they reciprocally blend, tone, mellow, and melodise each other, in the preceding chapters, we proceed, in the next place, to denote their equivalent relations, contrasts, and consonances, according to the same elementary relations.

41. Those colours are properly *concinous or consonant*, which when compounded or placed together, produce a third pleasing tone of colour or agreeable effect on the eye; just as from the coalescence of concordant sounds a third consonant sound is produced to the musical ear: thus Blue and Yellow produce in mixture the beautiful tones of Green, or give brilliancy and value to each other when in juxta-position. On the contrary, Blue and Green similarly posited, produce no pleasing tone

or tint but a disagreeable effect to the eye, and are accordingly dissonant or discordant. And this principle runs variously through all the relations of the preceding definitive scale according to their primitive powers in the neutral or achromatic compound, and will be readily detected in every case by the intelligent and practised artist, without the needless prolixity of individual detail.

42. But there is another highly important species of consonance dependent upon the same extreme principle, and to which contrast belongs, of which the concordant colours have been variously denominated reciprocally complementary, compensatory, &c., but of which the resulting third is achromatic, when the colours are compounded, or their utmost brilliancy is effected when the colours are opposed, the entire effects of which depend, nevertheless, upon the equivalent powers or quantities of each colour to neutralise or extinguish its antagonist.

43. The *neutralisation* or negation of colours, or their reduction to the achromatic state, depends upon the reunion of the three primaries, as demonstrated in the preceding chapter [12, &c.], whence it becomes evident that each of the PRIMARY COLOURS is neutralisable by that secondary which is composed of the two other primaries alternately; thus *Blue* becomes neutralised or extinguished by *Orange*, *Red* by *Green*, and *Yellow* by Purple; accordingly they are so opposed to each other,

and light to dark in each, throughout the following figure.

EXAMPLE X.

44. But although the colours reciprocally opposed in this figure are mutual contrasts which give to each other the utmost distinct and vivid appearance when in apposition, and extinguish, neutralise, or negate each other, as already remarked, with most power when mixed or in composition; their powers or activities, in these respects, are by no means equal or uniform; those of Red and Green being reciprocally as *5* to 11, those of Yellow and Purple, as 3 to 13, and those of Blue and Orange being alone reciprocally equal, as will be satisfactorily demonstrated hereafter in our third part.

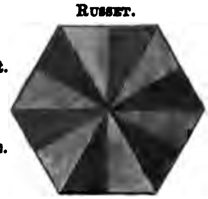
45. It follows upon the same principle, and in the same relation, that each of the SECONDARY COLOURS is subneutralised by that tertiary in which the remaining primary predominates alternately; thus, *Purple* is subneutralised and contrasted by *Citrine*, *Green* by *Russet*, and *Orange*

by *Olive*; as opposed to each other in light and shade in the next example.

EXAMPLE XI.

46. The same regulation extends to the TERTIARY COLOURS and their compounds alternately; for, since Red predominates in *Russet*, Yellow in *Citrine*, and Blue in *Olive*, it is evident, the simple compounds or pairs of these tertiaries take the relations of secondaries in a subdued degree, and that they concur altogether, in due proportions, in a neutral or achromatic state, and contrast and harmonise each other as opposed and connected in the following figure.

EXAMPLE XII.



47. This latter scheme of colours, comprehending in each division various compounds of the three

primaries, declines chromatically toward the neutral state of their elements. The perfectly neutral or achromatic state, and perfect contrast, depend however upon a due subordination of the *primaries*, in which Blue predominates in depth or breadth, and Yellow is subordinate to Red; or of the *secondaries* in which Purple predominates, and Orange is subordinate to Green, or, finally, of the *tertiaries*, in which Olive predominates in like manner, and Citrine is subordinate to Russet.

48. These three scales of contrasting colours, according to their positions and succession in the definitive scale preceding, are strictly analogous with the divisions of the principal scale of the musician, in which, by clefs or keys, he denotes, in like manner, the positions of sounds, as *Treble*, mean or *Tenor*, and *Bass*; and it will further appear, according to the same analogy, that the various keys and scales of colouring are coincident with the general relations of harmonic science.

49. It has already appeared that there are two kinds of consonance dependent on the same reciprocal principle or power of colours to neutralise each other by uniting in mixture, or to excite or animate each other in apposition, to one of which belongs the harmony of the *simple series*, and to the other belongs the like harmony of *two or more series* opposed; the first of which is in music called *melody*, the other, by way of eminence, *harmony*, or compound melody, or music in parts; accordingly,

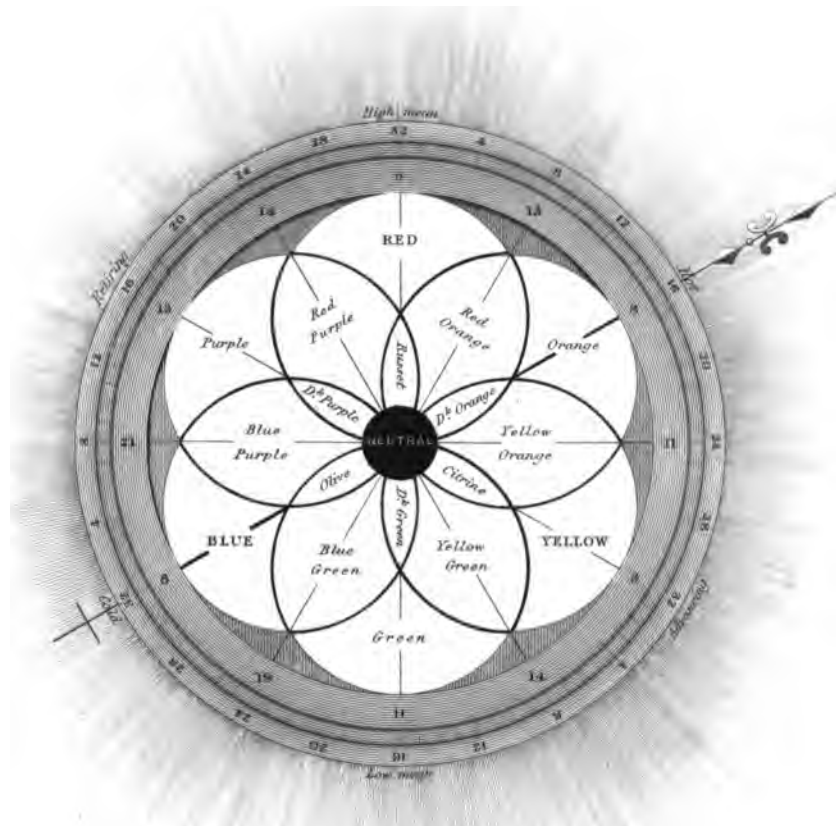
also, *contrast* in colouring and *counterpoint* in music are coincident.

> "Whence *light* and *shade* alternate,—*warm* and *cold*,
> And all the fair variety of things."—AKENSIDE.

50. We collect from the preceding doctrine:— Firstly, that *single colours* are pleasing, or the contrary, either according to hue, shade, or tint, or to taste or mental association. Secondly, that no *two colours in succession*, or opposition, will accord agreeably or harmonise, whose compounds will not constitute a pleasing tint. Thirdly, that no *three or more colours* co-arranged will please or harmonise, whose mixture, altogether, would not constitute, according to chromatic laws, a neutral tint, or accord in producing a tone or ruling colour expressive of the archæus or key of the composition; and, Fourthly, that therefore an attention to these rules is no less essential to skill of composition in colouring than are a fine natural perception and cultivated taste, not only in painting, but coincidently so in music.

51. To facilitate a right apprehension of the relations upon which these rules are established, recourse may be had to the diagram or universal scale, Plate II., wherein all the denominations of the three orders of colours and their compounds are laid down in circular succession, and every colour opposed to its contrast reciprocally, with the numbers denoting the equivalent powers of each

Scale of Chromatic Equivalents.



G. Field, Inv.r

W. A. Beever, Sculp.

specific contrast, from which may be estimated the powers of those that are intermediate and compound, as a key to the whole theory and practice of harmony in colouring.

52. This scale of Chromatic Equivalents is constituted of six coloured circles, comprehending the three primary colours, Blue, Red, and Yellow, opposed alternately to the three secondary colours, Orange, Green, and Purple, on radii within a circular graduated scale. These six coloured circles intersect each other, forming one small star at the centre, of secondary and tertiary compounds alternately opposed, by the crossings of three circles; and another larger intermediate star of opposed secondary compounds, formed by the alternate crossings of two of the circles. The double graduated scale, by which the whole is circumscribed, is divided round the inward border by numbers diametrically opposed, denoting the proportional powers with which colours lying on any radius of the circle neutralise and contrast any colour, simple or compound, on the opposite radius; while the mediating colours, which subdue each other without neutralising or perfectly contrasting, lie successively side by side round the whole, in the order of the Definitive Scale of Colouring [Example IX.], subduing and melodising each other, according to their various numerical powers.

53. These numerical proportions of the powers

with which colours neutralise, contrast, and harmonise, and subdue, soften, soothe, or melodise each other, have been demonstrated by the *Metrochrome*, described hereafter [Chap. XIV.], whereby it is ascertained that certain proportions of the primary colours, which, reduced to their simplest terms, are as 3 Yellow, 5 Red, and 8 Blue, of equal intensities, neutralise each other, integrally as 16; consequently, Red as 5 is equivalent to 11 Green, Yellow as 3, to 13 Purple, and Blue as 8, to 8 Orange, the latter being equal powers. The proportional powers of any intermediate compound colour all round the scale, may be ascertained by averaging the numbers of its components.

54. Some of these may be reduced to simpler terms; thus the equal numbers 8, denoting the reciprocal powers of *Orange* and *Blue*, to which the ends of the needle point on the scale, are as unity 1 = 1 (the simplest of all ratios), that of equality; and its colours are perfect contrasts, literally the points of extreme *hot* and *cold*, which are, so to call them, the chemical poles of light and shade, and the *poles of harmony* in colouring. This result is accidental, but it is a coincidence which evinces the truth of these relations, and singularly comports with the rule of harmony in painting, which has been founded on sense or feeling, and requires that equality or balance of warm and cool colouring in a picture upon which

tone or consonance so essentially depends.* These are the only contrasting colours which, like black and white, are equal powers; all other contrasts are perfect only when one of the antagonist colours predominates according to the proportions marked upon the inner scale.

55. Further, by a line diagonally across the needle or index, is denoted the positions at which colours must oppose each other as *advancing* and *retiring*; and a like line perpendicularly across the scale points out the *middle colours*. These three lines divide the entire scale into equal portions.

56. Again, by this scale may be determined the proportions in which any *three* colours neutralise, contrast, and harmonise each other. First, as 3, 5, and 8, are such proportions of the primaries, Yellow, Red, and Blue, so 8, 11, and 13, their pairs, are those of the secondaries, Orange, Green, and Purple.

57. Every three alternate colours of each of the stars or roses of the scale are complementary, and therefore are reciprocally contrasts, and harmonic, and these are pointed out by the same figures on the outward scale; thus, the three numbers 32 occur at the three *primaries*, Blue, Red, and Yellow, and those of 16; at the three *secondaries*; and so on of other numbers at other compounds.

* This consonance or union of hues and shades in painting, and of tones in music, the Greeks, according to Pliny (l. xxxv. c. 5.), denominated by the same term, TONOS.

58. This scheme is also a key to the whole science of nature in the painting of flowers, and it coincides herewith that the archetype of all floreal forms are triadic, consisting of the involution and evolution of triangles variously irradiated, the numbers of their leaves being invariably 3, 4, 5, or multiples thereof. The Scale of Equivalents also illustrates the circular diagram of Newton, and adapts the scale of nature to the general purposes of art.

59. The eye is quiet, and the sensorium soothed and complacent, when colours are opposed to each other in equivalent proportions chromatically; that is, in such proportions as in mixture neutralise their individual polar activities. This is the perfect harmony or union of colours. But the organ and the mind are also agreeably affected, when the mathematical proportions of opposed or conjoined colours are such as to produce other pleasing combinations to sense; and in this way the variety of harmony, and the powers of composition in colours, are produced; it is thus tones in colouring are governed, and the use of tone is to give repose to the eye. Thus colours in the abstract are mere variations of relation of the same elements. Black and white are the same colour; and, since colours are merely relations, if there were only one colour in the world, there would be no sense of *colour* at all, but only light and dark, however strange, offensive, or paradoxical, such assertion may appear.

60. The *neutralising* powers of colours, called

complementary or *compensating*, have been improperly denominated their *antipathies*, since they are the foundation of all harmony and accordance among colours; too much of any colour in a painting being invariably reconciled to the eye by the proper introduction of its opposite or equivalent, either in the way of compounding, by glazing, or mingling, or by contrast; in the first manners with neutralising and subduing effect, and in the other with exalting effect and brilliancy; in the first case by overpowering the colour, in the latter by overpowering the organ of vision, while in each the equilibrium, or due subordination of the colours, is restored.

61. It is not sufficient, however, that the artist should be informed what colours neutralise and contrast each other, if he remain unacquainted with their various powers in these respects; if he imagine them of equal force, he will be led into errors in practice from which nothing but a fine eye and repeated efforts can release him; but if he learn beforehand the powers with which colours act on and harmonise each other, the eye and the mind will move in concert with the hand, and save him much disappointment and loss of time, to say nothing of the advantage and gratification of such foreknowledge in realising their beauties with intention.

62. Hence the proportional powers of contrasting colours is of great importance to the artist who

employs them; for, if even he choose his contrasts aright, without such knowledge of their powers, he may fail to render them harmonious, as many of the Italian masters and their followers have done in the same case. There must be gradation and subordination throughout a picture; equal contrasts and masses, like equal lights, produce harshness, distract the attention of the spectator, and destroy the repose of the eye, and the gratification which springs from harmony through subordination and unity, the term repose implying harmony in every case throughout art.

63. A worse consequence than this of equal contrasts, even of rightly chosen colours, arises when the proportions of contrasted colours are inverted, and that which ought to be subordinate predominates; thus Green and Red, which afford one of the most pleasing and powerful of contrasts when the Red is subordinate, contrasts less agreeably when the colours are equal in mass and intensity, and even offensively in proportion as the Red may superabound; and the same law governs the contrasts of other colours according to their specific powers.

64. Not only does the scale of equivalents denote the powers and effects of colours reciprocally *in mixture*, but if the artist imagine the six circles of which it is constituted to be bright-coloured *glasses* of light hues, laid over each other alternately, as represented therein, he will readily con-

ceive and perceive the reciprocal powers of these colours to vary each other in *glazing;* while their oppositions denote also the powers of colours to neutralise or reduce each other without change of hue, by the same operation of glazing.

65. By attention to the numerical proportions and relations of colours, the student may approximate to a thorough comprehension of all their powers; and, assisted by a good eye and knowledge of his materials, may attain to perfect colouring. By a like attention to these powers of colours, the engraver, too, will be enabled to estimate those due allowances of light and shade which may be necessary to compensate for the absence of colours in his performance; or, in other words, to represent colours by their exact equivalents of light and shade.

66. The numerical difference of the three colours which constitute the *neutral*, affords the reason why beauty and variety of hue arise from the merely blending of shades, or varying of the lightness or darkness of a colour, even in the mixture of Black and White; because the greater power of Blue, or the cool element of neutral colour, becomes more apparent on lightening it, and varies the warmth and coolness of its hue; and this effect in forming tints, and in glazing, holds consistently throughout the whole scale of colours, so that, to preserve an equality of hue in any gradation from light to dark, it is necessary to

add warm colour in proportion as it descends into depth, and *vice versâ* to cool the colour as it ascends to light, as every good eye observant of nature is sensible.

67. The most powerful *chromatic contrast* is afforded by the middle colours Red and Green, distinguished on the scale as *high and low* in colour; for they are the colours farthest removed from the *achromatic* or neutral state, and its most powerful antagonists. Next to these in chromatic effect, as opposed to the neutral contrast of light and shade, is that of Orange and Blue, distinguished on the scale as *Hot and Cold*; and in a third degree of chromatic contrast, less removed from that of light and shade, is the contrast of Yellow and Purple, marked on the scale as *advancing and retiring* colours. There are thus three species of contrast which divide the scale equally, and coalesce in the various powers of the whole circular series reciprocally.

68. We have spoken of these and other modes of contrast in painting, practically in our "Chromatography;" our present concern is principally that of a correct theory, which demands the attention of the colourist to the above specific powers, upon the right understanding and observance of which expression as well as harmony depends; upon the right management of these proportional powers depend, also, what may be called the rhythm and repetition of colouring.

69. Upon the same, and a like knowledge and application of the other relations of colours, depend even their judicious mixture and material employment; but in a more peculiar and eminent respect, all the sensible effects, and also the consonances and dissonances, or discords of colours, depend thereon.

70. During the act of viewing any colour, the power of the eye is diminished with regard to such colour, at the same time that its activity becomes augmented with respect to the contrast; and the phenomenon of an ocular spectrum of the colour of such contrast is produced according to a law by which *every colour affects the eye with its opposite or harmonic colour*, in coincidence with the reciprocal relations whereby colours affect and neutralise each other; whence the sense of consonance and dissonance arises.

71. Thus by intently viewing a small *orange-coloured* object, its spectrum, of a *blue colour*, is induced in the visual organ, which, upon removing the eye to a *pale blue* surface, will be seen of an *intensely blue* colour, but upon a *pale orange* surface will appear *colourless;* and if the object viewed occupy the whole field of vision, the entire *pale blue* surface will become *deeply coloured*, or the whole *pale orange* surface become *colourless;* while other colours, viewed under the same conditions, will be variously affected according to their reciprocal relations, by which they unite conso-

nantly in third colours, or in neutralising each other, or dissonantly in breaking each other discordantly; whence arise the concords, discords, and expression of colours in the harmonic relations of musical sounds, the principal of which are exhibited in the following table.

TABLE OF CHROMATIC CONSONANCES AND DISSONANCES.

		Colours.	Consonant.		Dissonant.	Resolvent.
Contrasts.		1. White,				
	Primary.	2. Yellow,	by Purpling, ...	Russets	Orange:............	Blue.
				Olives	Green:	Red.
		3. Red,	by Greening, ...	Citrines	Orange:............	Blue.
				Olives	Purple:............	Yellow.
		4. Blue,	by Oranging, ...	Citrines	Green:	Red.
				Russets	Purple:............	Yellow.
	Secondary.	5. Orange,	by Blueing, ...	Greens	Yellow:............	Red.
				Purples	Red:	Yellow.
		6. Green	by Reding, ...	Oranges	Yellow:............	Blue.
				Purples	Blue:..............	Yellow.
		7. Purple,	by Yellowing, ..	Oranges	Red:	Blue.
				Greens	Blue:..............	Red.
		8. Black,				

72. Not only are colours thus affected by the state of the visual organ, but they are also similarly affected, precisely according to the same regulations, by the *colours of the light* in which they are viewed; whence, if a picture be painted or inspected in a cool light, all its cool colours will have acquired intensity, while all its warm colours will be depressed or neutralised, and the whole colouring deranged and degraded.

73. A like law operates, according to the above table, and the scale of equivalents, whatever be the colour of the light, subjecting the work of the artist while operating to corresponding defects.

Hence it is necessary, for correct effect, that he should paint in a neutral light; and equally so, for correct judgment, that the critic should view his work, uninfluenced, in a light equally pure; or, since it is hardly possible for a nice eye to escape these influences, they should be rendered as favourable to the work as circumstances may admit.

74. Every hue is subject to the regulation which governs the above table, and of these the dissonances or discords are boundlessly expressive of melancholy pathos through deficiency, as the consonances are of cheerfulness and harmony through completeness; it is hence allowable, nay, essential to the propriety of design, that the artist should employ occasional discordances, but in no case should he leave them totally unresolved by their complementaries, or so that they render the work repulsive as a whole, as Nicolo Poussin has done, knowingly and with design, in his picture of Perseus petrifying the Phineasians, No. 83 in the National Gallery, and as many others do unconsciously; a fault very properly censured by Sir J. Reynolds, who remarks that a picture should in general *invite* the spectator's attention by pleasing at first sight.—*Discourse VII.*

75. Each pair of contrasting colours in the *Scale of Equivalents* has the musical relations of the *fourth*, as is apparent through the *Analogical Table of Sounds and Colours* [Chap. IX]; which interval in the music of the ancient Greeks was

called *Diatessaron*, and was regarded by them as the only perfect concord, and that upon which all other concords depend; and it certainly coincides therewith, that each of these contrasts contains variously the primary triad of colours, the union, or various coalescence of which constitutes all harmony or accordance among colours; and any assemblage of colours which, like the primary triad, being mixed would produce neutrality, would, under a proper arrangement or combination, become harmonious.

76. For this reason, the most powerful achromatic contrast and perfect equivalents are those of the extremes of neutrality itself, viz. Black and White, which coalesce equally in innumerable degrees, and accompany all colours in their lightness or brilliancy, and darkness or depth, and give to every colour, in this respect, the power of contrasting itself; and every hue opposed to the same hue of deeper shade, appears *lighter or disappears* altogether, and, opposed to the same hue of less depth, appears *darker or deeper*; the same effect occurs, also variously, when the opposed colours differ, as may be easily inferred.

77. As the expression and character of musical melodies and compositions depend upon their proportional quantities in *time*, and have little relation to space, so the like character and expression in the sequences and compositions of colours are governed by their proportional quantities and positions

in *space*, and have little or no dependence on time. The first being an order of succession, as the latter is an order of co-expansion.

78. With regard to those indefinable mixtures and combinations of colours which present no regular hue or shade, either of colour or neutrality, being of too broken a character to admit of distinction or relation, they are the outcasts of colour, and therefore called *dirt*, but are perfectly analogous with what in like reference to musical sounds is called *noise*, that is sound that *annoys*, and very properly regarded by Rousseau as the jarring multitude of different tones combined; nevertheless, there is no *noise* that is not of some tone, nor any *dirt* that is not of some hue or colour, nor either of these that may not be picturesque, or that might not, under higher perceptive powers, be harmonised like the less broken colours, or greater intervals of sound; it is needless, however, nay, inexpedient and nugatory, to refine beyond general comprehension, feeling, and practice, and we have been content to class these colours in our "Chromatography" under the general denomination of *semineutral*.

79. By the present doctrine of chromatic equivalence, we are enabled to estimate with accuracy the individual relations and specific powers of colours, a subject which we have treated practically under each distinction in the above-mentioned work; we shall, therefore, not enlarge thereon in this place, but proceed to treat of the

general relations and harmony of colours deducible from the same source, remarking only, in conclusion, that this harmonic principle of equivalence is constant in the sky, and familiar throughout nature, as instanced in the *purple heath* compensated with the *yellow furze and broom*, on a large scale,—and the same regulation is carried out in the minutest objects, being often most exquisitely employed in the simplest flowers, and the smallest insects,—and even in those cases in which we find in nature large offensive masses of a single colour, we may, both by closer inspection, and by extending our view above, below, or around, discover its harmonic equivalence and compensation; and as the same natural regulation prevails in forms, &c. we may regard the whole of pictorial art as comprised in representing the unity in infinity of visible nature.

Ex. XIII.

Ex. XIV.

CHAPTER IV.

GENERAL RELATIONS AND HARMONY OF COLOURS.

80. HAVING discussed the particular and successive relations of colours upon which their melody and consonances depend, those general and expansive relations follow next in order to which *harmony of colouring* more especially belongs; which terms, harmony and melody, appropriate in general to the accordances of musical sounds, are by a strict analogy significant of the like successive and simultaneous effects of colours.

81. As the relations of two or more individual sounds or colours, succeeding each other by regulated transition, constitute what is properly called *melody*, by both the musician and colourist, so the like relation of *harmony* is constituted by at least three or more simultaneous coextended sounds or colours in consonance or opposition, and as the relation of harmony in colours is coexpansive, and an evident triunity governs the chromatic* system, we have adopted the equilateral triangle, the orderly combinations of which are infinite, as the

* The term *chromatic* throughout this essay refers to colours only when not otherwise denoted.

simplest and most proper figure for illustrating the infinite correlations of colours.

82. Of these general relations of colours the most simple is that of the primaries reciprocally with their principles, as exemplified in the accompanying diagram [Example XIII.], between the extremes of black or shade at the centre, and white or light at the circumference. Accordingly, the central *black* therein is an actual compound of the primary colours which surround it, in which *blue* is the predominant colour, tonic, or principal, *red* the dominant, and *yellow* is subordinate, or the subdominant, according to the proportional neutralising powers of these colours, as numbered in the scale of chromatic equivalents, and the similar subordination of musical sounds; and as there is an order converse to the above, namely, from white at the centre, to black at the perimeter,—we have denoted it by the inverted triangle behind, coloured of their binary compounds or secondary contrasts, circumscribed them by the primary iris, as elicited from Black at the centre,* and harmonised the ground with the grey tints of a morning sky; the whole of which is conformable to natural theory and consonant to visual sense.

83. This diagram illustrates, upon the simplest plan, the principle and *rationale* of the composition or arrangement of colours in a picture,—each prin-

* Example I., Chap. xiii.

cipal mass of colour therein appears, first in relation to light and shade, and requires to be repeated subordinately, or compounded as in the inverted triangle,—and, again, subdominantly, as in the iris and ground, but always in subordination to their principles as foci, and every colour balanced and invigorated by the opposition of its respective contrast.

84. Accordingly, the three principals of the primary triangle are so opposed to their three binary or secondary contrasts in the inverted triangle, Blue to Orange, Red to Green, Yellow to Purple; and the whole harmonic arrangement of the diagram refers to the principles and elementary relations of colours, delivered in our first chapter, upon which the melody and consonance of colours are founded and follow. And these relations coincide in the two scales of the musician and colourist, which mutually illustrate each other, as appears in the musical scheme, Example XIV., wherein the primary triad of colours are apposited with the common chord or notes, C, E, G, which constitute the primary triad of musical sounds, and the intermediate tones of both, also in the same apposition, in perfect agreement with their respective scales, the acute and grave of the one, coinciding with the light and dark of the other, represented by white and black, in uniform analogy throughout.

CHAPTER VI.

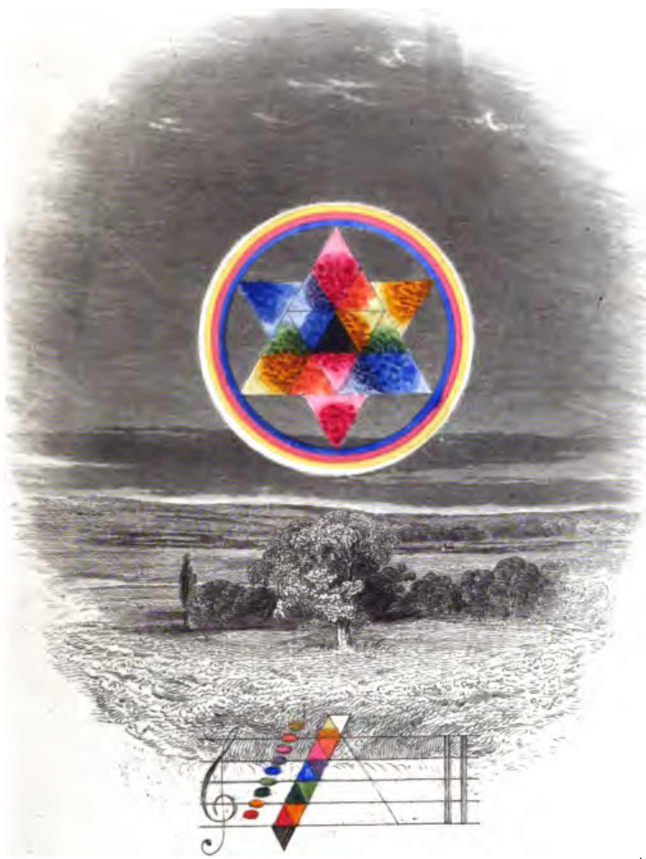
PRIMARY HARMONIES; OR, KEYS OF COLOURING.

85. THE second general relation or harmony of colours, is that of the primaries with their secondaries and elementary principles, as exhibited in the present diagram [Example XV.], upon the same archetype or plan as the preceding [Example XIII.], which illustrates the harmonic relations of the primary triad of colours as the principle and foundation of all other modes of chromatic harmony. We proceed, therefore, in the present and following schemes, to exhibit the more extended general relations upon which the many modes of harmony in painting, and the diversity of their regulations, depend.

86. It has before appeared in what manner the secondary colours proceed from their primaries in succession. In the present diagram this again appears simultaneously and in correlation, together also with their subordinate and interchangeable relations; for the particular is comprehended in the general.

87. Accordingly, the first general relation of

Ex. XV.



Ex. XVI.

Example XIII. is, in the present diagram, extended to three more general and subordinate harmonies, by which it is bounded under a similar regulation, wherein one of each of the three primary colours becomes the centre and ruling principle.

88. These three more general harmonies occupy the three bounding triangles of the four into which the principal triangle of this diagram is divided; and of these, the upper one, similarly divided, has *Red* at the centre as its archeus, or predominating colour of the *Light-Red*, or pink, *Orange* and *Purple* which surround it, and rules the whole, which may, therefore, be called the *harmony or key of Red;* as the similar compound triangle on the right or dexter side, consisting of the Yellow as a ruling colour, surrounded by *Green*, *Orange*, and Primrose, or *Light Yellow*, may be termed the *harmony or key of Yellow;* and that on the sinister side, of Blue as the archeus, surrounded by *Purple*, *Green*, and *Light Blue*, or watchet, may be denominated the *harmony or key of Blue.* How this regulation belongs to nature we have demonstrated and exemplified, Chap. XIII. Example III.

89. Thus, in every harmonious composition of colours, there is a *principal tone, archeus, or predominant colour*, to which its other hues refer subordinately; as, in like manner, every musical composition has a principal or predominant sound, note, or key, to which all its other sounds refer in subordination. And as in every musical composi-

tion there are three various ruling powers, the *tonic*, *dominant*, and *mediant*, or the *fundamental*, *fifth*, and *third*, so in the harmonious composition of colours there are three principal colours which are, as we have seen, of powers similarly related.

90. Not only are the above four divisions of the principal triangle of the diagram distinct harmonies of the primary colours, but they also constitute together one *more general harmony* in triunity, in which, as in musical composition, there is also a natural subordination of the archeii or keys, *a repetition and breaking of the prime colours*, an equal *balance of warmth and coolness*, and a *united regimen of light, shade, and colours*, throughout, by which brilliancy with harmony are secured as in a picture.

91. Titian availed himself of the natural principle and regulation of harmony in the colouring of the admirable "Bacchus and Ariadne" of our National Gallery, the art of which was apparent to Sir Joshua Reynolds, who thus comments upon it:—"The figure of Ariadne is separated from the great group, and is dressed in *blue*, which, added to the colour of the sea, makes that quantity of cold colour which Titian thought necessary for the support and brilliancy of the great group, which group is composed, with very little exception, entirely of mellow [warm] colours. But as the picture would, in this case, be divided into two distinct parts, one half cold, and the other warm, it was necessary to

carry some of the mellow colours of the great group into the cold part of the picture, and a part of the cold into the great group; accordingly, Titian gave Ariadne a *red* scarf, and to one of the Bacchantes a little blue drapery."

92. This principle is evidently, however, not confined to warm and cold colours only, but belongs to every order of colours, contrast, and composition, in forming a harmonious totality—a whole. It is this repetition in subordination which especially renders the *reflections* of colours and objects in water, &c. so pleasing and effective in pictures and landscapes, &c. In fine, it is also the principle upon which the *lights* are repeated and subordinated in the composition of a picture, and the entire regimen of the chiaroscuro is conducted.

93. Sir Joshua has given it as a rule, that the proportion of *warm to cold* colour in a picture should be as *two to one*, although he has frequently deviated therefrom; and Smith, in his "Remarks on Rural Scenery," would extend a like rule to all the proportions of painting, begging for it the term of the "*rule of thirds*," according to which, a landscape, having one third of land, should have two-thirds of water, and these together, forming about one-third of the picture, the remaining two-thirds to be for air and sky; and he applies the same rule to the crossing and breaking of lines and objects, &c.

94. This rule, however, does not supply a ge-

neral law, but universalises a particular, the invariable observance of which would produce a uniform and monotonous practice. But, however occasionally useful, it is neither accurate nor universal, the true mean of nature requiring compensation, which, in the case of warmth and coolness, is in about equal proportions, while, in regard to advancing and retiring colours, the true balance of effect is, approximately, three of the latter to one of the former; nevertheless, the proportions in both cases are to be governed by the predominance of light or shade, and the required effect of a picture, in which, and other species of antagonism, the scale of equivalents affords a guide.

95. The present diagram includes and extends the scale of the preceding one into that of the secondary colours, and not only exhibits the several keys or *orders of harmony* we have described, but also a similar *regulation of melodies* of colours, together with their various *consonances and contrasts.*

96. Thus, if the series of seven small coloured triangles, which constitute and border either side of the principal triangle, be viewed separately from the remainder, it will be found to contain the three primary colours under a different arrangement, according to position, on each side, constituting various melodies, in one of which *Red* predominates as its archeus, in another *Yellow,* and in the third *Blue;* each forming variously a beautiful series, analogous to the three like variations of the com-

mon chord, and octave in musical melody, and the positions of the triadic chord to its root in harmony, Example XXIV.

97. If, then, these three series, or melodies, be successively covered or hidden, and the spaces remaining of the principal triangle viewed apart, it will be seen that they afford three distinct harmonies, more extended, and including those before instanced (88); in each of which the three primary colours also appear ruling the composition as archei; 1st, in a single triangle at the apex; 2dly, broken with its dominant and subdominant colours in three triangles beneath; and, 3dly, opposed to its consonants and contrasts in five other triangles, as a base to the whole.

98. Of these harmonies one is ruled by *Red*, another by *Yellow*, and the other by *Blue;* and throughout the whole more general harmony of the large triangle which they constitute, every colour is invariably opposed to its appropriate contrast alternately [as in Example X.]; and in every section, however variously separated, the composition or series of colours it may contain will be harmonious or accordant.

99. The harmonic relations of this diagram will be rendered more apparent by that of Example XVI. beneath it, illustrating the analogy of these corresponding chromatic and harmonic scales according to musical notation upon the treble clef

of the diatonic scale, whence it may be extended through the three clefs, as on the left in the universal scale of sounds and colours. [Chap. IX. Example XXIII.] In other respects this present diagram agrees with the preceding example.

100. The indefinite sense in which the terms harmony, melody, &c., have been employed, has led to mistakes in practice, and may cast a portion of obscurity over these illustrations. The proper sense of the term harmony in painting, not only comprehends the *local arrangement of colours* in a picture, but also its *tone;* it is too often, however, confined to the latter sense by artists in general, while some, in equal error on the opposite extreme, restrict it to the former. But *local arrangement* is regulated by variety of consonance, and *tone* depends upon the *tonic,* or archeus, which rules the unity of the colouring throughout.

101. Hence the artist who restricts harmony to tone, imagines he has done enough with regard to colouring when he has secured a proper light and shade, with a warm effect, in his picture, for such is one (and one only) of the most pleasing keys or archei in colouring; and hence a taste for the harmony of sunshine, to the exclusion of other archei, has been too exclusively entertained: for in nature, when the sun does not appear, the sky tinges light and objects of its own colour, and

blue or gray becomes the archeus with *a cool effect;* and tone in painting is capable of the all-various modifications of its archeus; but these instances lead to practical considerations, of which only by the way.

102. And with regard to arrangement as well as tone and harmony in general, some of the greatest masters of the ancient schools appear to have been miserably deficient; and drawing and composition, the mathesis of the art, preceded its sensible effects in colouring, &c. The man who first philosophised or naturalised upon the rainbow, was, probably, the first who taught something of local arrangement to the artist, through the alliance of nature, philosophy, and art; and general arrangement may be regarded under a similar analogy with this most beautiful phenomenon.

103. The present scale is that of the flower-painter, and that in which others delight to revel in refracting the light of heaven throughout landscape, &c. It is, however, the diatonic scale in which nature (who employs colour for occasional gratification, and not for incessant excitement of the eye) rarely indulges, except in flowers and plumages, in the skies of coming and parting day, or in her more unusual meteoric phenomena. In her familiar practice she harmonises, as in the song of the nightingale, with the modest, pathetic, and expressive Dorian enharmonics of the tertiary scale; sometimes only with an occasional play of

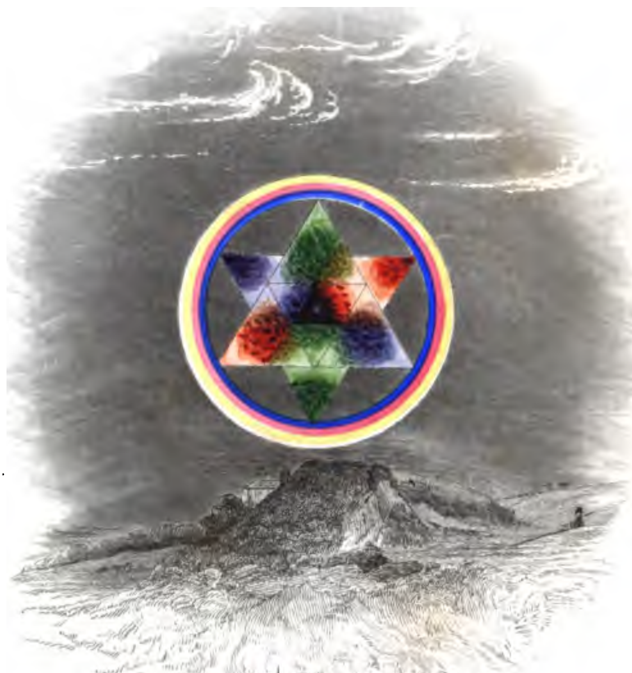
the primaries, or even more rarely sporting with all the scales in one united harmony:—

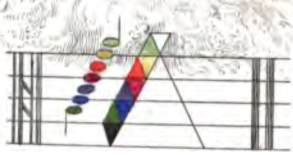
> "E'en as the harp and lute awake,
> And sprightly voice sweet descant run."

104. There is, accordingly, a manliness of taste in the perfection of the eye with regard to colours, as with the lower objects of sense, that appreciates their sober significant relation and harmonies; while in childhood, ere the sense becomes cultivated, and in age as it declines, a love of the gaudy, the stimulating and gorgeous, prevails. And hence arises the proper esteem of a cultivated taste for the refined harmonies of the secondary and tertiary scales in reference to the general colouring of nature and art. And even in decorative art, gay colouring is to be regarded as meretricious, when it defers from the understanding to the eye, vacant of meaning or illustration. The attractive gaudiness admired on a handbill would degrade a work of higher intelligence; nor should Intellect in any case wear the livery of Sense.

PL. V.

Ex. XVII.





Ex. XVIII.

CHAPTER VI.

SECONDARY HARMONIES; OR, KEYS OF COLOURING.

105. THE next general variety of harmonies in colouring, according to their archeii, are those of the secondary, or middle order of colours, coinciding in relation with those of the primaries preceding; they are, therefore, similarly developed in the accompanying diagram [Example XVII.], in which the secondary take the place of ruling colours, with their primaries and principles in reciprocal harmony alternately, and in one united harmony.

106. Accordingly, the quadruple triangle in the centre of this figure comprehends the secondary colours in relation and harmony with the principle of shade; for, as the primary colours unite in and constitute black or shade, and the secondaries are composed of the primaries, it is evident that *the secondary colours in union constitute Black.* Accordingly, the central black of the diagram is an actual compound of the secondary colours which encompass it, in which *Purple* predominates proportionately as 13; and *Orange,* as 8, is subordinate to *Green* as 11.

107. The above central harmony of the secondary colours is further expanded into three more general and subordinate harmonies, occupying the three triangles by which it is bounded, and according to the same principle and regulation as those, by which the primary harmonies of the previous scale [Example XV.] are governed, one of each of the three secondary colours becomes the centre and archeus or key, of three distinct harmonies.

108. Of these three harmonies the upper one, similarly divided and distributed as the former, has *Green* at the centre as its archeus or ruling colour of the Blue, Yellow, and Light-green which bound and surround it; as the similar division on the dexter side, consisting of *Orange* as the archeus or key, surrounded by Red, Yellow, and Light-Orange; and that on the sinister side having at its centre as the archeus *Purple*, bounded by its subordinates, Blue, Red, and Light-Purple, or Lilach; and of these the first may be distinguished as the *harmony and key of Green*, the second as *that of Orange*, and the third as *that of Purple*.

109. Thus, again, there springs from the same natural law and arrangement a second order of archeii, or keys, in colours, to which their subordinate hues refer, in musical relation as mediant and dominant to the tonic, or the third and fifth to their fundamental and octave, called the three

essential sounds, or primary triad of music; and they are, in like manner, dependent upon the correlative relations and subordination of the primary triad of colours, which constitute the unity of their elementary principles in an achromatic or neutral state, and are the pervading powers of all chromatic science.

110. In like manner, also, as the primary harmonies preceding, do the above unite in one more general harmony of the whole in like subordination, and according to a regimen precisely coincident and analogous to that of the three primary harmonies, and in all other respects does the present diagram coincide with the preceding. [Example XV.]

111. Thus the principal triangle contained in the series of small triangles which bound it, has three distinct melodies; which, viewed separately, exhibit each the three secondary colours under a diverse arrangement, ruled alternately by a different archeus; one affording a melody of the *Green*, another of the *Orange*, and the third of the *Purple*, or various expressions of the same colour, as before noted of the primaries.

112. So, again, if these three melodies be successively hidden, three enlarged harmonies of the three secondaries will successively appear, in each of which one or another alternately rules as the archeus or tonic; first, in a single triangle at the apex; secondly, with its principles in three triangles beneath; and thirdly, by its contrasts and

consonants in five consecutive triangles subtending them.

113. And of these harmonies one is ruled by *Green*, another by *Orange*, and the third by *Purple;* and throughout the whole harmony which they constitute together, every colour is opposed to its contrast reciprocally; and, however variously divided, every section will contain a various and accordant harmony.

114. Example XVIII. has been subjoined in illustration of the reciprocal analogies of the Musician and Colourist, upon the *tenor clef* of the former, and the *mean scale* of the latter, whence they may be extended upward and downward, as in the compound scale of sounds and colours. [Example XXIII.]

115. The archei, or keys of harmony, melody, and tone of the present scale and order of colours, are of a more temperate and less vivid character than those of the primary scale preceding, and coincide more intimately with that scale or genus of music, which, with the ancient Greeks, had obtained the name of the *Chromatic*, for what reason is unknown; but, probably, from some observed coincidence in the relation of half notes, and the broken colours of these minor scales. The principal peculiarity of this scale is that, as the *secondary and middle* scale, it may be harmonised and melodised upward with the *primary* colours, as in the present diagram, or downward with the tertiaries.

Ex. XIX.

Ex. XX.

CHAPTER VII.

TERTIARY HARMONIES; OR, KEYS OF COLOURING.

116. THERE remain yet the general relations and harmonies of the tertiary colours as archei, which are accordingly exhibited in the annexed diagram [Example XIX.], with their subordinates and principles, conformably to the distribution of the foregoing diagrams.

117. Accordingly the quadruple triangle at the centre of the present diagram, comprehends the tertiary colours in rule and harmony, with black or shade; and as the tertiary colours are composed of secondaries, and the secondary colours are compounds of the primaries which finally constitute Black, it follows that *the tertiary colours united also constitute Black;* and the central black of this figure is an actual neutral compound of the tertiary colours which surround it, in which *Olive* predominates in the proportion of 8, and *Citrine* in the proportion of 3, is subordinate to *Russet*, which is proportionately 5; altogether according to the powers of the primary colours, and the relations of the primary harmonics in musical sounds.

118. The above central harmony of the tertiary colours is farther distributed into three collateral general harmonic triangles, circumscribing its three sides; and these again are regulated and distributed precisely according to the analogy of the similar departments of the preceding diagrams [Example XV. and XVII.], in which the primary and secondary keys of colouring are exhibited as the tertiary are in this, one of each of the tertiary colours alternately being the centre and archeus of the three triangles respectively.

119. Accordingly the upper triangle has *Russet* for its archeus, ruling Orange, Purple, and Light-Russet, which surround and bound it, as the like division of the dexter side has its *Citrine* archeus, ruling Green, Orange, and Light-Citrine; and the sinister division has *Olive*, its archeus, toning Purple, Green, and Light-Olive harmonically; and these may be distinguished according to their ruling colours. 1st, as the *harmony of the Russet;* 2d, as the *harmony of the Citrine;* and, 3d, as the *harmony of the Olive.*

120. Again, therefore, there arises, according to the foregoing regulation of the primary and secondary colours, a third order of archei, or keys of colouring, having correlative hues referring to them in the musical relations of tonic, third, and fifth; and the chromatic relation of the primary triad of colours, which constitute a perfect achromatic unity, and afford the fundamental principle

of all chromatic harmony, melody, and consonance.

121. Further, also, in the manner before described when speaking of the primary and secondary archei, these tertiary distinctions unite in one general harmony, and coincide with the preceding diagrams in their various relations throughout.

122. Thus the principal triangle comprehends in the series of small triangles which bound it three distinct melodies, each occupying one of its sides, and containing the three tertiary colours variously arranged, and each being in its turn the archeus or ruling colour of three melodies, one affording the *melody of the Citrine*, another *that of the Russet*, and the third *that of the Olive*, according to the similar relations of the primary and secondary colours.

123. And again, these three sides being successively covered or hidden, the remainder of the diagram alternately will afford three extended harmonies under the respective archei of the Citrine, the Russet, and the Olive; that of the *Russet* at the apex, over three sections of its principles which rest upon five other triangles, subtending the whole harmony; that of the *Citrine*, in like order, on the left hand; and that of the *Olive* on the right; each harmony having every of its colours opposed to its reciprocal contrast, and the whole together being indefinitely divisible into sections distinctly harmonious.

124. The analogous scale of sounds and colours [Example XX.] has also been subjoined, in illustration of this correspondence of the harmonious structure of the two sciences of the musician and chromatist, upon the *bass clef* of the former, and the lowest scale of the colourists, although capable, like the analogous scales preceding, of extension, ascending and descending, according to the universal analogous scale, [Example XXIII.]

125. The expression and sentiment of the tertiary harmonies are of a more pathetic character, and better suited to breadth of effect than those of the primary and secondary scales of colours; accurately coinciding with the accounts recorded of the enharmonic genus of the ancient Greek music, which consisted of quarter tones, as these consist of the like broken or divided colours, and approaching to the achromatic state, as enharmonic sounds approach sounds expressive, but not musical.

126. Of this and the two preceding scales it may be remarked that the various character of beauty and expression belonging to them, adapts them to various objects and the various classes of painting; accordingly, the late President of the Royal Academy of Painting remarked, that the scale of secondary harmonies [Example XVII.] exceeded the others in beauty; on being requested to give a reason for which, he replied, that "it was a matter of feeling;" and any one acquainted with his works will perceive that it was the prin-

cipal scale of his high colouring; and another Academician remarked, that "the scales of the tertiaries [Example XIX.] was precisely what Titian aimed at in landscape," while to the natural eye, and that of the painter of flowers, the primary scale [Example XV.] is pre-eminently beautiful; nor is there any real contradiction in this, for beauty is universally relative, and in vegetal life, in which nature chiefly dispenses her colours, these three scales afford, successively, the various archei of spring flowers, summer fruits, and autumnal foliage; the colours of winter being neutral.

127. Upon viewing these coloured diagrams through a large magnifying lens, their various harmonies and relations become more striking and remarkable; and by a due regarding thereof, and study of their relations, we may interpret the more intricate combinations and remote accordances of colours throughout the infinity of nature, and extend them to all cases of art.

128. Since, therefore, it has been shewn that eligible distinction in the classification of colours ceases beyond the tertiaries, we here terminate the general distribution of their archei and harmonies, and deduce from the whole the following

UNIVERSAL COROLLARIES.

1st. *That there can be no perfect harmony or melody, contrast, or pleasing series of colours, in* *which either of the three primary colours, simple or compounded, is wanting.* 2d. *That the distinctions of harmony and melody depend upon a various predominance of one simple or compound primary colour, and a subordination according to determinate proportions of the other two in the composition.* 3d. *That* TONE, *although it gives repose, differs from* HARMONY, *and is governed by the archeus, tonic, or ruling and predominating colour of the composition, and becomes vicious in monotony.* And 4th. *That harmony, melody, tone, and contrast, arise from and terminate in that variety in unity of elementary principles upon which colour, light, and shade, depend.*

129. It is *the endeavour of nature after union and repose* that produces *harmony;* and this is the reason why we find the primary colours and their harmonies so sparingly employed in nature and the best pictures, and also why that which is more harmonious or beautiful to the merely sensible or less cultivated eye in the primary compositions of colours, is less so to the better disciplined and intellectualised eye; wherein the tertiary harmonies are analogous in effect to chromatic and enharmonic expression in the cultivated musical ear.

130. This principle of *union* pervades and holds all nature together; and to it is to be attributed not only *physical* and *sensible,* but also *moral and intellectual harmony;* not only the harmony of co-

lours and sounds, but domestic and social harmony result from *subordinated union.*

> "Th' *according music of a well-mixed state.*
> Such is the *world's great harmony*, that springs
> From order, *union*, full consent of things." *

It is the principle of *love*, in fine, it is the great religious principle of *universal harmony in tri-unity*, wonderfully symbolised in the relations and constitutions of colours, and not less remarkable throughout science.

131. It is apparent that the diversity of harmony in colours is precisely analogous to the regulation in music already noticed, by which any note called a key-note predominates and rules the composition; in which manner, any individual colour may become an archeus, ruling colour, or key to the composition in colouring, under a regulation by which its correlative colours are subjected to it as dominant and mediant to a key, and all other accompanying hues or tones employed are subordinated to them according to discernment and a correct regulation; this, also, is the principle upon which, what is properly called, *tone in painting*, depends, and should be regulated, as already remarked.

* Pope's "Essay on Man," Essay iii., verse 295.

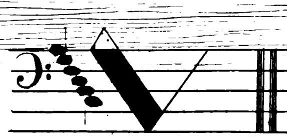
CHAPTER VIII.

ON THE UNIVERSAL RELATION OF COLOURS AND INVERSION OF KEYS.

132. As the particular relations of colours are included in the general, so are both these involved in the universal; and as we have treated in the preceding chapter of the two former, including the melodies, harmonies, consonances, and contrasts of colours, there remains only, for completeness, that *universal relation*, or regulation, wherein they are all comprehended; and this will be most simply exemplified in the accompanying scheme [Example XXI.], coincident with the three similar diagrams foregoing.

133. In this scheme of colours we retrace our previous course, beginning with *Black* at the centre, in harmony with the *tertiary colours* which surround it, which harmony resolves into those of the *secondary colours*, with the *primaries* passing into Light, by which the chief triangle is terminated and bounded. The inverse order of colours from shade to light is indicated by the inverted triangle behind, and the whole is circumscribed by an orb of the primaries in one universal har-

Ex. XXI.



Ex. XXII.

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mony: for there is a course through colour to latent negation, or neutralisation, in black and white, as well as to sensible negation through diluteness and depth.

134. The alternate series of colours which constitute the sides of the general triangle in the present diagram display also distinct *melodies;* and the various sections or subdivisions thereof, as developed in preceding examples, are distinct *harmonies* in both respects, according to the regulation and order of those examples inverted, and the present example includes the relations of the preceding in one brief example universally; as a right comprehension of the analogy of the system will at once render obvious, and make its farther description unnecessary.

135. By similar diagrams farther subdivided and extended, the more complex relations and harmonies of colours may be exhibited according to the same analogical principle; and it is evident, also, pursuing the same principle, that, by changing the ground from white to black, the order of these diagrams may be reversed, or that they may be adapted and varied according to any intermediate shade or hue; since, however, such variations are consequent to our theory, and are easily imagined, such farther illustrations are inexpedient.

136. The cultivated eye will discern that perfect pigments, and adequate execution, are alone wanting to render these schemes totally, and in

their parts, harmonious; they may, therefore, be considered as theoretically perfect. If, therefore, our theory be true, and through real analogy conformable to nature, as we, from an entire induction believe, *the chromatic system, like the universe of which it is a part, is an absolute unity, comprehending a relative infinity*—a PERFECT SYSTEM!

137. The developement of the system of colours from their chromatic elements is, therefore, as it were, a violence done to its unity; and it is in restoring this unity, or rendering it apparent to sense and understanding, without violating the relations and lesser unities it comprehends, and in rendering these lesser unities also apparent, that we produce the various harmonies, melodies, and accordances of colours.

138. For harmony in all cases consists in relation or permanent analogy, and springs from the reunion of that which is naturally one or united; the feeling or perception of harmony is, therefore, a perception of this relation or unity, and the more intimate such relation or unity is, the nearer to perfection is the harmony.

139. Accordingly, as remarked in a former respect, the chaste eye receives greater satisfaction from the mild harmonies, gentle contrasts, and delicate accordances of the tertiary colours, in which the three primaries are more intimately combined, and approximate that absolute or perfect elementary unity from which colours emanate; and

for the same reason the critical eye demands a concurrence of all the three primary colours, broken or entire, in every harmony; yet the common or uncultivated eye delights most in the crude combinations and violent contrasts of the primaries, and is rarely offended at their disunion, disproportion, or discordance.

140. Thus tastes differ through confinement and expansion of faculty, and that which is often most harmonious or beautiful to the rudely sensible or uncultivated eye may be least so to the cultivated or intellectual eye: to the first the more disjunct and crude relations are suited, to the latter the more comprehensive and refined; and while this delights in the most subtile harmony, the other often revels in harsh contrasts.

141. There is, nevertheless, an excess and boundary to the refinement of harmony in colours, denoted by the relations of the primaries as principles becoming so remote or complicated that indistinguishableness ensues, analogy ceases, and harmony terminates in monotony.

142. To what extent the powers of vision may reach in some individuals, or how far nature has extended an infinite process, may be difficult to determine; but it is evident in her works that she delights most in the latter harmonies, and distributes the former with a sparing hand. Consonant to this, also, has been the practice of the best colourists in steering equally clear from the

extremes of crudeness and monotony. Accordingly, in nature, and the best pictures, the broad harmony of landscape lies in the relations of the tertiary colours, while the more confined harmonies of flowers and fruits belong to the primary and secondary; nevertheless, the master hand of nature does not disdain their conjunction in subordination, nor will the same be rejected by the judicious artist.

143. By thus refining upon the simple unity or consonance of the primary triad of colours, we arrive at the three genera of harmony in colours exemplified in diagrams XV., XVII., XIX.; and it is remarkable that the musical *genera* of the Greeks, founded on the same analogy, were three, distinguished also by similar characteristic degrees of refinement, and requiring the same cultivation of perception and faculty; while their *genus spissum*, in which the three genera were reduced to one system, accorded with Example XXI., in which the three above scales are united. Without, however, presuming too much upon such coincidences, we deem it important to incline attention toward them—an opinion sanctioned by the great Bacon in his doctrine of *parallel or conformable instances**—while we proceed to a farther consideration of the analogy whereon they are founded.

144. So much for the universal, general, and

* "Nov. Org." Part II. Sect. II. App. 27.

specific arrangements and harmonic accordances of colours; and it will not be difficult to collect therefrom what the artist has already tacitly recognised as a principle of his practice, namely, that there is, or should be, a general effect of colour—a universal accord — wherein the particular unities and accordances are connected as a whole, determined by an archeus or key, in every work. And so it is in nature.

145. Thus, in viewing a well-coloured picture, or a landscape in nature, we look as it were through *a broad diffused prismatic spectrum or iris*, of which the *warm* extreme lies principally in the foreground at our feet, the *Blue, or cold* extreme over the eye in the highest distance, both bounded by *Shade*, or the invisible, but meeting in the *Light* of the middle distance, afford *Yellow, Green, and Grey hues* to the picture or scene, bounded or surrounded by shade, darkness, or the unseen beyond the field of vision, alternating contrast and variety with the lights, local colours, and reflexes throughout, and effecting universal compensation; that is the equivalence or satisfaction of harmony varied according to the key of the colouring.

146. In other cases, still alluding to nature in landscape, where *Red* interposes little or not at all in the picture, the work may be regarded as seen through that portion of the *prismatic spectrum*

in which the *Blue and Yellow* principally or only cross each other; the cool retiring colour will take the sky and the distance, the advancing warm Yellow occupy the foreground; and these blended and gradated will supply the intermediate greens of the mid-distance, contrasted and tempered with the local hues. The light and shade will take an inverse order, intermingling in the greys, and connect the whole in one harmonious unity related as above. By attending to these natural analogies the colourist will save himself from the beautiful error of applying the prism to his eye while painting, instead of representing objects as they naturally appear through the diffused solar spectrum of broad light and shade, by which error he converts the scene into a fool's paradise, seen through artifice, but not by the natural eye [228, &c.].

147. By inverting the natural order of the rainbow, and substituting that of the spectrum deduced from the black spot in our first experiment [Plate I.], Red and rosy hues blending into purple and orange, between the blue coolness of a sky, and the yellow warmth of a foreground, will take the place of the intermediate greens in the preceding case; as is sometimes seen in the painted saints of illuminated missals, and in arrangements of coloured draperies. The effect is, however, artificial, the inverted spectrum being of unfrequent occurrence in nature. We need not

advert to other variations of this class which the painter will readily imagine.

148. Painting is as much a logical process as any other act of the mind, and subject to logical methods. The artist, like the philosopher, may proceed analytically or synthetically in the colouring, designing, and painting, of his picture, or in each, as is more common, in a mixed mode; and in these respects the painter is usually governed by the peculiarity of his genius or tuition. If high finish and particularising mark the bent of his mind, he will proceed from part to part, finishing as he goes by a sort of chronological synthesis, and a final revision of the whole; if of a more daring and expanded genius, he will proceed by a simultaneous getting-in of the masses, and run over the parts in endless revision, incessantly attentive to the whole.

149. If in the latter procedure there is a temptation to stop short of individual perfection, content with a slight union of excellencies, there is no bound to the course, while in the former method there is great danger of producing only an aggregate of individual excellencies incapable of union except by undoing; the work is, therefore, in continual discordance, while the analytical process proceeds from harmony to harmony throughout the whole. There can be no question, therefore, which of these modes of practice is most favourable to harmonious colouring.

150. But if extremes are in general unfavourable to perfection, they are not less so in the present case, and an antithetical practice, in which these two methods are combined, wherein a principal particular is predominantly laboured, and to which the whole is subordinated as it proceeds, is chiefly to be commended in all cases; for this is the prime principle of beauty, truth, and excellence.

151. All works of art are, in their highest reference, the production of mind, which is, therefore, to be regarded as the ruling principle of all inferior powers and faculties, and the source of all *truth* in art, whether theoretical or practical; and the three modes of practice in painting dependent on these faculties are distinguishable as 1. *material and mechanical; 2. sensible and experimental;* and 3. *intellectual and studied.*

152. Of these modes there is an illustrative and instructive anecdote related of the three Dutch painters, Parcelle, Knipbergen, and Van Goyen, who for a wager agreed to paint each a picture in one day, in presence of an assembly of artists, who were to decide on their relative merits and success.

153. Knipbergen began, in the first mode or manner, to make a finished sketch of his subject, which he then transferred or copied piecemeal from the sketch to the canvass. Van Goyen, in the second mode, at once laid in the tinted light for the sky, then rubbed on various shades of brown,

and then masses of light in the foreground; from which apparent chaos he produced, with wonderful celerity and spirit, the various objects of his creative fancy, giving to, or taking effects from accident, to the astonishment of his brother artists. In the mean time Parcelle, in the third method, with palette and pencils unemployed, sat meditating in deep reflection on his intended work before he proceeded to execute it, which he did by slightly sketching his subject on the canvas, and gradually painting in and finishing his design.

154. The first of these wrought chiefly through memory and the hand, the second principally by fancy and the eye, the third with predominating thought and study overruling all his faculties, and each accomplished his work in the prescribed time; upon which the judges having deliberated, and in the same order decided that Knipbergen's picture was extremely good, that Van Goyen's was an excellent work, but that Parcelle's performance, having equal merit in all respects with those of his competitors, excelled them in *truth* and correctness, the result of deliberate thought and judicious premeditation; and accordingly gave their unanimous voices in his favour.

155. It is to be remarked, nevertheless, that meditation and thought can be of no avail in the practice of art, unless the mind be prepared by previous study, and thereby well supplied with matter of thought, and that deliberation differs

from dilitoriness. Of the above methods the first is that of discipline and synthesis, the second that of doctrine and analysis, but the last is that of true art subordinating all powers concurrently to one end antithetically.

PART II.

ÆSTHETICAL CHROMATICS.

CHAPTER IX.

HARMONIC ANALOGY OF COLOURS AND SOUNDS.

156. MUCH has been beautifully imagined and written on the affinity of the sister arts of Painting, Music, and Poetry, which involve all graphic arts; and much has been elegantly adduced from classic sources memorising their alliances; but little has been done, notwithstanding, toward establishing their true genealogy and analogy on a rational and philosophical foundation. The present part is therefore attempted in this latter respect, and with a view also to the entire relations of Chromatics with Æsthetical science; first, of the Chromatic with the Harmonic system; secondly, of the Chromatic and Plastic systems, chiefly in reference to

the art of Painting; and, thirdly, of the connexion of the whole with Poetic art in relation to all sense in æsthetical unity.

157. Hitherto we have considered the relations of colours as principal, borrowing only the terms of music to express their harmonising powers, but we will now extend our inquiry to the entire conformity of the systems of colours and sounds, and the identity of their scales. For there is a boundless analogy by which the sciences and arts are reciprocally connected and their forms identified, whence they mutually reflect light on each other; and the relation in this respect is so intimate among the æsthetical or sensible arts as naturally to have suggested their especial identity; whence the remarkable conformity of the science of colours with that of sounds, which we have already so often adduced, which the illustrious Newton attempted to establish upon a geometrical basis, and of which the very terms these sciences have employed in common, from the time of the ancient Greeks, are indicative.

158. It was this analogy that induced Father Castel to attempt musical effect by means of colours and an *ocular harpsichord*, in which, however, he failed; not from presuming on a false analogy—for colouring and music are both of them instrumental and visual, or vocal, independent of painting and poetry—but from an entire misconception of the

quantitative nature of colours, and a total ignorance of their *correlative sensible powers*, whence he was led to substitute the *arithmetical ratio and time* of the musician for a *geometrical ratio in space*, and to adapt a false prismatism of colours to the diatonic scale of the modern *musical octave.*

159. Had he, on the contrary, attempted the same effect upon a *geometrical and harmonical ratio in space*, with a true knowledge of the *equivalent powers of colours*, and the absolute conformity of the tonic, mediant, and dominant powers of the primary triad of colours with the *harmonic triad* of the musician, and a correct adaptation of the two scales founded thereon, we profess our conviction that he might have entirely succeeded in translating any tune, or musical composition or succession of sounds in time, into a like pleasing composition of colours expanded on a surface in space. But what is this, we inquire, but to paint? or colouring in painting, hitherto performed like the wild whistling of birds, agreeably sometimes to natural expression and feeling, but with little of the refinement and regulation of art.

160. For colour as expansible quantity bears the same relation to *space* that musical sound, as quantity successive, does to time; the chromatist has, therefore, not only his melody and harmony, but he has also, if the variety of expanded quantities may be so expressed, his breves and minims,

quavers and semiquavers, and rhythm; and these relations of colours answer to that which, in their music, the ancients called *harmonica* and *rhythmica* theoretically, and *melopœia* and *rhythmopœia* practically.

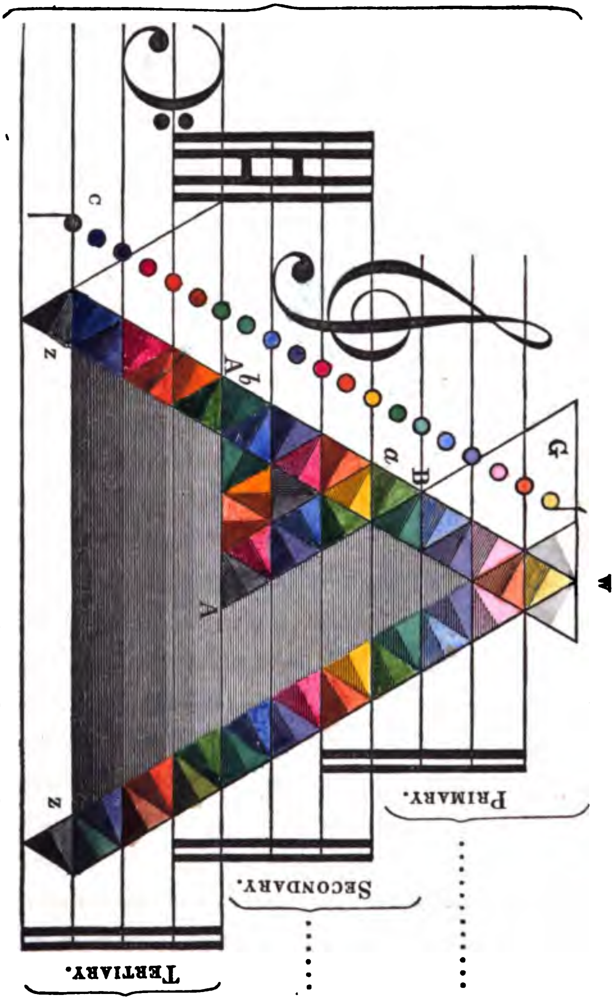
161. But, to render the entire analogy and perfect correspondence of the chromatic and harmonic systems completely apparent, it will be necessary to reduce them to the same universal scale; and this we have done in the accompanying analogous scale of sounds and colours [Example XXIII.]; first, by adapting the scale of colours [Example XV.] to the universal scale and notation of the musician, according to the modern diatonic series; and, secondly, by in like manner exhibiting the analogy of the various chromatic scales with those of ancient music.

162. Thus the middle triangle A A B of the present diagram, coloured according to that of Example XV., having the colours of its base A A carried downward in continuation below A *b*, and those of its right side A B carried upward above B, will present a series of colours corresponding to a similar series of sounds noted on the diatonic scale of the musician throughout the three clefs, from the note C on the base to G above the treble clef, the notes of the musical scale being opposed to their analogous hues of the scale and series of colours, from *light* to *dark* in the one, corresponding to

EXAMPLE XXIII.

MODERN DIATONIC.

ANALOGOUS SCALE OF SOUNDS AND COLOURS.



Enharmonic, *Chromatic,* *Diatonic.*

Genus Spissum.

ANCIENT HARMONIC GENERA.

acute and *grave* in the other, and the common chord, or harmonic triad C E G, occurring in each of the three octaves contraposed to the primary triad of colours, G *to Yellow*, E *to Red*, and C *to Blue;* the notes B D F of each octave corresponding in like manner to *Green*, *Purple*, and *Orange*, throughout the series.

163. This scale extends, that of Example XVI., downward through the tenor and base, and the concords and discords of the two systems are singularly coincident throughout. One of the semitones of the musical octave in the natural major mode falls between the notes B and C, corresponding to blue and green, which colours are discordant to the artist's eye, and require the intermediate *demitint*, or a neutral opposed to the *semitone*, to satisfy the eye, connect the octaves in series, and complete the harmony of the scale, and this affords a reason why greens, not crude and harsh, but broken with grey, abound in nature. The other semitone falls between the notes E and F, contraposed to Red and Orange, which the eye requires to be also semitonic and subordinate in painting.

164. It is remarkable that in the scales of music adopted by various nations, the 4th and 7th of the diatonic division of the scale have been omitted, being the B and F of the natural key of C, where the half notes of the octave fall, and correspond in the scale of colours to the *second Green*

and the *Orange*, which colours may be dispensed with without grossly infringing the melody of the scale. This musical peculiarity has been manifested in our own nation by the bards and musicians of Wales, Cornwall, Scotland, and Ireland; and in Italy, Morocco, India, China, and other countries, giving a distinguishing character to their music; thus also would the corresponding variation of our chromatic scale give a like peculiarity of character to its colouring, short of the full harmony of the artificial scale, but natural and coincident with the music of the Scots, &c., and not at variance with either science.

165. If we imagine the colours of this scale blended, or mutually penetrating each other in an infinite compound gradation from light to shade, and harmonically divided according to the intervals of the diatonic scale, we shall form a correct idea of the perfect coincidence of the two systems co-illustrated in this diagram.

166. In such case there will arise this distinction of the two systems, that the *notes of sound* being separated by intervals or spaces, while the *notes of colour* (we beg the term) will be the spaces themselves; but in this diagram the distances on the scales from one sound to another, and those from colour to colour, are equally intervals. Thus from the particular hue and shade of *Red* to that of *Orange* on the scale, and from E to F, the corre-

sponding sounds of these colours, are both intervals in which a series of intermediate hues and smaller intervals of sound have place.

167. We have already denoted the various other relations of this primary scale in a distinct chapter [V.], on the harmonies and keys or archæi of the primary colours, and in the two chapters following it, we have denoted the like relations of the secondary and tertiary colours; but we have here connected these in one scale, descending from the opposite or right side of the diagram in continuation, on the large triangle thereof, from the *primary scale on the treble stave*, through the SECONDARY, *mean, or tenor stave*, to the *tertiary on the bass*, the whole descending from white at w to black at z; or the three scales may otherwise be blended throughout the series of primary, secondary, and tertiary colours, in one universal scale.

168. The most remarkable analogy of this arrangement is that of the agreement of the harmonic system of colours with what is recorded of the ancient harmonic system of sounds, of which there are stated to have been three genera, distinguished as *Diatonic*, *Chromatic*, and *Enharmonic*, already noticed, and which the Greek musicians also united in a single scale, or *genus spissum*, in the order we have here connected the three scales, or genera of colours, as *Primary*, *Secondary*, and *Tertiary*, whose

relations to each other coincide with the differences of interval among these ancient musical genera.

169. But we have seen thoughout that this analogy springs from the agreement of the first principles of both systems in the common form and correspondence of relations of the primary colours and the three notes C, E, G, which constitute the common chord in music; and as it is by the inversion of this common chord that the musician obtains the other two positions and perfect consonances E, G, C, and G, C, E, so by a similar transposition of the primary colours in either scale, as in the three sides of the coloured triangle A A B of that before us, we get three positions and perfect consonances of colours.

170. Musicians, it is true, denominate the two inversions imperfect concords, not as dissatisfying the ear, but as unfit to commence or terminate a composition; in which respect colours also resemble sounds, since the like inversion of the primary triad of colours, though perfect in consonance or system, are imperfect in series.

171. Every simple interval in music, which the Greeks called a *diastem*, or an interval of two sounds, to distinguish it from a *system*, or compound interval, is a discord; but some compound intervals are concords, and some are discords, while *unisons* are held to be concordant; all of which holds correspondingly in chromatic science, wherein

simple intervals are discords, although they may be tolerated by a sort of appoggiatura, blending or breaking into intermediate hues or shades. Compound intervals are concordant or discordant, and unisons, and octaves, joining depth with brilliancy or chiaroscuro in the same tone, are semi-harmonious or concordant in colours.

172. Discords in colours, as in musical sounds, whether produced by transition, suspension, division, or addition, require preparation and resolution, except those of transition, which are prepared and resolved as produced in the melody or harmony in both sciences; and that the regulation of harmony and position is strictly analogous in sounds and colours is apparent in the following example of the three different positions of the three sounds of the harmonic triad in music, when they are taken as an accompaniment to the same root in the base.*

EXAMPLE XXIV.

We need appeal to the eye only for this analogy,

* Calcott's "Mus. Gr." Part III. chap. 1.

and, in like manner, may most of the relations in musical and chromatic composition be rendered visible, for the analogy of these sciences holds throughout, correctively, and they may therefore be translated; and this example stands in mutual illustration with the three positions of the primary triad of colours in Diagrams XV., XVII., XIX., and XXI., whereon assuming either member of the triad as a root or fundamental, the three relative positions of the three primary colours will be found on the three sides of each diagram, exactly according to the above example.

173. The boundary of the Grecian scale or system is generally understood to have been a *fourth*, that of Guido Aretini was a *sixth*, and the more modern system is the *octave*,* each of which has corresponding relations with the definitive or fundamental scale and system of colours; for every *four* sequent colours or tones contains the whole system of primary colours, and is precisely the order of Nature in the colouring of flowers. So, again, every *six* sequent colours contains the whole system of primary and secondary colours, and every *octave* returns the same colour or unison throughout, which relation of the octave might be given to either the sixth or seventh without violating the analogy of Nature by such variations of the scale.

174. The most perfect concords in music are

* Burney's "Dissert. on Ant. Mus.," p. 6.

those which arise from the most entire coalescence in sounds when struck in conjunction, and the most perfect consonances in colours are those which in unison approach nearest to neutrality, and, in both cases, they are those notes or colours which, when separated by distance, best affect or contrast each other. The Greeks justly held the *fourth* to be the only *perfect concord*, which the modern musician, nevertheless, rejects, and builds his system upon the less perfect *fifth* and *third*, which demand their fundamental or *octave* to constitute the perfect chord or consonance; the reason of both which is rendered apparent by their corresponding scales of colours, in which the *fourth* of every distinct hue is its perfect neutraliser, while, in like manner, the coloured consonances of every third, with its fifth, require either their fundamental or its octave, which are their complementaries, to perfect their consonance or neutrality.

175. The Greeks acknowledged concinnous sounds which they called *Paraphonoi*, or accords, lying between their *Symphonoi* or concords, and *Diaphonoi*, or discords, which latter, also, correspond precisely to those colours which, in our analogous scale, occupy the places of sixths, and sometimes fifths and thirds, to any fundamental; and such colours coalesce, harmonise, contrast, and neutralise imperfectly.

176. So precise is the parallel of chromatics and music, that whatever may be argued of the one

may be asserted of both. Thus every note and every colour may be made the archæus or key of a distinct harmony adapted to an infinity of expression, although the science of colour has made little advance in this respect, and the art has hitherto rarely deviated from the natural key of *Blue*, analogous to that of C major in music, and of the archæus Blue, Orange is the contrast. It is hence that the harmony of warmth and coolness in colouring is the first and only key practice has hitherto established in painting, although every colour may be adopted and adapted as an archæus, key, or tonic, according to the expression of the subject, the use of the *tonic* in each art being to give the repose which is essential to the gratification of its organ.

177. The places of a variety of colours amid any general hue, as observable in nature, and often admirably employed by the best colorists, are precisely as various and analogous as the *Graces* used in musical performances, and like them, also, are subject to the regulation of harmony and melody in both arts, although, for the most part, they are the effusion of taste and feeling.

178. But it is inexpedient to refine into all the analogies of the two sciences, it being sufficient, in the present instance, that those we have adduced are valid as science, and practicable in art. In pursuing and applying them, nevertheless, the artist has to guard against being seduced by sense, or

misled by mechanism, to quit the proper office of colouring, which is the administering to natural truth and poetical expression, avoiding thereby the parallel error of modern musicians, of trampling her elder sister under foot, by forcing colouring into subserviency to the eye alone, instead of addressing the imagination and affections through the eye, as the chief organ of mind.

179. Yet are not any of these coincidences, nor, in particular, those which refer to the music of ancient Greece, undeserving the attention of the artist as hints for practice, nor of the learned musician in regard to the genera, we therefore recommend them to their investigation, it being beyond our design to speculate further concerning the lost arts of antiquity. The examples we possess of Grecian works are sufficient to justify our faith in the excellence of those which are known to us only through their reputation; nor ought we to lose sight of the remarkable tradition, that it was by *the principle of analogy* (whatever they meant by it, or wherever they got it) that the Greeks carried the arts to the very acme of perfection.

180. Some of these analogies of the sister arts have been well pointed out by Avison in his "Treattise on Musical Expression," and by the celebrated Jones of Nayland, in his "Treatise on Music," wherein he remarks,—"In all composition great is the effect of *contrast*; soft notes are more soft after those that are rough, harmonious notes are more

harmonious after those that are harsh and grating, slow notes are more acceptable after those that are quick. The same art is applicable to air as to harmony, every concord is better relished after a preceding discord, and the force of every melody is most felt when it succeeds to a melody of an opposite nature, or is tempered with it; as the *chiaro* and *oscuro* stand together in the same piece of painting, and strike the eye at the same instant. In that well-known trio of Handel, *The Flocks shall leave the Mountain*, the savage roughness of the vocal base, full of rage and passions, sets off the plaintive softness of the melodies in the two upper parts."—P. *55*.

181. To the above coincidences of chromatics with harmonies or music, many others might be added, but the foregoing may render the uniformity of structure in the two sciences sufficiently apparent. If, however, there be still any perplexity or obscurity in our positions, it arises chiefly from the necessity of employing those terms equivocally and in common which belong properly to these sciences as distinct, but which, nevertheless, a little discrimination of the reader will make clear.

182. We may therefore terminate the present head with the remark, that, although colours have a science as distinct from any necessary connexion with that of *figures, or plastic, or pictural forms in painting*, as that of musical sounds is from *figurative language, or the images of poetry*, and are

similarly associated; nevertheless, each of these sciences has its highest office under such figurative conjunction, as we shall further shew; whence the field in which the chromatist may exercise his genius is as diversified and extensive as that of the musician. To disclose the subtleties of the science is, however, beyond the purpose of an essay, designed principally to illustrate the analogy of colours.

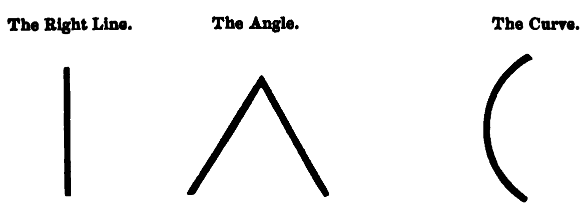
CHAPTER X.

ANALOGY OF FIGURES AND COLOURS.

183. The remarkable coincidence and analogy of the natural systems and sciences of colours and musical sounds, which we have amply unfolded, belong no less surprisingly to the systems and sciences of *Colours and Figures*, upon which all graphic art, pictural and plastic, depends; whence this latter correlation is rendered more intimate to our design than the former, and more interesting and important to the artist.

184. As the three primary colours, Yellow, Red, and Blue, are generated from a *spot* by the refraction, reflection, and inflection of light; so from the direct, reflect, and inflect motions of a *point* are generated the three Primary Figures.

Example XXV.



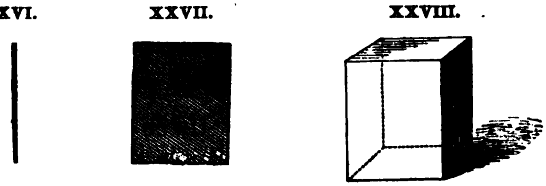
and as all the hues, tints, and shades of colours are produced by the variation and composition of the three primary colours, so are all possible figures, constituted of lines, surfaces, and solids, produced similarly by the variation and composition of the three primary figures.

185. It follows that all graphic art, and that of drawing in particular, consists elementarily in the ability to form the three primary lines, straight, angular, and curved, in all their variations of position, gradation, and composition.

186. As every colour, according to its distinction, comprehends *hue, breadth,* and *depth,* and an infinity of shades, or degrees of tenuity and depth, between its distinguishable extremes, so also has every figure its specific *form, breadth,* and *depth,* with infinite degrees. Thus by widening the *Right line* [XXVI.], or giving it breadth, it becomes a *Parallelogram* [XXVII.], and by superadding to it depth it becomes a *Parallelopipedon.* [XXVIII.]

EXAMPLES.

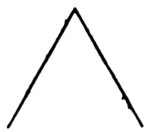
XXVI. XXVII. XXVIII.



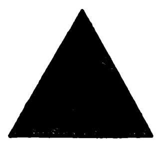
187. Again, by adding breadth or surface to the *Angle* [XXIX.] it becomes a *Triangle* [XXX.], and by superadding thereto depth it becomes a *Tetrahedron.* [XXXI.]

EXAMPLES.

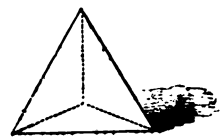
XXIX.



XXX.



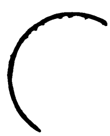
XXXI.



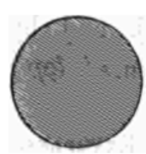
188. And, finally, by giving breadth to the *Curve* [XXXII.], is formed *Circular* figure [XXXIII.], and by superadding to it depth it becomes the *Sphere* [XXXIV.], which is the final extreme of all figures; just as colours may be deepened in degrees down to perfect depth or blackness, which is the final extreme of all colours.

EXAMPLES.

XXXII.



XXXIII.



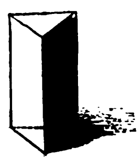
XXXIV.

189. Again, as the primary colours, by compounding in the simplest way by pairs, produce the secondary colours, so do these primary figures, by a like composition, afford three SECONDARY FIGURES. Thus by the union of linear figure with the angular, is composed the *Prism* [XXXV.]; by a like combination of the line and circle is produced the *Cylinder* [XXXVI.]; and, finally, by the only remaining pair of primaries is composed the *Cone* [XXXVII.]; and as the primary and

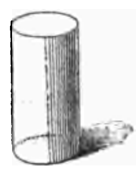
secondary colours are chief among colours, so are the primary and secondary figures chief among figures.

EXAMPLES.

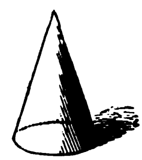
XXXV.



XXXVI.



XXXVII.

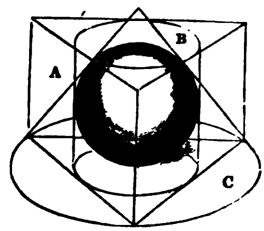


190. Like the more broken and tertiary colours, these latter figures are again adapted to tertiary and endless combinations in less regular and more composite forms leaning individually toward one or other of their primary and progenitor figures.

191. And as each class of colours may be commingled by a due synthesis in the final extreme of *Blackness*, so this analogy in composition extends to that which is final and all-comprehending in figures—the *Sphere*. Thus the *Prism*, the *Cylinder*, and the *Cone*, combine in the same sesquialteral relation to the Sphere coincluded in the following figure A B C. The discovery of which proportions between the two latter secondary figures and the sphere, especially delighted those great mathematicians, Archimedes and Tacquet. The entire figure may serve as a primary example, illustrative of the principle of graphic construction, grouping, and composition.

EXAMPLE.

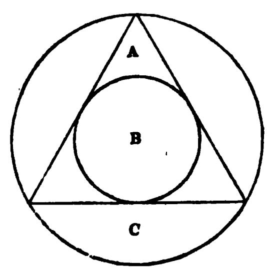
XXXVIII.



192. It is a remarkable analogy of the above group that the proportional areas of the bases of its three constituent figures circumscribing the central point touched by the sphere, are coincident with the proportions in which the three corresponding elementary colours harmonise and combine neutrally, and compensate each other.

EXAMPLE.

XXXIX.



193. It is by the reasons or ratios established in the original nature of these elementary figures that they are adapted to regular harmonious and discordant combinations in the manner of colours. Indeed the Infinite Wisdom that contrived these beautiful elements has fraught them with admirable

properties, wonderfully suited to exercise the logical intellect of the geometrician, and to the disclosure of infinite utilities for the advancement of all arts, and the benefit of mankind.

194. Our present concern is, however, confined to the analogies of sense and taste in the properties of figures and colours, which alone present an inexhaustible field to observation; desirous in every case to avoid needless amplification, to check exuberance of imagination, and to simplify for the sake of perspicuity, we quit the geometry of figures, and confine our remarks to their æsthetical relations and analogies, which the susceptible faculties of the artist will readily appropriate and improve.

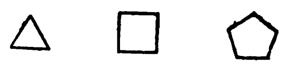
195. Among the most remarkable properties of these elementary forms is the mysterious analogy whereby each figure contains virtually all the others, as every colour contains all colours, every sound all sounds, &c.; indigitating, as it were, an essential identity of formal causes, the administration of one ruling universal intelligence.

196. Thus the Cone is *linear* in its axis, &c., *angular* in its perpendicular sections, &c., and *circular* in its horizontal sections, &c.; and, doubtlessly, the many celebrated properties of the conic sections arise from this accordance of the primary figures in the cone. The same holds equally of the sphere and other figures, and all figures coinscribe their own forms to evanescence.

197. Further, of those celebrated solids called

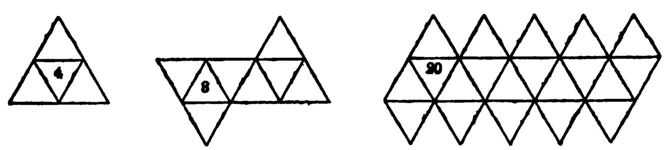
platonic bodies, which are formed of regular and equal plane figures terminated by right lines, of which three only can contain a solid, and that also under the three species of angular figure as *acute, right* or *obtuse;* namely, under *equilateral triangles, squares*, and *pentagons.*

EXAMPLE XL.



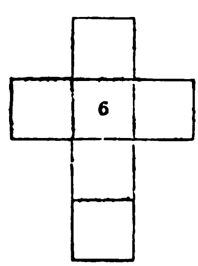
which three are the first and simplest plane figures; and of such bodies or solids the equilateral triangle affords three only, namely, the *tetrahedron* of 4, the *octahedron* of 8, and the *icosihedron* of 20 equilateral triangles, unfolded as follows:

EXAMPLE XLI.



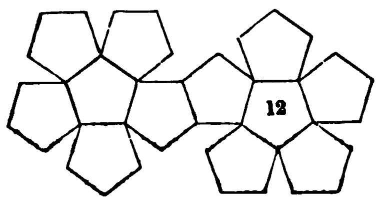
198. The two remaining plane figures, the square or right-angled, and the pentagon or obtuse-angled, can contain each only one regular solid, namely, of the first form the *cube or hexahedron*, of six squares, unfolded, in form of a cross, thus,

EXAMPLE XLII.



and for the remaining form, the *dodecahedron* of twelve pentagons, as unfolded in the following figure:

EXAMPLE XLIII.



199. These figures, as unfolded, are the archetypes in nature of all *floral forms*, as developed from their solid buds. They are found likewise in their capsules and other natural objects, and contribute beauty to many of the forms of art.

200. As each of the primary colours leans toward and participates of the other two, without relinquishing its distinct hue and character, so does, in like manner, each of the elementary figures run into and embrace the others without quitting its species; thus, the *angle*, which is the natural mean between the *right line* and the *curve*, holds the middle station, also, among the figures; whence it has great extent of application and a triple linear relation, as follows:

EXAMPLE XLIV.

Right-lined. Curved. Compound.

201. These, again, have a like participation, and, as *curvilinear*, are triply distinguished, as

EXAMPLE XLV.

Concave. Convex. Concavo-convex.

which also have their various intermedia and compounds abounding in the foliage of trees, architectural tracery, and other picturesque shapes of nature and art, under every variety of position, horizontal, vertical, and diagonal, &c.

202. These relations of figures may be followed into others endlessly, for the whole fecundity of forms depends upon a similar triple analogy, whereby the relations of the primary figures extend to all their variations, divisions, and compounds, to infinity; the entire regimen of figures in this respect being exactly conformable to that of colours, and presenting a boundless field for instructive exercise, speculative and practical, in the production, composition, and analysis of figure throughout art, and wonderfully facilitating invention.

203. As the *sphere* is last in the scale of shapes, forms, or figures, so it is the most perfect and uniform of all, and, in this respect, it resembles the point by which they are generated, between which and the sphere all other figures are included, the latter comprehending, between its periphery and centre, an infinity of points, radii, and angles, and

circulating with boundless fecundity into an infinite variety of forms; the point and sphere agreeing also in analogy with the generating spot of light, and terminating sphere of shade in colours.

204. Having thus briefly discussed the elementary figures of graphic and plastic art in reference to colours and painting, we leave their extended application to their correlative branches of sculpture and architecture, &c., to the reader, referring him for farther remarks thereon to our "Analogical Philosophy," wherein we have regarded the subject under other views.

205. It is sufficiently apparent from the foregoing premises, that all graphic designing, including *delineation or drawing*, *grouping or composition*, and *linear expression*, consists elementarily in the ability to form the three primary lines in their various positions, gradations, and compositions. It is also apparent by what nice and infinite progression figures run into each other, or, in other words, by what varying forms the figures of bodies are mellowed or melodised in a regular and infinite scale, coincident with those of the musician and colourist. A geometrical distinction is also to be remarked between the intimately connected arts of drawing, painting, and sculpture, whereby the first relates to *lines*, the second to *surfaces*, and the third to *solids*.

206. *Grace* is the melody of forms and motions, blending and flowing from one figure to another,

and is hence a chief element of beauty in forms, and it is as distinct from the *harmony* of forms, which consists in their contrasts, as the melody of colours and sounds is from their harmony.

207. *Symmetry* consists in the proportions and subordination of figures; and *Composition* consists in the conjunction of all these in regular and subordinated groupes and wholes; the analogy of which altogether, with the melody, harmony, and composition of music and colours, is precisely evident, and helps us to understand why *Beauty* belongs chiefly to melody in the arts of musical sounds, colours, and figures, and throughout the science of sense, and why the variety of our judgments and tastes concerning beauty is dependent on the requisitions of sense as influenced by cultivation and custom.

208. If we follow these coincidences briefly into some of nature's works, we may remark how both the regular, and seemingly irregular, forms, called picturesque and beautiful, arise from *circular* flowing into *angular* forms, and thence by gradation into the *linear*, as we see in the exquisite graining of woods, and other natural objects; which figures run *linearly* into each other, as in the outlines and ramifications of trees, foliage, &c., spreading *superficially*, and expanding into *solid* forms and masses, of like geometrical and harmonic relations, generative of plastic beauty; gliding and eliding from figure to figure, as seen in marbles, clouds, the

graceful flowing and convolving of the stream, &c.; eliciting picturesque beauties infinitely, according to unvarying principles of order and harmony, throughout figure, number, and motion, and variously expressive to sense.

209. The same may be remarked not only in the *solid* substances of nature, but also in the *liquid* rippling of the brook, the currents and undulations of rivers, the foam, billows, and breakers of the torrent and the ocean, and in the *elastic*, glorious, ethereal forms of the sky.

210. It was according to a similar analogy that Mr. Luke Howard ingeniously analysed the primary forms of the Clouds; one of which he denominated *Stratus*, another *Cirrus*, and the third *Cumulus*; the first being linear, the second angular, and the third globular or circular;* whence his compound secondary forms are *Cirro-stratus*, *Cirro-cumulus*, and *Cumulo-stratus*; and he compounded the three under the denomination of *Cumulo-cirro-stratus*, or *Nimbus*; an arrangement of this branch of meteorological science, wherein natural observation goes sagaciously home to original harmonic principle, simply, elegantly, and ingeniously.

211. It appears, farther, in a manner perfectly coincident and analogous, how figures contrast and

* See the vignettes which form the grey backgrounds to the preceding diagrams of colours, for which we are indebted to the skilful assistance of Mr. D. Lucas.

harmonise each other in art, with reference to pictural composition and its various forms—linear, angular, circular, and compound; and why the modern artist has made such eminent use of the primary angular, pyramidal or middle form in particular, in the grouping and composition of his *figures*, &c.

212. The most graceful of the modern masters have employed principally undulating curves in their figures and compositions, or the Hogarthian line of beauty—whence the grace of Coreggio; but the ancient Greeks composed variously with the three primary lines together; and to this may be attributed the more energetic, natural, and noble character of their works, and of those of Michael Angelo also, which were founded upon them.

213. Upon inspecting the great works of Raphael generally it will be remarked that he composed principally upon the *curve* and *circle*, of which his "School of Athens," his "Last Supper," and his "Death of Ananias," are examples; and Leonardo da Vinci delighted in *triangular* and *triadic* compositions, as appears in his great work of "The Last Supper." Thus we have evidence of this regimen of forms in three of the greatest masters of the chief modern school of design. We have spoken principally of historic composition, but the same principle and analogy apply to landscape, and every branch of pictural art.

214. Thus we may instance as an example of

the beauty arising from this harmony of forms in the grouping of trees, the effect with which the *tall and straight* poplar and the *angular and pyramidal* pine rise over a group of weeping willows, or out of a *circular* mass of trees; a sort of composition in landscape often introduced, admired, and felt, although not understood as other than the effect of variety; for although in variety there may be some accidental beauty, it is not every variety that is beautiful, and that is only such which subserves some law of harmony, of which we have here shewn the most universal in forms, coincident with those of colours.

215. The chromatic axiom before given, which prescribes in the harmonising of *colours* a due exhibition of the three primaries in community, belongs to a universal law of harmony, and is equally applicable to *forms*; for *there can be no perfect harmony in the composition of figures, in which either of the three genera is wanting, and the varieties of harmony in composition and design depend upon the various predominance and subordination of the three.* Hence, of the secondary figures, the *Cylinder* is harmonised and contrasted by the Triangle, &c.; and the *Prism* by the Circle, &c.; and the *Cone* by the Parallelogram, &c.; for by these means the three primary figures are combined in various predominance and subordination together.

216. Hence the chromatic rule, that *any secondary colour composed of two primaries will be harmonised by opposing to it the remaining primary*, comports also with plastic forms or figures. It is hence that the parallel forms of an architectural structure, composed of *right lines* and *angles*, give harmony and beauty by opposition to the irregular *curves*, and compound or broken forms of a landscape; and that the *circular* temple, or *cylindrical* column, contrast the *angular and devious forms* of mountain scenery, when such forms are in due subordination; and they equally destroy harmony when, by either of them unduly predominating, they subdue the unifying forms—the archeus and key-note of the composition; just as a touch of *Red* gives value to the *Greens* of a landscape, or when predominating it destroys the harmony of the picture.

217. The beautiful and regularly geometrical temples of the Greeks were admirably adapted to, and contrasted by, the rugged grandeur and sublimity of their localities, to which the exquisite senses of the Grecian artists had unquestionably, not accidentally, but designedly, adapted them. To secure consistency with contrast and fill the harmony, the key-notes and archeus of every composition must accompany, and be accompanied by successive and simultaneous consonances. Without these consistency may be without beauty, or

beauty wanting consistency, and both unsatisfactory to correct taste and judgment; which require that both sense and the mind should be satisfied.

218. Hence also arise, on the other hand, beauty and harmony from trees and animate figures, or a touch of landscape in subordination to architectural composition; the principle is universal: and wherever forms compounded principally of two primary figures predominate, the third primary figure introduced in subordination will infallibly contribute to the harmony of the composition. The cases of application of this rule are innumerable, and extend to every diversity of contrasting figures.

219. It is according to the same principle that the combinations of trees, shrubs, and flowers, with urns, basons, balustrades, and fountains, convolved with the tribes of parasite plants, amid grass-plots, steps, and terraces, ornamented with sculptures, and conjoined with architectures, afford beautiful delight—the winning graces of nature mixed and entwined with art, and, on the contrary, that the finest regions of the untamed wilderness, debarred of the episodes of the painter, afford hardly a picture worthy to be called a work of art; so that to conciliate taste, and interest humanity, the trace and hand of man must somehow animate and contrast the works of the Creator. In a higher respect are natural and divine analogies carried into re-

ligious art, affluent of sublime beauty, as exemplified throughout Gothic architecture.*

220. It is, therefore, on the whole, a fallacious and narrow maxim which has been entertained by some that geometrical forms are to be excluded from pictorial designs, as inimical to grace and picturesque beauty; yet these forms are, like the primary and secondary colours, beautiful in themselves individually, and all the precaution called for in the artist who employs them in composition is, to comport them with the harmony upon which general beauty, grace, and expression, according to the design, depend; and to employ them as he employs positive colours, not glaringly, but sparingly, in heightening or contrasting for due effect.

221. In coincidence herewith, the diatessaron or fourth, which was held to be the fundamental concord of all harmony in the music of ancient Greece, consisted of the above relation, and is analogically also the basis of all chromatic harmony, as we have shewn, as well as that of harmony in the composition of figures.

222. Thus our rules of subordination in harmony supply the conditions, in colour, figure, sound, &c., which the Greek HARMONIC METHOD, mentioned by various writers, requires, according to which, infinite individuals, differing from each other, have

* Mr. G. R. Lewis, in his "Illustrations of Kilpeck Church," and "Ancient Fonts," has treated expressly on this subject, with equal acumen and ingenuity.

symmetrical proportions and universal compensation of their parts, affording in each an harmonious whole. This the Greek sculptors appear to have accomplished in the varying forms of their statues, as readily as the painter can harmonise the endless variety of colours by a regular adaptation in subordination. And this *harmonic method* L. Da Vinci sought, for his figures, in the proportions of each individual with regard to itself, its design, and circumstances.

223. As to the human figure and human countenance, to which natural composition, and, in particular, expression, pre-eminently belongs, and in which these plastic relations are more diversified, compounded, and subtilised, to them our analogy equally applies; and the artist who aims at nature and originality may undoubtedly reap advantage, in his studies of the human figure, by looking beyond its anatomy to that upon which its anatomy is framed; or, in other words, to the anatomy of form itself. For, as in drawing a figure, he will evince his skill in its anatomy by exhibiting the very bones through the flesh without producing a skeleton; and, as in like manner, he will disclose his knowledge of the figure beneath the drapery that envelopes it, without producing nudity; so it is requisite he should carry his art one step farther, and, in all his figures, forms, and compositions, to indicate the *ruling primary forms* through every thing,

without exposing regular and naked lines, angles, and circles.

224. This geometrical analogy of composition in the human figure appears to have been noticed by the masters of the early schools of painting as derived from more ancient art, as appears in the works of Lomazzo and others, mystically connected with the occult philosophy of the time, and probably springing with masonry from the same original source. It appears, also, to have impressed several eminent modern masters and authorities with its importance.*

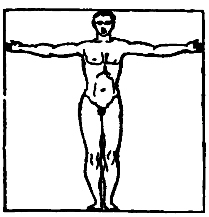
225. That the human figure is geometrically planned and constructed is further illustrated by our analogy; and that the Greek artists drew their rules of human and architectural proportions from a similar analogy, we learn from Vitruvius, who says, that if a man lie on his back with his arms extended, he may be exactly included in *a circle*, the centre of which being his navel, the circumference thereof will touch the extremities of his fingers and toes, Example XLVIII., and that if he stand upright with his legs straight and his arms extended, he will be exactly bounded by *a square*, Example XLVI., as he may also by a hexagon, and, with little

* See Hermanson Ten Kate on the "Beau Ideal;" Camper on "Anatomy and Painting," &c.; Hogarth's "Analysis of Beauty;" Stevens's "Homographia;" Flaxman's "Lectures on Sculptures," &c.

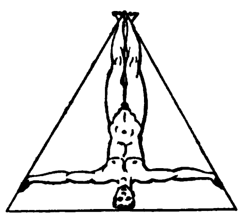
variation of the limbs, by other polygons to a circle; to which may be added, that if the latter figure have the crown of the head inverted upon the base of an erect equilateral *triangle*, Example XLVII., it will be similarly included by the other two sides passing the palms of the hand to the soles or tread of the feet; and thus is man in his external form analogously related to the three primaries of all figure, as he is subject also to a similar analogy throughout his nature, and is, in all respects, a microcosm.

EXAMPLES

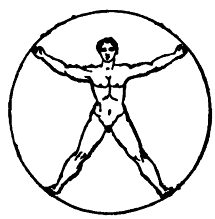
XLVI.



XLVII.



XLVIII.



It is probable, and may have been recorded, that the ancient Greek architects availed themselves of this analogy in the construction of their temples, as appears by the head and extended arms of a man occupying the pediment of an ancient ruin in "Miller's Antiquities," LIX., and it is apparent, that lines drawn from the crown of the head to the extremes of the hands of the figure, in the square above, Example XLVI., would afford the outline of a similar pediment, with space beneath for the façade of a temple of Grecian form and perfect symmetry within the square; the head and hands denoting appropriate places for ornaments above, with other coincidences which will suggest themselves to the architect. Thus Grecian architecture seems as appropriate to the civil service of man, as the Gothic or triangular is to the ecclesiastical.

226. Many other curious relations and coincidences of the parts of the human figure, with these geometrical primary forms, and their combinations, might be pointed out, not without use, in the adjustment of their symmetrical proportions; and some such have been adduced as mysterious, through inadvertence to the analogous relations of figure, by geometricians, artists, masons, and mystics. Nevertheless, we cannot but be persuaded that the ancients paid much greater attention to mathematical forms and proportions in fine arts than has been since done by the moderns, and that much of their excellence depended upon analogies which, although they stultify ignorance, facilitate intellect, refine taste, and widen the prospects of art.

We need not, however, dilate on the evident analogy which will strike the artist concerning the figure and subordinate measures and proportions of the body and members of man, which result from the direction of the triangle, Example XLVII., precisely in the manner of the coloured diagrams, Examples XV., XVII.

227. Were it possible in all cases to analyse the beautiful and expressive forms by which sense is affected, they would undoubtedly be found to arise from some nice combinations and adjustments resolving into the same identical elements. How exquisite and how beautiful, for example, is the play and adaptation of the primary figures in the human countenance,—the *arched or curved* brows, the *circular and globular* eyes, the *angular and pyramidal* nose, the *linear* mouth, with all the graces, forms, and flexures of line and contour, by which they insensibly vary and combine in the formation of this most beautiful, graceful, and expressive of all Heaven's most glorious works. But who shall analyse the subtilty of *motion* through which character and expression are depicted by these living forms?

228. How subtle also are the changes and gradations by which these figures exhibit themselves in succession or combination, in subordination or transcendence, in the same individual. Thus, in infancy, those forms are *round* which in manhood are *angular*, but in old age become wrinkled, *square*, and *linear*, as form declines towards the element from which it sprang.

229. We are disposed, therefore, upon the whole, to believe that the analogy of forms herein denoted is allied to that celebrated principle of analogy, aided by which, the artists of ancient Greece are stated to have realised abstract and ideal beauty,

and to have carried the plastic arts to that sublime perfection of which they have left us so many unrivalled examples; and, further, that it belongs to a universal analogy which is at once the principle of diversity upon which all variety depends, and of the unity which constitutes harmony in all representing art, and is, therefore, the natural foundation of all truth and beauty.

230. Thus all beauty, in sensible art or æsthetics, is relative and dependent on analogy and subordination; and this is manifest in every art, and even in accessaries,—as of drapery in painting, for no sooner is this rendered principal and without reference, than it becomes graceless and absurd, a costume or a fashion; to escape from which it must yield in all its changes to the *figure* it accompanies or adorns, but then it will partake in just subordination the beauties of form, variety, motion, grace, and harmony. It is by studying and copying nature in subjection to her simplest principles and most general rules, that art escapes from commonplace and vulgarity, and becomes original, masterly, and refined.

231. Although the arts both of colouring and design belong to sense in painting, the first is the immediate work of the *eye*, the latter of the *hand*; if this is more necessary or difficult, that is higher in nature, sense, and science, and more effective of feeling and pleasure. Artists have great need to be-

ware of the seductions of both, and to employ them as bases, as great means only, and neither of them as chief accomplishments and final objects of an art, the true end of which is to move our sympathies and excite our antipathies through the senses pleasurably, in alliance with moral purpose.

232. As music, although a distinct art, is naturally for the sake of poetry, so are chromatics, although also a distinct art, the natural ally of painting, and will not, it is devoutly to be wished, like its harmonic sister, be allowed to dissolve an alliance, or subjugate a higher relation upon which its chief office is founded, to revel in sensual independence, whatever advantage may arise from the exclusive cultivation of either art. We will now, therefore, investigate the analogy of chromatic with plastic science, upon which colouring in painting depends, and then finally advert to the corresponding analogies of poetry and music, and the general analogy of the whole of these arts by which they are held in triple alliance æsthetically.

233. The separation which we deprecate between colouring and painting, has an analogous depravation between the sister arts of poetry and music, arising from the popular cultivation of music as principal. "I disapprove," says Aristotle, "of all difficulties in the practice of instruments, and, indeed, in music in general. I call artificial and difficult, such tricks as are practised at the public games, where the musicians, instead of recollecting

what is the true object of his talent, endeavours only to flatter the corrupt taste of the multitude." * "These were the sentiments of the learned," says Dr. Burney,† "long after the separation of music and poetry, and these are the objections which recur and ever will recur to those who regard music as a slave to syllables, forgetting that it has a language of its own with which it is able to speak to the passions, and that there are certain occasions when it may be allowed to be a free agent." So has likewise colour a language of its own, effective to the eye, as in the latter works of an eminent landscape-painter, and an influence not unconnected with the passions; but this language and effect are much more elevated when legitimately engaged in conjunction with an appropriate subject in painting, as a friendly auxiliary power, and neither as a tyrant nor a slave. [145, &c.]

234. It is true, nevertheless, that such separate and distinct cultivation of the arts, is quite natural in their progress, and is the means by which they become individually perfected; but it is expedient to maintain their connexion and subordination, that, through such particularising, the nobler effects of their alliance may not be lost to mankind, and these arts, through division, fall into false extremes, sensuality, and contempt, of which music and painting are in danger, and poetry not without fear, if

* Repub. lib. viii. c. 6. † Hist. Mus. Vol. I. p. 425.

colour should drive design from the canvas, and harmonic art finally divorce

> "The heav'n-taught poet and enchanting strain."
> Odyssey ix. 3.

235. Had our veteran in landscape, when painting some late beautiful visions, instead of looking at nature through the *prism*, regarded it, as before hinted, through the *spectrum*, he would have approached much nearer to the *truth of nature*, and distinguished properly the *truth of vision* from the mere *truth of colouring;* in respect to which a recent author has, with much knowledge and enthusiasm, celebrated the grammatical accuracy of this artist. But he who lays too great stress upon grammatical and gamutical accuracy, will content himself with inferiority in painting and music, however he may prefer the florid to the fruitful; nor will grammatical, rhetorical, and prosodical accuracy, altogether redeem the finest failings in poetry.

236. With regard to this latter art, what has been well remarked in a review of Keat's "Endymion," that it is "*in truth at least as full of genius as of absurdity,*" may apply equally well to such chromatic exsuperances, in which, as in the poetry of Keates, "*a number of bright pictures are presented to the imagination, and a fine feeling expressed of those mysterious relations by which visible external things are assimilated with inward*

thoughts and emotions, and become the images and exponents of all passions and affections. To an unpoetical reader such passages will generally appear mere ravings and absurdity."* And such, also, it may be said will these chromatic effusions appear to an unimaginative spectator, unacquainted with the mysterious, the themeless music of painting; and a fair estimate of the real value of such art may, perhaps, appear in each case on reference to the productions of imitators.

237. Most persons have observed, when sitting before a large, clear, well-burnt coal-fire, in an apartment otherwise unenlightened, strange, elegant, and beautiful figures, and even grand and sublime visions of pictures therein, assisting and assisted by imagination; and if at such time there be strewed on the fire a sprinkling of sea salt, cool colours will arise, contrasting the hot and firy hues, giving to such visions all the chromatic truth and beauty of prismatic colours, affording enchanting pictures and fairy scenes to a fine eye and lively fancy. Others, no doubt, as Cozens did, have imagined fine designs and improved them into pictures from coloured blots; indeed, such things are often formed without apparent design, of which there is an admirable example in the British Museum, being a double portrait truly coloured and finely characteristic of the poet Chaucer,

* *Spectator*, Dec. 1842.

formed in the natural veins of a split agate, which has been engraved by Girtin, brother of the celebrated landscape-painter. But such things come through analogy of nature, and are not art, although the educated artist may be justified in availing himself of hints, accidents, and expedients.

238. The high purpose of art is not, however, satisfied by simple excitement of imagination, it requires also that the artist, whether poet or painter, should express its objects to sense and understanding, as Shakspeare did; "and give to airy nothings a local habitation and a name:" the want of which renders art mystical and fantastic.

239. Pettiness, prettiness, definitiveness, and particularity, are the first qualities of assiduous art in its early efforts. Every thing therein is addressed to outward mechanical common sense, and nothing to inward sentiment and poetical imagination. In its advancement mind takes a share in the productions and enjoyment of art, till imagination usurps the place of reason and sense, and art, becoming fantastic, visionary, and conventional, quits nature altogether. But it belongs to sane understanding, good taste, and good sense, to preserve the middle station and legitimate course of art, in which it emulates general nature with effect and refinement, equally removed from the extremes of the visionary and the vulgar.

240. Still to those who make old pictures their standard of colouring, the new light may render

eminent service; for independently of ultramarine, which is erroneously supposed to have improved by age, the materials of the old masters were inferior to those now employed, and their key of colouring was necessarily lower, and compelled them to harmonise much below nature. It is in philosophy, also, as in art, when instead of truths and realities it offers us nothing but mysteries and paradoxes; we cannot say there is nothing in them, but we may reasonably doubt whether that which is in them is worth our research; and when the mysterious comes to be preferred to the true, we may justly protest against it as pernicious.

241. How much more painting depends, nevertheless, on the medial faculties of sense and passion in the artist than merely on either his intellectual or physical powers, we have some evidence from the distinctions which have been made in the Italian schools with respect to the esteem due to the works of the same master, as produced *con studio* through the mind, *con diligenza* by the hand, or *con amore* with sense and impassioned regard; of which the latter have ever been of chief estimation. Hence also arises the esteem which the sketches of the artist, as distinguished from his slighted performances, often justly obtain from the truly connoissant above his finished works, from possessing more truth of nature and spirit of the master and of the art, than his more laboured and embodied performances.

242. So much for the chromatic relations of painting through the analogy of figure with colour, as before shewn of colour with sound, whence their common alliance with music or harmonic science, of which we have demonstrated the chromatic analogy whereby it is connected with painting on the one hand, as it is, through words or sounds, significant in language, with poetry on the other; and thence gives laws and regulation, as it were, to the whole as harmonic arts. We now, therefore, proceed to the more intimate association of chromatic art with poetry, and the analogical conformity of these arts, and their various relations to material, sensible, and intellectual natures. To those who would investigate the analogy which subsists between *Musical sounds and Geometrical figures*, independently of chromatic science, the way is open; and the celebrated Tartini, so eminent in Harmonic art, has deduced all musical harmony from the geometrical relations of the *Circle* and the *Square*; he was of opinion, also, that from sentiment, supported by science, and assisted by physical truths, "a discovery might be made, one of these days, what and how great the extent of *physico-harmonic science* is, of which music is but a small part," &c. —See STILLINGFLEET's "Principles and Power of Harmony," p. 119, &c.

CHAPTER XI.

POETIC ANALOGY OF COLOURS.

243. FINALLY, in Æsthetical Chromatics, there remain for discussion the analogous elementary accordance of literary art and poetry with the system of colours and colouring, in the manner previously pursued with regard to the arts of music and painting,—in process, also, from the figures of matter to the figures of mind, from geometrical and plastic, to rhetorical and poetic figures, the common use of terms in these arts indicating a general accordance in nature and relation.

244. Painting is a branch of *graphic art*, which, dividing, became on the one hand *literal*, and, on the other, *pictural*,—on the one hand hieroglyphical and symbolical, expressive to intellect, and, on the other hand, imitative and expressive to sense,—on the one indicative, on the other portraitive; and it is probable that the invention of letters or general signs, and the establishment of painting or individual representation as a distinct art, are coeval. Aiming at the same end, and diverging through distinct media, the one became poetry, the other painting, and they are truly sisters

of the same parentage, in conjunction with music or harmonic art.

245. Poetry conjoins signification and expression to harmonic sound, and the first matter of such signification and expression is the human voice.

246. The primary vocal sounds, as represented by letters, are the vowels I, O, A, analogous in sound to the primary triad of the common chord of music, as they are in figure to the primary forms of the *line*, *circle*, and *angle*, in painting; and from these powers, addressed to the ear and eye, the entire scale of alphabetical consonances and letters may be deduced,* from which all the more compound sounds significant of the poet are produced in the construction of words, as figures in painting are produced by colours. Music, painting, and poetry, are therefore coincident, sororal, and analogous, at their elementary foundation even.

247. Poetry, as a whole, has three principal references; the first of which is to words, or the *poetry of language*; the second to images, or the *poetry of imagination*; and the third to thought, or the *poetry of intellect*. The first is of material, the second of sensible, and the third of moral reference; and of these the second is principal, for poetry, like its sister arts of music and painting, is chiefly a sensible art, it is the highest of them it is

* See Analog. Phil. Vol. I. p. 84.

true, and bordering on the higher department of intellect.

248. Words are to the poetry of language what colours are to painting. The varied repetition of a colour is as the alliteration of painting, and poetic diction and colouring are the same. So, again, poetic configuration is to the poetry of imagination what drawing is to painting; and the soul of both these arts is alike the expression of beauty, passion, and sentiment, which analogy has not failed to elicit the observation of the rhetorician.

249. The mechanism and machinery of both arts are coincident, they both demand variety, but a variety subordinated to unity. The rhetorical harmony of poetry requires this, and painting is rhetoric made visible; it is oratorical, dramatical, and epic, in the nearest approach to reality, and the various rules of these arts reciprocate, and are practically available in each.

250. Their subjects and their modes of treatment are also coincident, and poetry and painting may be regarded as variations of the same art, and alike subordinately divisible; thus the poetry of language involves *grammar* or prosody, which has a distribution and regulation analogous to colours and sounds; *rhetoric* or prosopopœia has a like analogy to painting and music, in regard to figures, and is the poetry of imagination; and invention is the *logic* of these arts, the poetry of intellect and

thought, appealing to reason, and teeming with similar analogy.

251. Poetry then is the language of analogy through which thoughts are figured by imagination as sensible images to intellect. The art consists in raising and adapting these images to passive intellect, so as to emove the passions and affections through sentiment and harmonious sounds. It is this that allies poetry to music, on the one hand, by sounds significant, and, on the other, to painting, by images decorated by figure and colour in ideal beauty, or deformity generalised from the infinite field of nature, of which the instances are innumerable. Thus Collins sings and paints:—

"Ah! Fear, ah! frantic Fear,
I see, I see thee near.
I know thy hurried step, thy haggard eye!
Like thee I start—like thee disorder'd fly.
For lo! what monsters in thy train appear."

252. Again, conjoining the three arts, he sings:—

"But thou, oh! Hope, with eyes so far,
What was thy delighted measure?
Still it whisper'd promised pleasure,
And bade the lovely scenes at distance hail!
Still would her touch the strain prolong;
And from the rocks, the woods, the vale,
She call'd on Echo still, through all the song;
And where her sweetest theme she chose,
A soft responsive voice was heard at ev'ry close;
And Hope enchanted smiled and waved her golden hair."

Ode to the Passions.

253. Thus these arts unite as one universally, and as such they appear combined in the drama, wherein poetry, music, and painting, conjoin under a variety of subordination, analogous in regulation to the keys of music, the archei of colouring, and the ordonnance of a principal figure in painting, &c., infusing a triadic order even into the parts. Thus, in the Greek drama, each of the odes or choruses consisted of three stanzas,—the strophe, antistrophe, and epode, concerning which, however, this is not the place for particularising; we merely mark a coincidence, for language is inadequate to the perfectly unfolding and conveying of these subtle relations, and it is only requisite to suit inquiry to the subsisting state of knowledge, in the progress of which language adapts itself to the gradual unfoldings of nature, experience, and thought.

254. So harmonious is nature, and so disposed by nature is man to harmonise, that although discordance accompanies harmony, as shade does light, he will from feeling compose and relish harmoniously in art, without science or knowledge of either the natural or artificial rules of harmonising. It is hence that in music, painting, and poetry, the common uncultivated sense or instinct can appreciate and produce harmonies, and will avoid and be offended at crude, unprepared, and unresolved discordances.

"From harmony, from heav'nly harmony,
This universal frame began;
From harmony to harmony,
Through all the compass of the notes it ran,
The diapason closing full in man."—DRYDEN.

255. All the scales of harmony in colour, sound, &c., are framed of alternate concord and dissonance, but these dissonances undergo compensation, or preparation, and resolution, variously at every step; whence the majority of the productions of nature and art, however produced, afford harmonies which sense and understanding can tolerate, and accidentally, too, such as high cultivation and knowledge can approve.

256. Hence, also, it results that public judgment on the works of nature and man, maugre his want of science and cultivation, may often be rationally approved as the results of a correct general sense. Thus no air or composition in music becomes popular that is not justly conformable to the true nature and science of melody; and so it is also in regard to a poem, a picture, or other subject, for this bias of nature toward truth is universal. Nevertheless, this general instinct or common sense, however admissible in taste or useful in social life, must be sedulously excluded from the jurisdiction of reason, philosophy, and pure art.

257. Nor does it follow that the bias, or mere instincts of nature, are sufficient to the high attainments or perfect enjoyment of these arts, for there

is no bound to refinement, combination, and excellence therein; and these are dependant, not on common sense, but on a knowledge of their true relations, the rules founded thereon, and unceasing study and practice.

258. But when these rules and relations are understood, any poem set to music, or subject of poetry capable of becoming that of a picture, will admit of being painted to the same melody and harmony of colours that correspond to music in which such poem may be set, and conformably so to the strict rules of art.

259. As music relates to *sound* simply, and poetry (or figurative speech) to *signification* or figure, and as, when united, they become *sound significant*, so it is with *colour* and *figure* in painting; the first belongs to its *harmony*, the latter to its *poetry*, while in the *perfect picture* these are united. Thus these arts are throughout perfectly coincident, philosophically entitled to their classical relation as sisters, and to be regarded as *the three graces of art*, entwining and supporting each other.

"As genius inspires,
The sister arts shall nurse their drooping fires;
Each from his scenes * her stores alternate bring,
Blend the fair tints, or wake the vocal string."

COLLINS.

260. All the sister arts are especially arts of

* Shakspeare's.

pathos and expression, through colours, figures, and sentiment,—the latter the highest and proper medium of poetry is also the chief end and aim of the three. We proceed therefore to shew by what natural analogies and artificial associations colours are connected with, and tributary, practically, to pathos, sentiment, and expression, natural, pictural, and poetical,—a matter of eminent importance to the painter, and a subject of no mean interest to the poet, since colour is a prime medium of the one, and the sole means of the other, and the chief object of universal sense, through which these artists create, animate, and decorate,—raise, invigorate, and adorn their figures and designs with life, beauty, and expression,—passion, sentiment, and sense.

261. This is properly the highest department of our subject, is of moral reference, and follows its sensible relations, which are first and principal in an æsthetical design like the present, and will lead us into the consideration of colours in their individual and appropriate characters and capacities, with regard to poetical and pictural expression practically.

262. We will premise a few general remarks ere we denote the individual expression of colours in the natural order of their developement. The relative physical and sensible powers upon which the expression of colours individually depends, being chiefly of practical reference in painting, we have treated thereof more fully in our "Chroma-

tography," under each of their denominations, and shall confine ourselves herein to their æsthetical and moral expression; a subject which, if it have not been totally overlooked, has at least been involved in neglect and obscurity. There may, indeed, be some who, although they must themselves have *reddened with hope* and *whitened with fear*, either from organic defect or uncultivated faculties, question these powers altogether, yea—

"The man,
Whose eye ne'er open'd on the light of heaven,
Might smile with scorn, while raptured visions tell
Of the *gay-coloured radiance flushing bright*
O'er all creation."

Yet the artist and the poet acknowledge these powers of colour, from having seen and felt their effects; and having felt them, it becomes a purpose of their art to excite the same feelings in others gifted by nature or attainment to appreciate and enjoy them.

263. This alone is sufficient to render these powers of colours a subject of interesting inquiry, when, according to the expression of Addison, they are "obliged to put a *virtue* into *colours*, or to find out a proper dress for a *passion*." In which way Spenser, who was a great poetical colourist, sings in his "Faërie Queene," that *Humbleness*, figured as "Hamilta," in colour neutral and retiring,

"Was an aged sire all *hoary grey*:"

of *Faith*, figured as "Fidelia," in the pureness of light,

> "She was arrayed all in *lily white*;"

that *Charity*, in the figure of "Charissa," and in glowing colour,

> "Was all in *yellow* robes arrayed:"

that "*Falsehood*," in colour various, flattering, showy, and discordant, was

> "Clad in *scarlet red*,
> Purfled with *gold* and *pearl* of rich assay:"

of *Vanity*, his "Praise-desire," in colour attractively advancing and retiring,

> "In a long *purple* pall, whose skirt with *gold*
> Was fretted all about, she was arrayed:"

that *Hope*, figured as "Speranza," in colour fresh, distant, and celestial,

> "Was clad in *blue*, that her beseemèd well:"

that "*Reverence*" was in colour subdued,

> "Right cleanly clad in *comely sad* attire;"

and "*Idleness*," thrown into darkness and shade, the contrast of all light and glory,

> "The nurse of sin
> Arrayed in habit *black* and amice *thin*."

We thus trace Spenser briefly through the whole chromatic scale, and must grant to his colours and figures a well-chosen and expressive analogy. His description of the abode of Mammon, and the whole of his allegories, evince with what masterly effect he employed the expressive powers of light, shade, and colours, in moral description.

264. And thus again sings Gray, figuratively and enharmonically, in broken colours,—

"These shall the fury Passions tear,
The vultures of the mind,
Disdainful *Anger*, *pallid Fear*,
And *Shame* that skulks behind;
Or pining *Love* shall waste their youth,
Or *Jealousy* with rankling tooth,
That inly gnaws the secret heart;
And *Envy wan*, and *faded Care*,
Grim-visaged comfortless *Despair*,
And *Sorrow's* piercing dart."

Wherein every line is allusively figured or coloured, and he paints the ruthless sisters Fear, Envy, and Care, as faded, pale, and wan, and grim Despair; and the artist well knows to represent the same according to nature on the canvass, by livid, sere, broken, and sombre hues, and tints of varying corresponding expression.

265. As the former colours are referred to the clothing of the poet's figures, so are these to their complexion and countenance; nor need we look for better evidence of the more subtile expression of colours than is to be observed upon the human face—that masterpiece of nature's expression, in which is acknowledged the *redness* indicative of anger, resentment, and the sanguine passions, and

the blush of bashfulness and shame, betraying an infinity of consciousness; the sallowness, or *yellowness*, of sickness, grief, envy, malice, and the biliary passions; the cold livid *blueness* of hate, fear, terror, agony, despair, and death; with a thousand other hues and tints of expression and pathos, readily felt, but difficultly described or understood.

266. Whether these colours of the human countenance are to be ascribed to the various agency of nerves, blood-vessels, and lymphatics; whether the *warmth and redness,* expressing active feelings, be not attributable to *arterial action,* and the *cold hues* of passive agony to *venous reaction;* and whether the passions denoted by the *sallow or yellow* hue are not *biliary affections;* are questions we merely suggest to the anatomist, who traces all pathetic expression to organs, and takes no account of sensible and moral influences, the currency of the senses and passions, for the idiosyncrasies of medical physiology are irrelevant to our inquiry.

267. In changing our view from the face of man to that of nature in the sky, we find colour equally efficient in giving character, sentiment, and expression to the landscape, indicating the calm and the storm; and in infinite ways betraying through these larger features the latent emotions of the spirit of nature.

268. It is by this power of colours that the *greenness* of spring indicates the youth, vigour, and

freshness of the season; that the light, bright *yellow* and *orange* hues of summer denote its floral powers; that the glowing *red* and *purple* hues of fruits and foliage proclaim the richness of autumn,—

> "Yon hanging woods that, touched by autumn, seem
> As they were blossoming hues of fire and gold;"*

and that *blue*, dark *grey*, *white*, and *black*, express the gloom and wintry coldness of nature.

269. The analogy of the natural series of colours with the course of the day and the seasons, coincides with the ages of man, or the seasons of life, and adapts itself to express them in the hues and shades of attire and complexion, literally and metaphorically, from the *white or light* of the morn or dawn of innocuous infancy, through all the colours, ages, and stages of human life, to the *black or dark* night of guilt, age, despair, and death.

According to the like coincidence and analogy, the ancient poets and painters personified the spring, or *Ver*, as bright, infantine, and crowned with flowers; *Æstas*, or summer, as lively and youthful; *Autumnus*, as fruitful and manly; and *Hyemas*, or winter, as aged, decrepid, and dark.

270. Throughout all seasons, and in all countries, it is by the colour of his crops that the hopes, fears, joys, acts, and judgments, of the husbandman are excited; nor are the colours of the ocean and

* Coleridge.

the sky less indicative and important to the mariner, nor the colours of his merchandise to the merchant; so universal is this language of colours the sole immediate sign to the eye, which is the chief organ of external expression and intelligence.

271. Whether it be the face of nature or of man that is tinged with the various expression of the gloomy and the gay, it reciprocates corresponding sympathy in the spectator; and we even form judgments of the disposition, temperament, and intentions, as well as of the youth, vigour, age, race, sex, and class of individuals, from colour and complexion; hence colours have been made common symbols of the passions and affections, &c., denoting by a tacit consent their connexion with moral feeling and expression, available in the descriptions of the poet, and transferable by the pencil to the canvass.

272. Of such popular symbols *black* denotes mourning or sorrow; *grey*, fear, &c.; *red* is the colour of joy or love; *blue*, of fidelity and constancy; *yellow*, of jealousy; *green*, by a physical analogy, of youth and hope; and *white*, by a moral analogy, of innocence and purity; as *light*, by intellectual similitude, is of truth and knowledge, and as *darkness* is of ignorance and crime.

273. The foregoing remarks are not confined to the more positive colours individually, but extend to the neutral and broken compounds; every hue and shade having its corresponding shade of ex-

pression, giving scope to the refinements of taste; the most subtile and sublime expressions vibrating in all cases to the most delicate touch. The subject is fertile, but enough has been adduced to confirm the general fact, if it can be doubted, of the natural, sentimental, and moral expressions of colours, analogous to that of musical sounds; and of their individual expression, poetical and pictural, we purpose to treat in the order of our previous developement, as a sequel to the present inquiry.

274. By what mysterious power colours and sounds thus vibrate and reflect these affections, is beyond our present inquiry; the fact being established, we may, by investigating its instances, confirm our theory, or advance our practice; in which we already acknowledge the power of colours to soothe and delight by gradation of hue and shade, to excite and animate by their various contrasts and harmonies, and to distract and repel by infraction and discordance.

275. It may be doubted, indeed, whether the expression of colour is not naturally more efficient than that of form or figure; for though the latter has also its natural expression, it owes its chief force to custom, association, and consent; whence lines and forms have almost engrossed the office of expression with the painter, but, aided by colour, the expression of form becomes irresistible.

276. Perhaps, however, colour and form have peculiarities of expression which ought to be dis-

tinguished; and if we may venture an opinion thereon, the expression of form is more powerful in proclaiming the ardent passions, and that of colour in portraying the more delicate emotions of internal feeling and sentiment; the one is the expression of sculpture dependent on the external alone, the other an internal movement more indicative of the soul, compared with which the former is cold and inanimate. The first is the rhythmus of expression, and like those of poetry and music, strikes every eye; the other is the sympathy of certain natural chords which vibrate to the eye gifted or cultivated to perceive and feel them.

277. The colouring, therefore, which the artist infuses into, no less than that with which he clothes and surrounds his figures, is by no means arbitrary or local, or merely a matter of conformity to the natural object, or of sensible satisfaction to the eye; but has also in its ultimate view a rational and moral reference, dependent on the subject and the sentiment intended to be conveyed; and our common habits of thinking and speaking coincide herein, when we attribute moral and sensible qualities to colours, denominating them faint or strong, true or false, foul or fair, harmonious or discordant, dead or lively, fresh, sedate, solemn, good and bad, modest and meretricious, gloomy and gay, &c.

278. It is hence by tone and colour that the artist is able to excite and aid the ruling and sub-

ordinate sentiment of his performance in the manner of the musician; and that, although he copy nature in his colouring, he will not do so servilely, but with taste, discrimination, and reference to these ends. There is *the ideal* in colouring as well as in forms, which belongs to the perfection of beauty and sentiment, which are chief objects of attainment to the painter, and that to which the philosophic minds of the Greeks aspired. "Is not painting, Pharrhasuis, a representation of what we see?" said Socrates; "by the help of canvass and *a few colours* you can easily set before us hills and caves, light and shade, straight and crooked, rough and plain, and bestow youth where and when it best pleaseth you; and when you would give us *perfect beauty* (not being able to find in any one person what answers your *idea*) you copy from many what is beautiful in each, in order to produce this perfect form."* It is the same in colouring, wherein *ideal beauty* must be induced or generalised from the individualities of nature, for there is no other source of fine ideas in art or science.

279. Many are the victims of the error of looking out of nature for art, in which even the romantic is not far removed from the real, for, if it were, it would not interest us, and, to an attentive observer, actual life is full of romance. He who has rarely removed from his home, and whose

* Xenoph. Mem. CX.

life may have been a course of domestic habits, may have remarked that he seldom or never enters the world around him without encountering an adventure; and often one of a very novel and romantic character, well worth relating for its amusing or moral interest, and not without reference to a whole. But life is so full of these adventures, and we are drawn and pressed so many ways, that they are suffered to escape, while the vile unnatural caricatures and fictions of the novel and the stage are allowed to usurp their place in art, and to nauseate a better taste for the exquisite realities of life; and thus, and even worse, dramatists copy the drama, and painters, painting, while nature, even in colouring, is neglected for exaggeration and false display.

280. It is in the natural employment of his colours, therefore, that the artist properly attains the reputation of a colourist; and in this respect he may, perhaps, take a hint from, as well as contribute something to, the poet, who has not failed to avail himself of the natural powers of colours on the imagination, in exciting, heightening, and extending ideas and sentiments, in the construction of epithets, the decoration of figures natural and rhetorical, and in all the imagery and witchery of his art. We may hence remark that many of the most exquisite passages of the poets are indebted principally to colours for their beauty and effect.

281. The poetic expression of colours must, of

course, be limited to the signification of terms, which, in regard to colours, has been hitherto confined to their simple names and relations; poetry, therefore, falls far short of nature and painting, in this respect: it is, nevertheless, open to all the refinements of language and art, on which point much remains to be done by the poet, and herein the painter may refund part of the obligation he owes to the bard—

"Blend the fair tints, and wake the vocal string."

282. Poets, like painters have been comparatively good or bad colourists; and it is remarkable that the poets of nature are invariably the best, while the poets of art and imitation are as indifferent colourists as those painters and copyists are, who have studied colouring, without nature, in pictures only. Hence some of the early poets, who probably drew their images more immediately from nature, have availed themselves more, and more truly, of the powers of colours than later poets; thus Spenser, and Shakspeare in particular, are painter-poets, and Lessing attributes the qualification of a perfect colourist—"another Titian"—to the poet Ariosto. It is different in the schools of painting, in which colouring has been the latest attainment of the art, but not without traces of natural colouring in its early examples.

283. But, if the poet is indebted to colours for the decoration of his figures and descriptions, much

more so is the painter, who owes more to the effect of light, shade, and colour, for expression and sentiment, than to either of the other branches of his practice; yet the latitude and license of the poet, with regard to the use and expression of colour, is even wider than that of the painter, and hardly bounded by the usage and variation of nature herself, when it suits his sentiment to deviate in this respect; hence, with the poet, the sea becomes "the *black* ocean, the *green* ocean, the *purple* main, the *azure* deep, the *white* wave," &c.; the same of the sky, the land, the forest, and other natural objects, no less than with the fictions of his own imagination.

284. In collating the poets for instances of this poetical colouring, none appears to our view to have had more just, natural, and technical, conception of the beauties, relations, and powers, of colours, than our great dramatist, whose genius seems to have been almost universal. Sometimes he harmonises with the primary colours, as thus:—

> "Thou shalt not lack
> The *flower that's like thy face*, pale *primrose*,
> Nor the *azured* harebell, like thy veins."—*Cymbeline.*

Sometimes he employs the secondaries, as in the order of Titania to the fairies to honour her love, so justly admired by Dryden for its poetical beauty:—

> "Feed him with *apricots* and dewberries,
> With *purple* grapes, *green* figs, and mulberries;

And pluck the wings from *painted butterflies*,
To fan the moon-beams from his sleeping eyes;
Nod to him, elves, and do him courtesies."
Midsummer Night's Dream.

285. In both the above instances one of the three colours is unexpressed, as it generally is in natural objects, particularly in flowers, and even in their species; for example we have roses of *red, yellow*, and compound colours only, for nature does not afford a *blue rose*, but in its place roses of purple hue, and colours retiring toward black; the same may be remarked of the hollyhoc and other flowers. Colours are, nevertheless, sometimes given with poetic license to flowers and other objects in pictures, which nature never dared to give, and though the colours may, in such case, be required in the picture, they are, when so given, an offence to truth that makes its impression on the mind of the spectator. The adherence to nature and truth, this best policy of honesty in all things, is one of Shakspeare's irresistible charms, and belongs to excellence in every art. How natural, tender, expressive, beautiful, and true, is this, his inquiry concerning a sign of sorrow:—

"What's the matter,
That this distemper'd messenger of wet,
The *many-coloured iris*, rounds thine eye?"
All's Well that Ends Well.

286. That our bard discriminated nicely in colours is apparent from the following:—

"There was a *pretty redness* in his lip;
A little *riper and more lusty red*
Than that *mixed in his cheek;* 'twas just the diff'rence
Betwixt the *constant red* and *mingled damask*."
As You Like It.

And again:—

"If you will see a pageant truly play'd
Between the *pale complexion of true love*,
And the *red glow of scorn and proud disdain*,
Go hence a little."

287. With what truth and effect he avails himself of the chromatic discord of *green and yellow*, which he uses metaphorically for youth and jealousy, as though he theorised in colours, in the following beautifully expressive passage:—

"She never told her love,
But let concealment, like a worm i' the bud,
Feed on her *damask cheek;* she pined in thought;
And, with a *green and yellow* melancholy,
She sat, like patience on a monument,
Smiling at grief."—*Twelfth Night.*

The chromatic discord therein resolves itself in "*damask*," which is a *purple-red*, the perfect contrast and equivalent of "*green and yellow*."

288. Of this management of contrast in colouring, Shakspeare is a great master; witness the blood of Duncan on the hand of Macbeth, contrasted and opposed to the colour of the ocean:—

"*Macbeth.*—Will all great Neptune's ocean wash this *blood*
Clean from my hand?—No; this my hand will rather
The multitudinous seas incarnadine
Making the *green* one [ocean] *red.*

"*Lady Macbeth.*—My *hands are of your colour*, but I shame
To wear *a heart so white.*"

289. Innumerable instances might be adduced of the correctness of our poet's judgment and feeling in employing the peculiarly beautiful relations of *red* and *white* when mingled or opposed; but the above and following may here suffice:—

> "I have marked
> A thousand *blushing apparitions* start
> Into her face; a thousand *innocent shames*
> In *angel whiteness* bear away those blushes."
> *Much Ado about Nothing.*

290. Not to multiply instances, we refer the reader to our "Chromatography," in which we have treated of the powers and expression of individual colours throughout their series, and illustrated them by examples from other poets; the single authority of our great dramatist being more than sufficient to establish the fact of poetic colouring, its general relations and expressive effect, in strict analogy with chromatic theory and the painter's practice. Shakspeare, indeed, exercises his skill and genius therein with so masterly a hand, as often to produce these chromatic effects by mere allusion, clothing immaterial things in imaginary colours:—

> "Thus conscience does make cowards of us all;
> And thus *the native hue of resolution*
> Is sicklied o'er with *the pale cast of thought*."—*Hamlet.*

Not deeming it necessary to tell us that "the native hue of resolution" is of a *hot and fiery red*, nor that such colour is subdued by a *cold grey* "cast of thought," the very means the painter would take to scumble down, or "sickly o'er," such "native hue." In a word, Shakspeare invariably evinces a refined feeling of our art, in adapting the relations of colours to his own; but in what feeling or sentiment could he be wanting who drew all by the hand of nature from the fountain of truth!—

> "And he, the man whom Nature's self had made
> To mock herself, and truth to imitate
> With kindly counter under mimic shade,—
> Our pleasant WILLY,—ah! is dead of late!"
> SPENCER.—*Tears of the Muses.*

291. Milton and other of our poets abound with fine examples of expressive poetic colouring, but theirs have not always the truth and nature of Shakspeare's. Byron evinces less sympathy for genuine chromatic expression, and his palette is principally set with *black* and *red,* "and tints each *swarthy* cheek with *sallower* hue;" but in this there is something not less characteristic than are the *purple* and *gold* displayed by Homer.

292. Upon the whole it may be concluded that the sentiments and affections of the mind, as raised and expressed by hues, shades, and colours, can nowhere, except in nature, be better studied than in the examples given of them by the poets. As to the elements of passions and pathos, which is next in the course of inquiry, it belongs to another department of knowledge, that claims the attention

of the philosopher. Our present design has been accomplished if we have in any measure vindicated the classic sisterhood of the graceful arts by the analogies of nature and science, and justified to truth the recourse and allusions to their alliance which have so constantly enriched literature, delighted taste, and liberalised the understanding. Yet ought we not to pass wholly unnoticed the analogy whereby *beauty*, *truth*, and *good*, the prime objects of intellect, coincide with the primaries of colour, figure, and sound; every two asserting its third in harmonic unity, whence the moral influence of the arts of beauty: in fine, this harmonic principle pervades the universe, and ere the mind can in any degree comprehend moral truth and beauty, it must be prepared for them by a correlate amount of good.

293. Having thus disposed of the general æsthetical relations of colours, it could serve little useful purpose to carry the inquiry into the chromatic relations of other sciences remote from useful reference to the artist, and unconnected with the philosophy of taste; there remains, therefore, only to our design, what is called the philosophical, but is strictly the physical, branch of our subject, and to this we proceed.

PART III.

PHYSICAL CHROMATICS.

CHAPTER XII.

CHEMICAL DOCTRINE OF LIGHT, SHADE, AND COLOURS.

294. Having dismissed the æsthetical analogy and chromatic relations and harmony of light, shade, and colours, we proceed finally to the physical doctrine and facts by which the premises of our work are confirmed on a solid foundation in nature and science.

295. According to our chemical doctrine of light and colours, delivered under other relations, and our brief inquiry into their physical causes,* *the ethereal matter, called electric, is light in a*

* "Outlines of Analogical Philosophy," vol. II. p. 42; "Chromatography," chap. iv.; and Appendix to the first edition of this work.

latent state, and *light is the electric fluid*, so called, *in an active and sensible state;* and as the latter has been identified with the ethereal matter, or power, called *magnetic*, and both the magnetic and electrical powers have two elementary corresponding states, which, in the former, are called *polar*, so, agreeably to these relations, is *all light to be regarded as polar*, or polarised; and it may hereafter be rendered evident that this is a universal, and not a specific, attribute or property of light.

296. Upon this foundation we have built our theory of the nature and relations of light and colours; regarding light as having two states, the one sensible, and the other latent, or as *visual* and *electrical*, and not as a simple substance, but as an effect of the concurrence of a double elementary power (electral and thamal), one element of which is the active principle of light, the other passive or reactive, and to be regarded as the principle of shade or darkness; the first coincident, if not identical, with the *oxygen* of the chemists, the other with *hydrogen;* for which appellations the more appropriate names of PHOTOGEN and SCIOGEN may be substituted with regard to *light*.

297. Accordingly, the sunbeam, as it reaches the earth, is a compound of these elements of light and shade; and sunlight may be analysed, by prismatic refraction and chemical election, into *photogenic, oxidising, or whitening rays*, and *sciogenic, hydrogenising, or blackening* rays, and, at

the same time, into others that are variously composed of these elements and variously *coloured;* which, again, being synthesised by a lens, become reunited, or focal.

298. Light is, therefore, the effect of the concurrence or conjugation of two ethereal, electrical, elementary substances, or powers;* the one an agent, of which the sun appears to be the source or fountain, the other a reagent, analogous to *shade,* existing throughout planetary or atmospheric space, and thence called *sky,* from the Greek Σκια. Hence the sun's light is a species of *oxidation or combustion,* a sort of flame attended by sensible or latent heat as an effect; and all light is to be regarded as similarly constituted, and produced by the active uniting of an *oxygenic or photogenic* principle, or element, with an *hydrogenic or sciogenic* element.

299. Light has, nevertheless, been regarded, both by common and philosophic observers, as a simple substance or effect, having merely intension and remission, and not as containing in itself antagonist elements or principles.

* The received doctrine of *plus* and *minus* in electricity is entirely at variance with the true elements of general physics, and must give way to the improvements of experience and a reformed theory, to which it opposes an obstacle; for however essential simplicity may be to easy comprehension in science, it loses its characteristic when particular simplicity is opposed to that which is more general or universal, into which it introduces complexity.

300. Newton was the first who taught to regard the sunbeam as a compound of rays of various colours and powers; but still he regarded it simply as light, and its heat as accidental; for, although colours cannot be independent of light, yet are heat and light entirely distinct. Subsequent investigations have shewn that his analysis was chemically defective; he erred, also, in regarding light as composed of colours, as he did also in other respects important to art, on account of the great authority of his name.*

301. Herschel has investigated the calorific rays, or heat, of the sunbeam; but this is rather to be regarded, in accordance with Newton, as accidental, or as an effect of another sense, than as a constituent principle of light, for heat is not essential to light, nor light to heat or caloric.

302. Scheele and others have demonstrated the existence of rays of an invisible kind, accompanying the colours of the sunbeam in the prismatic spectrum, which have been variously denominated *deoxidising*, *chemical*, *phlogistic*, and *hydrogenising* rays, and prove the existence of a tenebrous, *sciogenic*, or dark principle, by which light is modified.†

303. Thus we have elements and demonstrable

* See chap. xiii., exp. i. ii. and especially exp. xiii.

† "Crell's Journal," vol. iii. p. 202; and "Scheele's Essays," p. 206.

principles in place of hypothesis, upon which to explain the various phenomena of light and colours. Accordingly, we may regard the *transient colours of refracted light*, and also *light itself*, as *Oxides of Hydrogen*, or PHOTOIDES *of* SCIOGEN, produced as species of combustion or flame, attended by heat or caloric, as remarked in the sunbeam, prismatic spectrum, &c.

304. Thus, also, are the *inherent colours of solids and liquids* to be regarded under the same analogy as *oxides of hydrogen;* or, which is the same thing, as of oxygen united with a phlogistic or inflammable element: and thus the physical cause of all colours is to be explained upon the same elementary principle and reasoning.

305. Farther, all substances, whether solid, liquid, or elastic, are *attractive* or *repulsive* of oxygen and hydrogen, of one or both, or they are *neutral* or indifferent; and all visible substances are coloured; whence the affinities of light determine it either to be wholly or partially reflected, transmitted, or refracted, or to enter into chemical combination with material substances and become absorbed.

306. From these properties and this constitution of light, through a wide experimental induction, we deduce the following propositions:—

I. That light is electrical, and consists of *two elements which are concurrent and polar;* the one positive or oxygenous, the other negative or hydrogenous.

II. Neutral homogeneous substances, or such as are in a state of indifference, *neither attractive nor repulsive* of the elements of light, are *transmissive* or TRANSPARENT, and *achromatic* or colourless.*

III. Substances *entirely repulsive* or reflective of these oxygenic or photogenic, and hydrogenic or sciogenic elements of light, are WHITE and OPAQUE.

IV. Substances *entirely attractive* or absorbent of, or having entire affinity for, both elements of light, are BLACK and OPAQUE.

V. Substances having *partial and equal affinities*, attractive or repulsive, for both elements of light, according to the proportions in which they constitute light, are partially transparent or opaque, *i. e.* SEMIPELLUCID, and colourless or GREY. Thus *White*, *Grey*, and *Black*, correspond to the *plus*, *par*, and *minus*, of electricity.

* Hitherto there has been neither physical nor rational explanation of *transparency*, every mechanical arrangement of parts being quite insufficient to account for this phenomenon. *Transparency and opacity* are physical properties entirely relative, there being no substance absolutely transparent or opaque; for glass and the diamond reflect, and leaf-gold transmits light and colour; and, as effects of vision, we have no doubt of their being chemico-mechanical qualities, transparency being indicative of perfect chemical with mechanical union, which are disturbed and wanting in all cases of opacity.

VI. If substances have *unequal affinities* for these photogenic and sciogenic elements, they are COLOURED, and transparent or opaque, according to the above conditions.

VII. If, in consequence of this affinity, a substance reflect, refract, or transmit light with *one proportion* of the sciogenic element in defect, its colour will be YELLOW; if in a *second proportion*, less deficient, it will be RED; and if in a *third proportion*, but in excess, it will be BLUE; and these primary colours, variously compounded, afford secondary and tertiary colours. Thus Yellow and Red affect the positive pole or photogenic extreme, and Blue the negative or sciogenic.

VIII. The relative proportions in which the primary colours emerge from, or enter into, the constitution of light in a neutral or achromatic state, are approximately *three of yellow*, *five of red*, and *eight of blue*, as determined by the Metrochrome, and denoted on the Scale of Chromatic Equivalents.* And as the two first belong to one extreme of the prismatic spectrum, wherein the principles of light are unfolded, and on which extreme the sciogenic element is in defect, and as the latter colour belongs to the other extreme wherein the same element is in excess in the proportion of eight, as equivalent to three and five of the other two colours, it is apparent that the two

* See Chap. XIII. exp. xxvii. and plate II. p. 26.

elements of light are equal and complementary powers, which powers, in regard to vision, we have denominated *photogen* and *sciogen*, but, in a chemical respect, oxygen and hydrogen, and, as electric, magnetic or polar, positive and negative.

307. Such, briefly, we take to be the chemical constitution and physical causes of light and colours, upon which their chromatic relations and visual effects depend; and it will accordingly be found, by reference to the first part of this work, wherein these relations are fully developed, that the present physical theory of light and colours, deduced from their chemical elements, is entirely coincident with their chromatic laws and relations; in fine, in whatever view we investigate the subject, it presents the same simple, identical, and infinite system.

308. Hencc our physical doctrine of light and colours is illustrated and supported by many additional facts, observations, and experiments of natural philosophers; among which may be noted the innumerable *dark* bands, or lines, mixed with the *light* of the solar spectrum, and abounding most at its *cold* extreme, discovered by Fraunhofer, which indicate the two prime elements of light, photogen and sciogen.

309. Again: In the *oxygenation*, or oxidisement of metals, which have been not unaptly regarded by Davy as compounds of *hydrogen*, and also in other inflammables, the inferior degrees of

oxidisement produce *Black*, *Blue*, *Green*, &c., but the higher degrees afford *Red*, *Yellow*, *White*, &c.; not uniformly, indeed, but generally, according to the unknown constitution and circumstances of the bases of these inflammables themselves.

310. So, also, in the colours of flame arising from hydrogen gas, and other inflammable substances burning in air or oxygen, we may observe at the base of the flame, in which the *hydrogen* abounds, colours tending to *Blue;* and toward the apex of the flame, where it is more *oxygenated*, its colours tend to *Yellow;* between which two colours lie the hues of *Red*.

311. The common chemical agents act with regard to *inherent* colours in a manner precisely correspondent to the present chemistry of light, in which *White*, *Yellow*, and *Red* accompany the *photogenic* or oxygenic element, and *Blue*, *Purple*, and *Black* go with the *sciogenic* or hydrogenic element; and the former colours neutralise, contrast, and compensate the latter, and *vice versâ*, as we have seen.

312. Accordingly, Red, Yellow, and White, are affected by oxygenous and acid chemicals; and Blue, Purple, and Black, by hydrogenous combustibles and alkaline substances and agents. These also are similar antagonists; whence, again, Acids convert the vegetal greens and blues into reds and yellows, and Alkalis change vegetal reds to purples and blues.

313. But as colours, according to an ancient theory, are *shades of light*, as we hold them to be *Sciodes of Photogen*, or chemically *oxides of hydrogen*, and as metals are regarded by Davy as hydrogenous; so, by the union of oxygen with metals, are produced oxides of every possible variety of inherent colours, corresponding with the transient colours of light and the whole chromatic scale, in strict relation and analogy also to the chemistry of light; the metallic oxides affording the *light or photogenic* order of colours in proportion to their oxidisement, and also the *dark or sciogenic* order, according to the degrees of their hydrogenisation or carbonisation, until it terminate in Black, or absolute reduction to the metallic state, or perfect hydrogenisation, according to the suggestion of Davy.

314. Again, in the general and more permanent changes which pigments and natural colours undergo, *oxygen bleaches or lightens* them, and *hydrogen deepens or darkens* them; while light and air, containing both elements, effect both these kinds of change variously, according to affinities already spoken of; and the colours of all organic bodies, even to the plumage of birds and insects, depend on the same elements, and we have found them subject to the same chemical changes and affinities uniformly.

315. Upon this analysis of light depends the true explanation of refraction, by transparent and

inflammable bodies, whereby the sunbeam is decomposed chemically and electrically, *photogen* and *sciogen* developed, and colours elicited from their various combinations, as above shewn, and hereafter demonstrated according to optical laws; together with the powers by which coloured bodies variously absorb and fix the photogenic and sciogenic elements of light.

316. The natural philosophers having regarded *darkness* as the negation of light only, has occasioned the *sciogenic* element which is inherent in light to be overlooked; but no mere *negation* can produce the *positive* effects of darkness, such as the chemical changes which take place on pictures, and in oils, resins, and colours subjected to darkness, producing various hues of brownness and blackness.

317. Ancient philosophers, it is true, explained the production of colours by a mechanical hypothesis of the union of light and darkness; but this, although true in a chemical respect, is mechanically false,—the mechanical mixture of light and dark affording only *neutral shades*, whilst their various chemical combinations produce *hues and colours*, the first being a sensible mixture, the latter a latent composition. In the former respect, therefore, modern philosophers are justified in rejecting this doctrine in its ancient acceptation.

318. As light is a *chemical substance*, electri-

cally constituted, and polar, having a *positive* and *negative* element, whatever action throws neutral light into an electrical state, or polarity, separates its elements, totally or partially; in the latter case affording colours, and in the former developing *photogen* and *sciogen*, or light and shade.

319. Now in passing through variously refracting media,—such as prisms, lenses, and lensic prisms, and thin bodies of varying densities, &c., such as air, glass, and various crystals,—light is decomposed and variously reduced toward its latent, elementary, electrical, or polar states, by the separation of its *photogenic* and *sciogenic* or polar elements, during which *colours* are evolved according to the various degrees of the decomposition; *Blue* passing to the one pole or extreme, and containing most of the sciogenic element, and *Yellow*, followed by *Red*, proceeding to the other pole, and retaining most of the photogenic power.

320. And this polarising effect of prisma and lenses is the more powerful in proportion to the greater inflammability and density of their refracting substances; for such abound with the hydrogenic or sciogenic element which elects, or attracts, from light its oxygenic or photogenic element with predominant affinity.

321. It is according to the same law that, when light is repeatedly *reflected* diagonally, from various surfaces, through angular or prismatic spaces, it becomes *polarised*, and *specular or catoptric*

colours are produced.* Thus whatever disturbs the balance of the elementary or polar principles of light, denoted by the terms photogen and sciogen, produces or evolves colours.

322. This chemistry of light is admirably illustrated by, at the same time that it accounts for, the effects of the beautiful novelty of *photogenic painting*, so ingeniously accomplished by M. Daguerre, Talbot, and others, wherein sunlight reflected from an object cast by a lens upon paper prepared with chloride of silver, forms an image thereof, in which "the parts upon which no light falls will remain *white*; the portions, on the other hand, strongly illuminated, will become completely *black*; the demitints will be represented by *greys*, more or less dark."†

323. According to the same chemistry we may account for the variety of colours so beautifully displayed in vegetal and animal nature, and principally in flowers, which acquire their colours as they expand, and undergo all the relative changes of hue and tint in their progress and decay, which the immediate combination of these chemical agents may be made to produce in the laboratory of the chemist.

324. Upon the same principle may be easily explained the production or evolution of the *trans-*

* See Chap. XV.

† Dr. Meme's Daguerre's "History of Photogenic Drawing," &c. p. 10.

ient colours of refracted light, &c. Thus photogen or oxygen, and sciogen or hydrogen, having different affinities or activities in the luminous compound light, are unequally affected or resisted in passing through transparent bodies according to the various constitution of such bodies; and, consequently, they are unequally refracted,—the oxygenous, or more active photogenic element, being less so than the hydrogenous or sciogenic; the refraction of hydrogen being about six and a half times more than that of oxygen when they are of equal densities; and being thus variously dispersed and compounded in their passage through prisms, lenses, &c., they produce or evolve the variety of colours. In like manner may the electrical and magnetic phenomena of the atmospheric regions exhibiting colours, as in the aurora borealis and australis, &c., be explained by the same chemic theory.

325. Newton had remarked that inflammable or *hydrogenous* substances refract light more powerfully than other substances, and that the diamond did so most of all; whence he framed the admirable conjecture, since proved, that the diamond itself is inflammable. By a like analogy we may infer that, as non-inflammable substances refract light but weakly and with faint colours, it is probable the *oxygenous* element predominates therein, or that they are oxides, which accords with the brilliant discoveries of Davy; and as various substances

have not only various powers of refracting or bending the course of the elements of compound light, and therefore various powers of separating or dispensing colours therefrom, the chemistry of light and colours here advanced affords the most satisfactory theory of visual and chromatic phenomena as effects of the *photogenic* and *sciogenic* elements of light, which are identical with the oxygen and hydrogen of palpable chemistry. Whence we have ventured an explanation of the chief cause of durability and fugacity of colours and pigments upon these principles in another place.*

326. Thus *colours* are *shades* of light, and our theory reinstates, in a corrected sense, the ancient doctrine of light and colours, which has been for a time superseded by the beautiful, ingenious, and plausible system of Newton, which could be no more demonstrated mathematically than a geometrical theorem could be substantiated chemically or physically, neither of them belonging to the category of the other, nor being connected by legitimate analogy. Nor does it derogate from the just reputation of the prince of mathematicians and sovereign of astronomers, that he may not have been either a physician or a philosopher in the genuine sense of these appellations.

327. Again, VISION and its various phenomena,

* "Chromatography," p. 96.

physically regarded, are to be explained according to the same chemical theory, for nature is, throughout, elementarily simple and uniform. Accordingly, if the eye, by the agency of the retina and optic nerve, have *equal affinities for the* PHOTOGENIC *and* SCIOGENIC *elements* of light, it will at once discern their intensity or power in *light* and *shade*, and also their various subordination in *colours*.

328. To conceive this operation of vision clearly, we have only to regard the sensible or nervous power of the visual organ as a secretion of these elements of light accumulated, as it were, electrically by a machine, in a latent state, ready to recombine sensibly with their antagonist principles in external light, when reflected from external objects, under the various appearances of light, shade, and colour, whereby this organ becomes variously affected and exhausted; and we well remember having once, in the full strength of the organ, so entirely exhausted its power by long-continued exertion in writing on white paper, that sudden blindness and darkness ensued, and although, after closing the eyes for a short time, vision returned, with renewed secretion, we have since avoided such extreme exertion.

329. This may serve to account for the incapability of vision when the eyes are suddenly removed from darkness to light, or from light to darkness; while defective secretions of the organs may ex-

plain the various defects and disorders of vision with regard to colours, and the use and abuse of coloured spectacles, and other remedies thereof.

330. This theory of vision, deduced from our chemistry of light, resolves perfectly also the curious phenomena of OCULAR SPECTRA, in which the eye discerns those adventitious or accidental colours (variously interpreted by different writers, and first especially treated of by Dr. Jurin *) which have no apparent cause out of the organ itself; for the balanced affinity of the eye for the two elements of light and colours is, of course, destroyed by the action of any colour in which either of those elements predominates, such predominating element neutralising or exhausting its own proportion of the opposite or antagonist element in the organ, while the other element remains free, or accumulates therein during the act of intent vision, and, therefore, the organ decomposes, by a due election, the light of objects to which it wanders, and affects them with an opposite colour, till the balance of elements in the organ becomes restored.

331. Accordingly, the spectrum or adventitious colour occasioned by any coloured object, attentively viewed, is always of the opposite hue, or that compensatory contrast or harmonic colour which re-

* In an essay "On Distinct and Indistinct Vision," with plates, appended to Smith's "Optics," although similar effects had been noticed by Boyle, Kircher, and Aristotle.

stores the equilibrium or neutrality of light and vision, of the laws of which, and their fundamental application to chromatic harmony, we have amply treated in our third chapter, and throughout this work.

332. A single case of these well-known experiments may suffice for illustration here:—thus, if a large *red* wafer be laid on a sheet of white paper in the full light of a window, and actively viewed with undeviating eyes during a few seconds, and the wafer be then removed, a *green* spectrum of the size and shape of the wafer will occupy its place on the paper, or may be seen in any other part of the paper to which the eyes may be directed. And if any other coloured wafer be substituted for the red, by an invariable law of nature, the colour of its spectrum will be of its opposite hue or contrast, as expressed on our scale of chromatic equivalents.

333. This effect of any colour intently viewed, in producing its opposite or compensatory colour as an ocular spectrum; the effect of any two colours of the prismatic spectrum, when cast separately and simultaneously into the two eyes, in producing a compound sensation and single colour in the observer;* the effects of colours contiguously contrasted in balancing or subduing each other by a similar affinity; the like effects of transparent colours in glazing or mixture in painting; the har-

* Experiment XIV., following.

monising influences of colours, and the whole machinery of equivalence in all its forms, as displayed throughout this work,—are all explicable upon the electrical and polar affinities of these elementary principles of light and vision.

334. That the visual organs do secrete these elements of light, and hold them in a latent state ready for the acts of vision, according to their affinities with the elements of external light from outward objects, is evinced by many phenomena; such, for instance, are the light and dark circles which appear when the side of the closed eye is pressed, the spark elicited in the operation of couching upon puncturing the retina, and the powerful action of light upon the eye, which may have been long secluded from it.

335. We may thus account easily for that temporary blindness which succeeds gazing on the sun or any powerful light, as an effect of sudden exhaustion of the matter of vision. Thus, also, that kind of nyctalophia which occurs in tropical climates, which comes on at the close of the day, and goes off as it advances, appears to arise from defective secretion or excessive exhaustion, being attributed to diseased digestion, or the power of the sun's light, and cured or relieved by seclusion from light during day; while that kind of nyctalophia called moon-eyed, which is common to the Bushmen of Southern Africa, who sleep out the day, and are blind when the sun shines, but, like feline animals,

see well in seeming darkness, may well be supposed to arise from redundant secretion or defective excretion of these principles of light and vision.

336. We may explain thereby, also, more to our present purpose, why the brilliancy of colours declines upon long viewing them, especially in a strong light, owing to the exhaustion in the organ of one of the elements, inducing an antagonist action or spectrum, and also why the eye receives satisfaction in every case of harmonic combination of colours.

337. The eye itself, the organ of vision, presents in its mechanical structure some remarkable coincidences with the present physical doctrine; thus, it has three visible parts,—the pupil, *black and transparent*, the sclerotis, *white and opaque*, and between them the iris, *semitransparent and of all colours*; and they form three concentric circles on the face of the eye, and possess the three powers of transmitting, refracting, and reflecting light. In its internal structure, too, there is a numerical conformity of the three humours, aqueous, vitreous, and crystalline, as there is also in its three coats, the cornea, choroides, and tunica ruichi, &c.

338. Although modern opticians have taken no account of the agency of the eye in the phenomena of light, shade, and colours, and have regarded them solely as external effects of light, it is perfectly consistent with the present theory that there are two modes of obtaining colours by the refraction of

prisms, &c., by one of which the eye converts the light and shade of its objects into colours visible to itself only; the other, by which external light is itself distributed by a prism in colours on a screen, visible also to the eyes of others. The first of such colours, therefore, belong to the agency of the eye and sensorium alone, while the latter is external, and belongs to the agency of light, of which sufficient evidence will be adduced in the following chapter.

339. A knowledge of these elementary powers and effects of light, colours, and vision, is equally interesting and essential to the artist, the physician, and the optician; in fine, the physiologist may thence take a hint toward a physical interpretation of all sensation in the nervous system, of its double office, and of the union of all sensible impressions in the sensorium or brain, as a link of identity or connexion between the physical and metaphysical world.

340. To conclude, we know not whether this attempt to interpret the physical causes of colours, light, and vision, chemically, may satisfy other minds, but of these we are entirely assured, that the first elements of things are powers, and not particles, that the modern corpuscular and undulatory doctrines, with all the mathematical and mechanical explanations hitherto employed, are totally incompetent to the solution of these phenomena, and that all the hypotheses they have afforded, like those

which they superseded, must ultimately fail at the foundation, however ingeniously supported, incapable even of answering the inquiry of the poet:—

> "Why does one climate and one soil endue
> The *blushing poppy* with an *orange hue*,
> Yet leave the *lily pale* and tinge the *violet blue?*"
>
> M. Prior.

341. One of the best and most ancient of these hypotheses was that of Empedocles, the Pythagorean, from which school have emanated some of the most refined and important modern systems. In the "Theætetus" of Plato, Socrates is introduced speaking thus:—"Let us follow what we just now said, establishing *nothing as essential one thing*, and thus *black* and *white*, and any *other colour*, will appear to us to be generated from the *darting forth of the eyes* to a convenient lation. And every thing which we denominate *a colour* will neither be that which *darts forth*, nor that which is *darted forth*, but something *between these*."

And in another place Socrates is made to define colour as "*the flowing off* from figures [objects], *commensurate with the sight*, and *by that sense perceived*."—Sydenham's "Meno of Plato," p. 49.

342. Plato, as we learn from his life by Olympiodorus, was "conversant with *the painters*, from whom he learnt *the mixture of colours*," his doctrine concerning which is delivered in *the Timæus*, but that he was not acquainted with their true nature

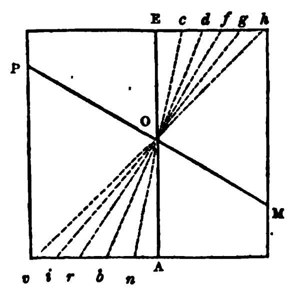
and relations is evident from the following concluding remarks upon their mixture or composition:—"But if any one undertake the investigation of these for the sake of the things themselves, such a one must be ignorant of the difference between a divine and human nature; since a God is indeed sufficient for the purpose of mingling many things into one, and of again resolving the one into many, as being at the same time both knowing and able; but there is no man at present who is able to accomplish either of those undertakings, nor will there ever be one in any future circulation of time."—"Timæus," p. 543.

343. It is apparent therefore how abstruse Plato regarded the systematic union and relations of colours; but as to the Pythagorean doctrine above, it wanted nothing but a just application of the discoveries in modern chemistry and physics to render it as consistent and intelligible as the magnificent solar system of the same philosophy has been by Copernicus and Newton.

344. Malebranche, also, in a short "Treatise on Light and Colours," which he first presented to the world in the English version of his celebrated "Research after Truth," in 1700, not long previous to the first edition of Newton's "Optics," propounded a difficulty concerning colours which he was unable to solve upon atomic or Cartesian principles, and regarded, like Plato, as insurmountable. Nor are we aware that any subsequent philosopher

has either noticed or encountered it, and therefore it remains for solution.

345. His question is, "*How ten thousand rays of different colours, which cut one another in one physical or sensible point, transmit through the same point all their different impulsions to the eye?*" He adds afterwards, "*Which appears to me so great a difficulty as that none but the true system of the world can entirely dissipate and resolve;*" and he thus illustrates his problem: "Let A, P, E, M, be a chamber painted with a great variety of colours, as opposite as may be; that is, let there be White at A, next to Black at *n*, Blue at *b*, next to Red at *r*, Yellow at *i*, next to Purple



at *v*. From all these points, A, *n*, *b*, *r*, *i*, *v*, let lines be drawn, all cutting in one common point O, and let an eye be placed beyond it, as in E, *c*, *d*, *f*, *g*, *h*: all these different colours will be seen through the same point of intersection O. And since this figure represents only one row of colours, whereas we must imagine as many as there are visible points in a sphere, the point of intersection O must receive and transmit an infinite number of different impressions without destroying one another."

346. The wonder of this curious problem, and the chief difficulty of its solution, seems to us to lie in the assuming that light and colours consist of *rays* and *atoms*, or *revolving globulæ*; nor does it relieve, but only more entangle the question, to attribute *vibrations* and *undulations* to such rays and atoms, according to more recent hypotheses, for all these are mathematical fictions assumed for illustration, and utterly without physical or logical proof, while they are certainly incapable of qualifying various coloured lights for simultaneous uninterrupted transmission through the same point.

347. By setting aside these inadmissible conditions, and granting, as we must, that the eye is not merely passive, but concurrent in its own office of vision, as we have endeavoured to shew, the difficulty of conceiving the power of vision extended to any variety of colours through the same point or space without interference or confusion, according to the fact, will be overcome.

348. In such case, the various proportions of the principles of light which afford colours, being supplied by the object at *v*, *i*, *r*, *b*, *n*, there will be as various a concurrence of the eye, producing coloured vision at *h*, *g*, *f*, *d*, *c*. How the consciousness of the mind becomes affected, is a question for another science.

CHAPTER XIII.

OPTICAL CHROMATICS.

THE CHROMASCOPE.

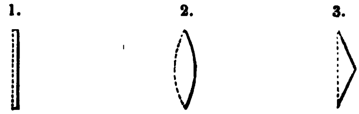
349. There are three species of optical effects of colours; that of the *refraction* of prisms and lenses,—that of the *transmission* of light through transparent media,—and that of the *reflection* of specula, &c.

350. We have accordingly adapted several instruments, in these respects, to a variety of experiments illustrative of the preceding and general doctrine and philosophy of light and colours, the chief of which instruments are the *chromascope*, adapted to the achromatism and chromatism, or synthesis and analysis of light by refraction,—the *metrochrome*, designed for the commixture and commensuration of colours by transmitted light,—and the *catoptron*, suited to confirm the principles and relations developed and demonstrated by means of the former instruments from effects of reflected light and colours.

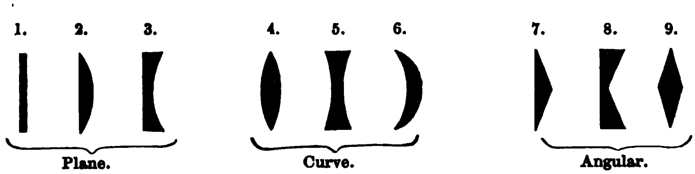
351. We proceed, therefore, in the next place, to the description and uses of these instruments, and first of the CHROMASCOPE, for the understanding of which some previous description of the forms of which optical glasses are susceptible will be necessary.

352. Of optical glasses, prismatic, lensic, and specular, there are three determining original forms, coincident with the three primary plastic forms or figures of geometry:—1, the *plane*, 2, the *spheric*, and 3, the *angular*; *i.e.* in sections thus:

1. 2. 3.



And these simply conjoined or compounded afford all the other forms of lenses; whence follow, 1, the *plano-plane*; 2, *the plano-convex*; 3, the *plano-concave*; 4, the *convexo-convex*; 5, *the concavo-concave*; 6, the *concavo-convex*, or *meniscus*. These are common forms, to which may be added the *prismic*, which partake of all these forms, as instanced in the following sections, 7, 8, 9, &c.



And these forms are farther capable of that infinite variation of composition and gradation which terminates their genera in the cube, tetrahedron, sphere, &c.

353. Of such glasses, the angular are of chief importance in chromatic optics, and they are susceptible of all the variety of forms of lenses and specula; *linear*, as in the common prism, 2, *lensic*, as in the lensic prism, and 3, *annular*; and may accordingly be plane, convex, concave, or composite, infinitely, in the manner of, and in composition with, lenses and specula, &c.

354. It is apparent, also, that,—as lenses, hitherto formed upon the curve, may be combined with the prism, as in the lensic prism, more particularly to be described, and as they may also be combined with cylindrical form in a similar variety,—the forms of optical glasses comprehend all the variety of secondary figures, *prismatic conical*, and *cylindrical*, and their compounds.

355. And thus much we have preliminated concerning the forms and figures of which optical glasses are susceptible, for the better understanding of the nature and variety of the LENSIC PRISM, which is new in optics, and of the effects of the *chromascope*, which instrument is dependent thereon. To the learned optician it is unnecessary to mention that the third elementary form of lenses has been totally unknown or unnoticed, and unemployed, from the earliest times of the science; which circumstance has probably occurred from inadvertence to the true geometrical elements of figures.

356. The common triangular glass prism has been consecrated to science by the genius of Newton, as the instrument which, while it exhibits the beauties and wonders of light and colours, unfolds also the mystery of their union and separation; * it has accordingly held a principal place among the instruments of the natural philosopher, unvaried and unimproved to this day.

357. It is geometrically evident, notwithstanding, that as the figure of the common prism is generated by the rectilinear motion of a triangle, so it is capable of infinite variation, according to figures generated by a circular, angular, or compound motion of a triangle. Accordingly, by the motion of

* Nothing is either above or beneath the attention of the true philosopher. The mind of Newton was too great to despise even the toys of children; *soap-bubbles* blown from a tobacco-pipe, and the triangular *prism*, long before known as a toy under the appellation of *Fool's Paradise*, became in his hand simple, yet mighty instruments of science. The splendour of the colours afforded by the prism had, indeed, at all times attracted the attention of philosophers, and had been especially under the observation of Newton's immediate predecessors. Digby had accurately described them in 1644, in his treatise on bodies, and theorised thereon, on Aristotelian principles, with nice discrimination, founded on the curious experiments of a Mr. Hall of Worcestershire, who had written a work on luminous colours, of which we have not been able to find any other trace; although, coincident herewith, some announcement of a publication on the same subject, by a Mr. Hall of the same county, lately appeared, but whether this latter had any connexion with the former we are unable to tell.

a triangle A B C, fig. 1, pl. IX., round one of its sides A B, as an axis, is formed, as it were, a circular prism, which, from its uniting the properties and figures of a lens with those of a prism, may be called a LENSIC PRISM, or double convex PRISMATIC LENS A B C D, and fig. 4., A B I K. Again,—by a like circular motion of a triangle E F G, fig. 2, upon the angle F, which corresponds to the angle of refraction in a common prism, will be generated a similar double concave *lensic prism*, opposed to the above, E F G H, and fig. 4, U K I T.

358. The figures above mentioned are sufficient for the present purpose, yet it is evident that they are extremes, between which lie an indefinite series of intermediate figures, and that there are innumerable others, both conical and annular, generable upon the boundless variety of figure and motion. It is obvious also that *prismatic specula* may be constructed upon the same principle, which will afford by reflexion optical effects analogous to those of these lensic *prisms* by refraction. We thus produce new *secondary optical powers*, the *primary* species of which are the *lens*, the *speculum*, and the *prism*, adapted to the three general habits of light by which it is *transmitted*, *reflected*, or *refracted;* whence arise the various powers of artificial vision, and the wonderful effects of all optical instruments.

359. To facilitate the use of these *lensic prisms*,

Fig. 1.

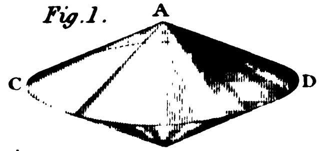


Fig. 2.

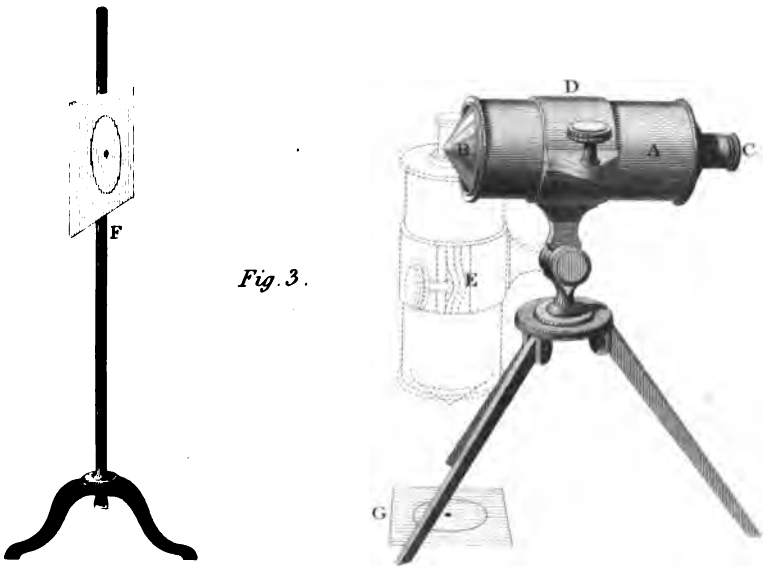
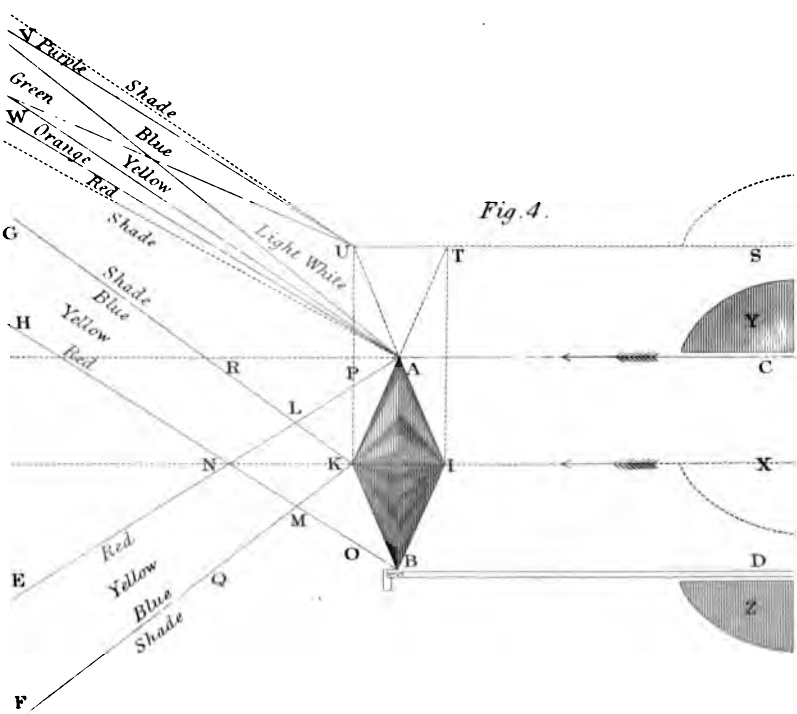


Fig. 3.

Fig. 4.



W. A. Beever. sc.

in a variety of experiments, the CHROMASCOPE has been constructed, of which the following is a brief description.

A, fig. 3, pl. IX., represents the brass tube of the chromascope, nearly two inches in diameter, and about five inches long; at one end of which is fixed, by a screw-collar, the plano-convex, or other lensic prism B; and at the other end is a small sliding tube, about two inches long and half an inch in diameter, for holding an eye-glass of seven-inch focus, or occasionally small lensic prisms; and, as a guide for the eye to the centre of the principal tube, it is fitted with a screw-cap having a small perforation at C.

The whole is held by, and slides in, the short tube, or collar D, connected with a supporting tripod, having a universal joint, by which the chromascope may be turned from the horizontal position to the vertical, dotted at E, or otherwise elevated at any angle, or in any direction, for viewing objects, G, on a table, or on a portable screen or tablet F, &c.

360. This description of one form of the chromascope will be sufficient for a clear comprehension of the following experiments.

EXPERIMENT I.

In the centre of a white card, six inches square at least, form a black spot $\frac{1}{20}$th of an inch in diameter. Place the card upon the table G, fig. 3, pl. IX., in sunshine, or a clear light near a window, and so adjust the chromascope over it, in a vertical position, that the spot may be close to, and concentrical with, the lensic prism; then (having removed the lens of the eye-piece, which is unnecessary in this experiment) gradually sliding the chromascope upward, looking at the same time through the tube, the spot will appear to expand, and become refracted into a beautiful annular spectrum, or aureola of the three primary colours, resembling a rainbow, as represented pl. I. fig. 1.

If now, under these circumstances, a concave lensic prism, pl. IX., fig. 2, of the same refractive power as that of the convex prism of the chromascope, be interposed between it and the object, the aureola will be, by a counter refraction, reduced to a black spot at the centre.

361. REMARKS.—It would be difficult to account satisfactorily for the production of colours in the above experiment by analysis of simple light, since the coloured spectrum would vanish if the spot were removed. It is to be presumed, therefore, that the principle of shade from the spot concurs with the principle of light from the ground, by the medium of the lensic prism, in producing the circular iris. This is apparent also from the next experiment. It is necessary, therefore, to restore the ancient doctrine of the derivation of colours from light and shade, or black and white, which

dectrine passed to the schoolmen from Aristotle, who improved it from his master Plato, who acquired his knowledge of colours, it is said, from the philosophic painters of Greece. From the schools it passed to Kircher, Des Cartes, Hall, Digby, and others immediately preceding Newton, who, adopting the number of seven colours, derived the whole erroneously from light alone.

362. This concurrence of *shade* with *light* is demonstrable in all similar effects of prisms and prismic lenses in which coloured spectra are produced, although no account has been taken thereof, such phenomena having been attributed to the sole effects of light. Nevertheless this concurrence is remarkable in the experiments of Newton, "Optics," b. III. obs. 6, on the inflections of light and their colours, and it affords easy explanation of all the experiments and observations contained in the third book of his "Optics," and particularly obs. 6.

363. Opticians regard the motion of the sun's light as propagated in parallel rays, and attribute the like parallelism to other lights, abating always the diameter of the light, and this may be very allowable for argument as a mathematical fiction, but cannot be maintained as a fact; for light is an infinite agent, diffusing itself expansively from every point, till utterly expanded, or expended, in darkness, the patient of light, according to its various affinities; and to this we owe the penumbra

of shadows, and all the effects of transient colours, from prisms, lenses, and specula, and of colours meteorological and spectral.

364. Of the optical, dynamical, and mechanical relations of light and shade, so far as respects the present inquiry, we need only briefly remark that the motion or action of light is either *direct*, *reflect*, or *inflected*; that the DIRECT LIGHTS of the sun and moon are always, optically, regarded in straight lines nearly parallel to each other; that artificial lights diverge from themselves as centres in radii, and all lights partake of the colour of the medium through which they pass; that, of REFLECTED LIGHT, the angles of reflection are always equal to the angles of incidence, and partake of the colours of the reflecting surfaces; and that REFRACTED LIGHT, in passing through transparent media or by opaque objects, whether it be direct or reflected thereto, becomes always inflected with a developement of much or little colour, and that the shadows of light, in every case, are the chromatic equivalents of such light.

365. Sir Isaac Newton justly regarded light as a material substance emitted from luminous objects, and, therefore, subject to attraction and repulsion by other material substances, so as to be variously diverted from its natural direct course or motion; which hypothesis of Newton may be considered as confirmed by the discoveries of the celebrated chemist Scheele, and others, who have satisfactorily

proved the existence of a compound structure of the matter of light, and exhibited its elements, with their chemical relations or affinities.

366. Upon this hypothesis Newton established three dynamical laws of light as material; to this effect:—

1st. That, in passing through the same medium, the motion and rays of light proceed in straight or direct lines.

2d. That their angles of incidence and *reflection* are in the same plane and equal.

And 3d. That the angles of incidence and *refraction* are in the same plane, and their sines bear an invariable ratio to each other in the same medium.

367. But the physical cause of this motion of light, whether it be *transmitted* through, *reflected* from, or *refracted* by, and combined with other substances, is not mathematical, but chemical; and hence the effects of *transparency*, *opacity*, and *colours* of light dependent thereon, are to be explained properly, not by mathematical and mechanical, but by physical and chemical laws and relations, as we have already attempted.

Experiment II.

368. If the preceding experiment be performed with a *white spot upon a black* ground, in place of the black spot upon a white ground, a similar

spectrum of the same colours will be produced, in which the orders of the colours will be inverted; the *blue* in each case lying toward the *black*, and the *yellow* toward the *white*; the *red* being intermediate in each. See Chap. I. "On the Relations of Colours;" and pl. i. fig. 2.

369. REMARKS.—Various doctrines have prevailed respecting *the number of the primary colours*, there being authorities for from *one** to *seven*; but the last, having been a favourite number, and being sanctioned by Newton, and sup-

* The late Governor Pownall maintained the doctrine of *one* only primary colour, viz. *red*. Orange and yellow he held to be declining reds, and blue to be a privation of light, &c.—"Phil. Mag." vol. xxii. p. 3. But Goëthe has inverted this doctrine, and assumed the *yellow* and *blue* to be two extreme primaries, which, conjoining, form or afford red.—Goëthe's "Theory," p. 279.

Dr. Hooke (as also lately conjectured by Dr. Prout) held also that there are only *two* primaries, red and blue, of which all other colours are composed.—"Micrographia," p. 64. And J. Scheffer, in his "Arte Pingendi," 1669, distributes colours into two classes, *simple* and *mixed*, and distinguishes the first triply into red, blue, and yellow, thus,—"Simplices colores numero sunt tres: rubeus, cœruleus, et flavus;" and adds, "Et sociabiles cunctis, Lux, id est, Albus, et Umbra, id est, Niger." § 44, p. 158.

Indeed this was the authorised doctrine of the schoolmen, and is recorded by Father Kircher, Digby, and others, previous to the time of Newton, all derived from the same Grecian source.

Scheffer treats also, under the above head, of the disagreement of the learned, preceding his time, respecting the number of the primary colours—whether three, four, or five.

ported by the apparent cogency of his attempt to demonstrate the geometrical analogy of these seven primaries with the diatonic octave of modern music, has been most generally received. If, however, the coincidence of the three colours, *blue*, *red*, and *yellow*, with the consonance of the primary triad C, E, G, of the musical scale, be the true foundation of such analogy; and if it be demonstrable that all other colours may be composed of these three, and that only is primary and elementary which cannot be composed, as is the case with these three colours, then are they the only true primary colours; and as such they are recognised by the artist, as they were also by the ancient Greeks, according to the testimony of Aristotle.* Thus Homer designates—

> "Jove's wondrous bow, *of three celestial dyes,*
> Placed as a sign to man amid the skies."
> Pope, *Homer's Iliad,* b. xi. v. 37.

Milton, too, if poets may be thus adduced, alludes to the rainbow in these words:—

> "A *dewy cloud,* and in the cloud a *bow,*
> Conspicuous with *three listed colours* gay."

And Damascius uses this comparison: "As the uniform colour of the sun appears in a cloud which possesses *three catoptric intervals,*

* Opp. 1629, vol. ii. p. 575.

through the various-coloured nature of the Rainbow."* [393].

370. The late Dr. Wollaston, however, controverted both these grounds of doctrine, and pronounced the number of the primary colours to be *four*, because, on looking through a prism at a beam of light, ten or twelve feet distant, in a darkened chamber, he saw distinctly that number of colours; had he chanced to have viewed the light within an inch or two of its source, and had then gradually receded, while looking through the prism, he would have discovered that his fourth primary, *green*, arose from the crossing of blue and yellow.

371. Had Newton, too, examined his spectrum near its egress from the prism, he would have perceived that his *green*, *orange*, *violet*, and *indigo primaries*, arose from similar crossings of blue, red, and yellow rays; and natural philosophers will be compelled, however tardily or reluctantly, to admit that there are in nature three primary colours only, conformably with the theory and practice of the artist. Sir David Brewster has indeed recently adapted the Newtonian principles to this number.

372. Professor Wünch, of Frankfort-on-the-Oder, published a theory to prove, in opposition to Newton, that light consists not of *seven*, but of three primary colours—*red*, *green*, and *violet*. He

* "Excerpta ex Damascio, à Wolfio," p. 232.

remarked that, by mingling prismatic streaks of red and green, a *bright yellow* secondary is produced; by mingling green and violet, a *bright blue*, &c. There is such a perverse ingenuity in this doctrine, it is founded on so singular a delusion, and is so remarkable an instance of the involution of truth and error, as to merit a particular exposition.

373. First, then, *it is true that there are but three primary colours;* but green and violet may be composed, and therefore they are not primary. It is *true, again, that the green and red rays of the prism may, in confluence, produce or yield a yellow;* but for no other reason than because yellow, which is a component of green, and accompanies the warm red of the prism, is in excess or predominant in the mixture: otherwise red and green, duly proportioned, neutralise and extinguish each other, so that light would pass through or from them colourless. *It is equally true, that the green and violet of the prism mingled afford a blue;* because blue occurs in the composition of both these colours, it is therefore in excess, and predominates over the neutral portion of their mingled red and green rays. Upon the same principle may the entire doctrine of this author be confuted, except only with respect to the *number* of the primary colours.

374. Goëthe, like Professor Wünch, has attributed *pure red* to the union of *orange* and *violet;*

but red exists ready formed in both these colours. He assumes, also, *two reds*, one produced by mixing, which he calls an *existing red*, and another which may be called *non-existing*, for it is compounded of *blue* and *yellow ; i. e.* he augments or deepens both these colours, till he gets a *blue*ish red, and a *yellow*ish red, and then, by mixing them, gets what he calls an *intense and pure red*, but which ought to be a dirty or *green red!* that is, no positive colour at all: for blue and yellow compose green, and green and red are complementary. Goëthe, however, contrives to use these secondary reds as a primary colour in composing all other hues.

Such a foundation leads, apparently, to endless absurdities; for if yellow, by darkening or deepening, become red, red by diluting would become yellow; and if blue by darkening become also red, then red by diluting would become blue. — See Goëthe's "Theory," p. xlii. p. 279; No. 705, 801, &c. Such mistakes lead to confusion in theory, and to error in practice.

EXPERIMENT III.

375. It is not necessary that the objects and grounds, opposed in the preceding experiments, be black and white to produce a coloured spectrum; it is sufficient that they be *lighter* and *darker* with reference to each other; nor is it necessary that

they be not coloured, since a *blue*, *red*, or *yellow spot*, upon a ground lighter or darker than itself, yields, in the manner above described, a coloured spectrum, as in the preceding experiments; in which, notwithstanding the particular colour of the spot itself predominates, each of the primary colours appears distinctly. If, also, a *grey or coloured spot* be formed on the line of division of *a ground half black and half white*, and be viewed in like manner, a circular spectrum will arise in the opposite halves, of which the order of the colours will be inverted and opposed.

REMARKS. — The coincidence in these effects of coloured spots, with the consonances of the primary triad in every musical sound, demonstrated by Mercennus and Dr. Wallis, is remarkable. They illustrate also the natural relations, according to which colours rule and harmonise each other. See Exp. VII. and XIII. See also Examples XV., XVII., and XIX. &c.

EXPERIMENT IV.

376. If, instead of a spot, an O, or *small circle*, be viewed with the chromascope, adjusted as in the foregoing experiments, *two* concentric, annular, coloured spectra, resembling the above, will appear; and if two or more concentric circles, not exceeding the diameter of the lensic prism, be so

viewed, the number of the annular spectra appearing will, by an effect equally beautiful and surprising, be *double* the number of the circles viewed, in consequence of the circles being circularly refracted.

EXPERIMENT V.

377. That the above affords the true explanation of the double spectrum, we may be convinced, by viewing, in like manner, a narrow circle circumscribing a broad spot, fig. 1 below, in which case the single iris, or spectrum resulting from the spot, will appear between the two irides of the circle; there are, therefore, a double incidence and double refraction produced, the one prismatic or angular, the other orbicular or circular, whence the magnitude of the spectra of this instrument in comparison with those of the common prism.

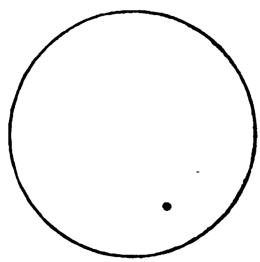
FIG. I.

EXPERIMENT VI.

378. If a circle, fig. 2, following, of not less than an inch diameter, and not exceeding the diameter of the lensic prism, be viewed as before in sunshine or a strong light, but with the chromascope gradually raised till the prism is rather more than the diameter of the circle above it, a circular spectrum will appear expanding as the instrument rises, but

not *two*, as in Exp. IV., because the second iris, being beyond the field of vision and angle of refraction of the instrument, never enters it. The visible spectrum of this experiment is however more beautiful and brilliant, and the primary colours more distinct and better defined therein, than those of the spot and smaller circles are, owing to a more perfect refraction of the object.

FIG. II.



379. REMARKS.—The spectra in these experiments will not afford perfect circles and distinct colours, unless the glass of which the lensic prisms are formed is perfectly free from veins, and of uniform density. Native crystal gives perfect circles, but refracts with too little power to afford well-coloured spectra. Perhaps the diamond alone would yield perfect lensic prisms both for the form and colour of the spectra; and such prisms, however small, would afford beautiful aureolas, and become effective ornaments set in jewellery. It remains also to be tried what would be the effects of these lensic prisms when constructed of other transparent substances, solid and liquid, such as

salts, resins, &c.; and of Iceland crystal in particular, which has the property of double refraction, and when formed into triangular prisms of the common shape, produces sixfold, and, by combination, other multiple refractions. This property of Iceland crystal, and other substances observed by Newton, and illustrated by Martin, remains hitherto without satisfactory explanation.

Experiment VII.

380. Instead of the *black* circle, fig. 2, let similar circles be formed of the purest prismatic *blue*, *red*, and *yellow* colours; and let each be viewed in the manner of the last experiment, when they will severally afford a spectrum each of the three primary colours; in which, nevertheless, the particular colour of the circle viewed will be predominant. These experiments may be varied and multiplied, by employing *circles* in the previous manner of *spots*, and changing their grounds, as in Exp. III., and with increase of beauty and effect.

381. Remarks.—In Exp. III. the same effects result from coloured spots that are herein produced from circles of single colours; but the irides, in the present experiment, are more brilliant and better defined than in the former, and somewhat better illustrations of the consonances upon which the harmonies of colours are varied and regulated.*

* See Exp. III. XII., and XIII.

This is not confined to the primary colours ; circles of the secondaries, or any colours whatever, darker or lighter than the ground on which they are formed, afford, with the chromascope, similar-coloured spectra, in which the original colour of each circle becomes the archeus or key, the fundamental of a distinct harmony.†

EXPERIMENT VII.*

If three coloured circles be formed concentrically, at about equal distances apart, one of which being *blue*, another *red*, and the third *yellow*, and, being viewed as in previous experiments through the chromascope, they will afford simultaneously *three irides*, each of which will be blue, red, and yellow, with a predominance of its own colour ; and if the external circle be yellow, the internal circle blue, and the intermediate circle red, the blue and yellow extreme circles, with their irides, will exchange places, and the red circle continue, with its iris intermediate to them, for the reason and demonstration before given, Experiment IV. and V. ; while in the second compound spectrum, beyond the field of the instrument, the circles, for the same reason, will preserve their original positions unchanged. The compound consonance or harmony of colours, in this experiment, is exceedingly pleasing, and susceptible of variation through all the scales of colouring.

† Examples XV. &c., No. 88, &c.

Experiment VIII.

382. Let a circle of any diameter, *exceeding* that of the lensic prism, be drawn upon a vertical tablet or screen, similar to that represented at F, pl. ix., fig. 3, increasing the breadth of the line by which the circle is defined in proportion to its diameter. Place this in the light of the sun, or other pure strong light, and let the chromascope be adjusted horizontally, at right angles to the screen, opposite the centre of the object thereon, as in fig. 3, D, and at a distance therefrom, equal, at least, to the diameter of the circle to be viewed. Then, looking through the chromascope, a beautiful coloured iris, similar to the former, will appear.

383. If this experiment be performed, without the tube of the chromascope, with the lensic prism alone, so that the field of vision may be extended by bringing the eye near the prism, and the object be then viewed at greater distance, an orbicular spectrum of greater magnitude and beauty will be produced.

These circular spectra will be single, because the second spectra, or irides, lie far beyond the field of the instrument; it being evident that the iris, appearing in this experiment, is similar to that which arises *within* the iris formed by the spot. In Exp. V. fig. 2, the *outward* one being lost beyond the field of vision.

384. Remarks.—In the latter mode of this ex-

periment the object may be placed upon the floor, or in any other convenient position to be viewed, as against a wall, &c., observing only that the ground of the object be of uniform colour, and of sufficient extent to render the spectrum distinct.

385. These phenomena of the lensic prism throw light upon those of solar and lunar *halos*, occasioned by the refraction of atmospheric vapours, sleet, rain, hail, snow, &c., having the sun or planets for centres, and being more or less coloured, and single or several; in which latter case there is a second or more numerous refraction of the halo itself, with inverted colours. In fact, also, the *rainbow* is a portion of a halo, having the sun or moon for its centre, and reflected on a distant cloud or dark sky. We know that both these phenomena are attributed by Gassendus and Newton to the "duly figuring of the hailstones," or rains which occasion them, but which interpretation we regard as a mathematical fiction, into which these great men were naturally led by the bias of their minds, hailstones having little accuracy of figure, and no coincidence of refraction individually.

In the above way, also, the experiment may be repeated with *circles of any magnitude*, for which a screen of sufficient extent can be had, the diameter of the circle determining the distance at which it is to be viewed, and the beauty and magnitude of the coloured spectra will be proportionate. The preceding experiments, with coloured circles, &c., are, of course, susceptible of the same variation and enlargement.

EXPERIMENT IX.

386. Let C A D B, pl. IX. fig. 4, represent a longitudinal section of a portion of the principal tube of the chromascope, and of its *convex lensic prism* A B I K, (described fig. 1, A B C D,) passed through the window-shutter of a darkened chamber by means of a scioptic ball, Y Z.

Thus disposed, if a beam of the sun of the diameter of the tube be passed through the lensic prism in the direction X I K N, it will converge toward the point N, forming a cone of light P O N, and diverge from the point N over a cone of shade N H E.

If the light be received on a sheet of white paper at O P, where it first totally emerges from the prism, the circle of light on the paper will be bordered with *red.*

If the paper be withdrawn to Q R, the circle will be bordered with *blue;* and at the intermediate position, or focus L M, the two circles coincide without noticeable colour.

Beyond Q R the circle diverges into a ring or bow, which expands in diameter in proportion to its distance from the prism upon the cone N H E. The breadth of the ring itself increases in similar proportion, and the coloured lights of which it is constituted cross each other, and diverge, as represented in the upper part of the diagram, between the dotted lines U V and A W, the blue and yellow braids of light mingling and crossing at two or three feet distance from the prism.

These phenomena may be rendered beautifully visible in the atmosphere of the chamber by the steam of hot water diffused therein; as it may, also, by means of smoke, or powder and a powder-puff, &c.

EXPERIMENT X.

387. Again, let X I K, S T U, fig. 4, represent the chromascope, as in the above experiment, and T A I K U a section of the *concave lensic prism*, described fig. 2. The braid or beam of light of the diameter of the tube T I, passing through this prism in the direction C A R, will diverge from the point A, over a cone of shade A W E, forming the iris of which U V W K F E represent a section.

388. REMARKS.—These phenomena of transmitted light indicate the effects of other figures of the lensic prism; they elucidate also the powers of optical glasses in general, and throw light upon the phenomena of coloured rings observed by Sir Isaac Newton between two object-glasses pressed upon one another: * for the figure of *spheric lenses* may be considered as comprehending an infinity of lensico-prismatic figures, in the same manner as the circle comprehends an infinity of triangles, &c. Hence there is a double circular refraction in the

* "Optics," Book ii. Part. I.

incumbent lens in Newton's experiments, and a like reflection in the recumbent lens, which concur in producing the coloured rings; and the phenomena of spherical and prismatic lenses admit of similar explanation; for light, in passing from one medium to another of different density, is invariably refracted and reflected, and if the medium participate any how of the angular or prismic form, as must be between lenses of different sphericities, such refraction and reflection must be adequate to the production of colours.

389. In the pressure of two slightly convex lenses the phenomena of coloured rings arise concentrically from a neutral transparent medium in regular succession, according to the degrees of pressure. By the gentlest pressure capable of producing colour, *warm red*, surrounded complementarily by *cool green*, alternately arise. By a slight increase of pressure these rings of colour expand, and *warm green*, succeeded by *cool red*, arise. By a little more pressure these expand, and *cool yellow* succeeds at the centre; and by continuing to increase the pressure, gradually these rings are followed by rings of *warm* and *cool green*, *blue*, *purple*, with *neutral shade*, *cool red*, *warm orange*, *yellow*, with *opaceous light*, and, ultimately, *dark transparency*. The whole presents, then, a series of concentric irides of broken and declining colours, going off, as it were, round a sphere. Variation of pressure produces variety of appearances, best seen

by reflected light; but the above is the regular course of the phenomena, carefully induced and observed.

390. It is here apparent that from a neutral transparent medium arises a succession of irides, *coloured* precisely in the order of the rainbow, and those of the lensic prisms, with a constant alternation of *light* and *dark* throughout the series. The purest, most positive, and broadest bands of colours, arise with the gentlest pressure, and as the pressure becomes increased, the colours gradually decline, until, under extreme pressure, the centre, forced into close contact, becomes transparent and colourless, the rings of shade and light, or black and white, succeed each other alternately, and nearly colourless; altogether coincidently with our theory.

Experiment XI.

391. Admit a beam of the sun into a darkened chamber through the chromascope, in manner of Experiment IX., or by fixing its lensic prism in the scioptic ball, when a magnificent coloured iris or bow will be cast upon a screen or the walls of the apartment wherever it is directed, by turning the ball, and will be of a magnitude proportioned to the size of the room and the distance from the prism, and of a brilliancy unexampled even in the solar rainbow itself.

In the same manner, on a clear night, when the moon is in her second or third quarter, a lunar bow of faint colours may be produced.

392. REMARKS.—A large white screen upon a double axis, horizontal and vertical, is of great convenience in these experiments, to receive the solar spectrum at different angles and distances. Upon the reverse of this screen, large circles and other objects may be formed or suspended.

The present experiment affords a method by which a rainbow, of any arc, may be superinduced upon a picture into which the artist may design to introduce it, so as to try its effect, and the best way of accomplishing it.

393. Of that most beautiful natural phenomenon, the *rainbow*, none of the explanations hitherto offered can be pronounced universally satisfactory. The received hypothesis of the refraction of the solar rays in single spherical drops of rain, rapidly descending, dividing, subdividing, and dispersing as they fall through the atmosphere, is, notwithstanding the rich mathematical dress that envelopes it, remote from the light of demonstration. Is it not more consonant to nature and experience, that the bow should be produced by one sole refraction in the entire mass of rain and the condensed atmosphere which accompanies it, than from the confusion of innumerable refractions of isolated particles or drops, neither of uniform figure, magnitude, nor position? To us the rainbow is no other than the image

of the sun refracted in a manner precisely analogous to the refraction of a *spot of white or light* upon a *black or dark ground*, as in Exp. II. XXIII.

394. It is a law of optics, that when light passes from a rarer to a denser medium, and *vice versâ*, it becomes refracted; and it is well known that the rainbow is produced by a partial shower, invariably opposed to the sun, and that it never exceeds a semicircle. Partial rain, in its descent through the atmosphere, is progressively accelerated and resisted; hence we may infer that the shower in its fall takes a form nearly hemispherical or lensic, and that it is densest at the centre: add to which, the local density of the air is increased by diminution of temperature during a shower of rain; the whole of which is favourable to the refraction of the sun's rays, in the form of a rainbow, from the entire mass of rain, and reflected from the cloudy sky opposite, in the manner of the solar bow from the lensic prism, and this agrees with an ancient doctrine [369].

395. In like manner may be explained the beautiful colours of the clouds at the rising and setting of the sun, when the horizontal course of its rays through an atmosphere full three times the length of its vertical height, increasing in density to the centre, frequently charged with vapours, and of a hemispherical or lensic form, produces, by refracting those rays, an iris, invisible on account of the transparency of the atmosphere, but visible

by the opacity of the clouds, which float or fall into the strata of its coloured lights. This is proved by the changes of colours which take place upon clouds, as they drive rapidly along under such circumstances, in windy weather. That such clouds are rarely seen of a blue or purple colour, is accounted for by the blue portion of the iris lying toward shade in all cases, and in the present case falling upon the earth, or below the visible horizon, and by the blueness of the sky above.

396. Of the exceedingly great power of this lateral refraction of the atmosphere, we have conclusive testimony in Mr. Monck Mason's "Æronautica," p. 200; wherein it is remarked that the visible horizon to the spectator in an air-balloon does not recede, but becomes comparatively elevated, as the balloon rises, till at length the extensive plane of the earth beneath takes the appearance of an enormous hemispheric bowl. And that the refractive power of the atmosphere undergoes sudden and extraordinary changes, is as strikingly proved by a friend of Mrs. Somerville's having seen, on the plains of Hindostan, the whole upper chain of the Himalaya mountains, previously invisible, start into view upon a sudden change in the density of the air, occasioned by a heavy shower after a very long course of dry weather.—"Connex. Phy. Sci." p. 167.

397. If in the above experiment a stripe, or several stripes, of any opaque substance affording

shadow, be in or upon the prism, a secondary or several concentric bows will be produced, analogous to the secondary rainbow, which is hence probably produced by a similar streak, or streaks, of clouds intercepting the rays which produce the original bow. These things belong, however, rather to the naturalist than the artist, to whom, nevertheless, the rainbow must ever be an interesting object, and one that is to most eyes so enchanting, that he must be worse than inanimate who is unaffected by its beauty, since it is true as the poet has sung, in language which, though highly figurative, is yet naturally just, that when—

> "Iris her lucid various bow on high
> Gaily displays, and *soothes the weeping sky*,
> The boist'rous *winds are hush'd* in deep amaze,
> And Ocean *stills his angry waves*, to gaze!"

And the Iris of mythology is feigned to be the daughter of Thaumas or Thaumantius, the child of admiration! while to all observers the rainbow is no less a natural sign that the ravages of the elements have ceased, than it was a religious pledge to the progenitors of mankind that the Divine displeasure was appeased.

Experiment XII.

398. The magnitude of the spectrum in the last experiments renders it particularly advantageous for the performance of other experiments in

or upon transient or prismatic colours. Thus: having thrown a coloured spectrum into a darkened chamber, in manner of the last experiment, a perforated screen was placed across the most vivid part of the bow, so as to intercept it, except only at a small opening at the centre, through which a braid of coloured light was permitted to pass from the pure *blue* part of the spectrum. This *blue* ray was then received upon a second convex lensic prism; passing through which it afforded, on a white screen placed to receive it, a second spectrum, in which, like the first spectrum, *red* and *yellow* colours accompanied the *blue*.

399. On varying the above arrangement, so as to produce spectra individually from *red* and *yellow* rays of the original spectrum, they were each found to afford separately a compound spectrum, in which the primary colours, *blue*, *red*, and *yellow* were displayed, with a predominance, however, in each of the colours of the light which produced it.

The same results took place from all parts of the original spectrum.

Experiment XIII.

400. The opening in the perforated screen used in the preceding experiment, being formed to give passage to smaller or larger portions of the coloured prismatic rays from any part of the spectrum, as before mentioned, by means of variously perforated

slides of pasteboard, tin, or thin sheet-lead; and the coloured lights being intercepted at their openings by semi-transparent coverings of white tissue paper, or colourless ground glass, they afforded a specific brightly coloured spot from any part of the solar spectrum cast upon them, which, being viewed through a prismic lens, exhibited a brilliant spectrum of the primary colours, *blue, red,* and *yellow,* whatever might have been the colour of the spot so viewed; in which, however, the ruling colour, as in the preceding experiment, was that of the spot itself.

401. REMARKS.—The two latter experiments are important in a variety of respects, both to the artist and naturalist; they demonstrate that each of the colours produced by refraction in the prismic spectrum is farther refrangible into the other colours,—all into all. That therefore the doctrine of homogeneal and heterogeneal light and colours, upon which the erroneous theory of light, and false chromatic system of the natural philosopher depend, notwithstanding the high authority upon which they are maintained,* is as contrary to fact as it is irreconcilable with the true relations of light and colours, and the general analogy of nature.

We, therefore, present this fact of the convertibility or metamorphosis of colours to the farther

* Newton's "Optics," Exp. 5, Theor. ii. Prop. ii. p. 506, et seq.

investigation of the naturalist, our chief purpose here being to illustrate the principles of colouring, of the relations of which in art it satisfactorily exhibits examples of invariable nature, similar to those of Experiments III. and VII. These experiments also demonstrate the indivisible triunity of light and colours, so analogous to those of the radical musical sounds, &c.

Experiment XIV.

402. Remove the screen employed in the latter experiments, and let a person be placed in the solar bow at a proper distance from its entrance, so that it cross his eyes, and the *blue* of the spectrum or bow fall upon one eye, and the *yellow* into the other, either by means of a screen or mask perforated with two openings, or even without them; if, then, he close the eye upon which the *blue* falls, and look with the other eye toward the prism in the scioptic ball, he will perceive *a yellow light;* then, opening the former eye, having first closed the latter, he will perceive *a blue light;* but, finally, if he keep his position steadily, and open both eyes simultaneously, he will perceive A GREEN LIGHT only, demonstrating the concurrence of the two former colours, and both organs, in the conjoint sensation of the secondary colour *green.*

This experiment extends to other cases, not only of the secondary but also of the tertiary and other compound colours, and explains some anomalies of single impression from double vision, commonly attributed to mental association, but which is hereby demonstrated to be a conjoint sensation.

403. Remarks.—As far as the organs are concerned in this experiment, the image in one eye is *yellow*, in the other *blue*, and it is by an act of the sensorium they become GREEN: so in the erect view of the inverted image which appears on the retina in vision, that has so much perplexed philosophers, it is by an act of light reflected from the object that the image is painted inverted on the retina; it is by another and perhaps similar act between this image and the sensorium that the cognition of the true and erect position of the object arises. It is the same as to number, motion, and magnitude; *two* images are painted, one on each retina, but a *single* image only is cognised; if the one eye receive a larger image than the other, as is sometimes the case in imperfect vision, viewed alternately with one eye, the object will appear large, with the other small, while, viewed with both eyes together, the object will appear of a mean magnitude. The same may be observed upon using a pair of spectacles, of which the two glasses have different foci, and consequently different magnifying powers.

404. We have seen by the present experiment, that if light (or any white or light object) be viewed through a *blue* medium with one eye, and at the same time through a *yellow* medium with

the other, the conjunct sensation of such object will be *green;* and in this way all colours may be compounded in the sensorium itself; and if after some time thus viewing a white object as *green*, the coloured media be removed, the object will appear *red*, according to the law by which ocular spectra are produced; nevertheless, if the object be viewed by that eye alone to which the *blue* medium had been applied, the spectrum would not, according to the same law, be *orange;* nor if viewed by the eye alone, to which the *yellow* medium had been applied, would the spectrum or object be purple, but would in both cases be RED; demonstrating that ocular spectra belong to the *sensorium*, and not to the *organ*, that in vision the sensorium is active, and that the return sensation through each eye will be *compound*, although the exciting cause, with respect to either eye, has been simple; *i. e.* both the eye affected by *blue*, and that affected by *yellow*, would singly and alternately see *red*, instead of orange in the one case and purple in the other; and, in like manner, according to this new analogy, in all other cases of vision through coloured media.

EXPERIMENT XV.

405. Let an assistant be placed, as in the last experiment, in the broad spectrum of the lensic prism, so that the *red* fall distinctly in one eye and the *green* in the other; if, then, each eye be alter-

nately shut while the other remains open, the colour respectively shining upon each organ will be seen alternately as before; yet, if both eyes be opened together, NO COLOUR WHATEVER WILL APPEAR.

By means of a small mirror held in the hand, the experimenter may perform these experiments upon his own eyes, without an assistant; but in either case the spectator should be placed at a distance from the lensic prism, to be governed by the breadth and colouring of the spectrum.

REMARKS.—This experiment extends, like the preceding, to other cases, and demonstrates in a new way the neutralising, extinguishing, complementary, contrasting, or compensating powers of colours, which may justly be considered as the key to chromatic science.

406. Mr. Smith, of Fochabers, has lately published a very pleasing experiment, which discloses a new mode of ocular excitement, producing coloured spectra. Mr. Smith (says Sir David Brewster*) states, that when a candle is held near the right eye, so as to be seen by it, but not by the left eye, and then when both eyes look at a narrow strip of white paper, so as to see it double, the image of the paper seen by the right or excited eye will

* "Lond. and Edin. Phil. Mag." Vol. I. p. 249, 343; Vol. II. p. 168.

be *green*, and that seen by the left, or eye protected from the candle-light, will appear *redish.*

407. On trying this experiment with a strip of paper, nine inches long and the tenth of an inch wide, we observed the effect described to arise gradually; when immediately removing the light from the right to the left eye, we found the colours at first to remain as above unchanged, but gradually they declined, and both images became as *colourless* as the light; they then again gradually acquired colour, that which had been *green* becoming *red*, and that which had been *red* becoming *green*. It is evident, therefore, that these colours depend upon opposed spectra *produced in time;* by the *hot* light a green spectrum, and by the *cool* compensating shadow a *red* one, and that they are equivalent and complementary, evincing also our doctrine of the excitement and exhaustion of the principles of light and colour in the organ of sight; whence it may become a useful practice in painting, that the artist view his colouring with his right and left eyes alternately closed, so as not to be subject to error by the false excitement of either organ.

408. That the colours *green* and *red* are equivalent and complementary in the above Smithian experiment, may be farther proved by gradually turning the strip of paper from the perpendicular to a horizontal position, when the *double* object will merge exactly into the *single*, and the two colours

coincide and become white as the light. In whatever way this neutralisation of equivalent colours is produced, there is a union or coalescence of the primary triad, blue, red, and yellow, in due subordination; and it is remarkable, that when it arises from the union of two colours, as in the present experiment, these colours bear the relation of that interval in music which is called the *fourth*, corresponding to the *diatessaron* of the Greeks, which was held by them to be the concord upon which all others depend.

409. These spectral effects of vision, or second sight, are not confined to colour, but extend to motion, &c. Thus we put a circle of a foot diameter, all over mottled of *a red* colour, into moderate *circular motion* upon its centre, looking steadfastly at it during some minutes; when, the eye being removed to a white wall, a spectrum of the same form and size, and of a *green colour*, appeared thereon, which spectrum appeared also *in motion in a contrary direction*, affording a double compensation or contrast of colour and motion. In these experiments, properly coloured glasses, or other media, such as transparent coloured liquids, may be substituted for the colours of the spectrum, and with the same results.

Experiment XVI.

410. Let a solar bow be cast upon a white screen in a room nearly darkened, in manner of

Experiment XI., at a distance of ten or twelve feet from the lensic prism, at which distance the secondary colours, orange, green, and purple, become apparent. Then hold a small flat ruler across the iris, so that it cast a shadow upon the screen, when it will be found that the space of the shadow which displaces a portion of the bow will be supplied with an inverse spectrum, the colours of which will be perfect contrasts, colour for colour, to those of the bow; thus, in place of *purple* in the bow will be *dark yellow* in the shadow, in place of *green* will be *dark red*, and in place of *orange*, dark *blue*; and so it will be with other contrasts and colours of the bow, taken nearer its source with a proportionably narrower ruler.

411. REMARKS.—This experiment is important to the artist by demonstrating that *shade* is in all cases a contrast to *light*, not only in effect or power, as chiaroscuro, but also in colour.

It corrects also the error into which the naturalist has fallen in explaining the phenomenon of the blue shadows which occur with the orange light of the rising and setting sun, or other warm-coloured light, noticed by Leonardo da Vinci, Counts Buffon and Rumford, and attributed by them to *blue* reflected from the sky, but which, in truth, is merely complementary to the *orange*, or golden colour of the light; for if, at any time of day, any colour be given to the sun's light, by passing it through coloured glass into a darkened chamber, the shadows of such light will always be of the colour which contrasts it, notwithstanding the reflex blue of the sky; accordingly, if in a bright sunny day, when the sky is bluest, the shadows of an object be projected on white paper at a window opposite the north, into which the sun never enters, such shadows will be so far from blue, that they will be of colour more or less warm, in proportion to the blueness of the sky. The same effects are also uniformly produced by the colours of artificial light, and if two lights be admitted through coloured glasses which are complementary, their shadows will be also complementary, and, if made to cross, will neutralise each other. In this way, moonlight and *candle-light* afford the first an *orange shadow*, the other, a *blue shadow*.

412. Another remarkable circumstance of the *coloured shadows* of our experiment is, that those of a colour related to light, such as yellow or orange, will appear *lighter* than their lights, which are purple and blue, and *vice versa* of those coloured shadows whose colours are related to shade, evincing, physically, the truth of such relation, by which some colours appear to carry light, and to *advance*, while others carry shade and *retire*, according to the principles of painting; and interpreting also the beautiful compensation of nature, by which shade increases with light, and *vice versa*. This subject will be farther illustrated when we hereafter describe the *catoptron* and its effects, chap. xv.

413. Fuseli has ascribed, with praise, to Leonardo da Vinci, the invention of "the principles of *purity of shade*." * that is, shade free from all colour, or of a neutral tone, and regarded as the absence of light. But Fuseli was no colourist, and the principle he celebrates is conducive to error, for chiaroscuro belongs inalienably to colouring, and the principle which separates them is false; for every shade is not merely absence of light, but is also its contrast in tone of colour; *hot lights* requiring *cool shadows*, and so on, throughout colouring, connected by gradations of intermediate shade and tint. A uniform shade tint, according to the above principle, has vitiated the colouring of the continental schools.

EXPERIMENT XVII.

414. Upon viewing, in the manner of Experiment I., a black spot, three-quarters of an inch in diameter, upon a white ground at about three inches distant from the lensic prism, a beautiful *blue* circle, inscribed with white, and circumscribed by black, will be produced; and if a similar white spot, upon a black ground, be viewed in the same manner, a *red and yellow* circle, inscribed with black and circumscribed with white, will appear. By varying the colours of the ground and spot in this experiment, circles of any required colour

* Sect. vi.

may be obtained; thus, a *black spot* upon a *yellow ground* will yield a circle of *green*, &c.

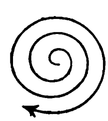
415. REMARKS.—If we view a white wafer on a black ground through a convex-lensic prism, it will be fringed with a pure blue; if, on the contrary, we view the same with the concave-lensic prism, it will be yellow and red, or orange. This experiment may be inverted and carried through all the variety of grounds and coloured disks, with results very evident and accountable after the foregoing experiments; and if rings of sufficient width be employed instead of disks, both appearances will take place together, the blue at one edge of the ring, and the yellow-orange at the other, &c.

EXPERIMENT XVIII.

416. If any number of concentric circles, variously distinguished by figure or colour, circumscribing a spot in manner of Experiment v., fig. 1, be viewed in the same way, a compound spectrum of the like number of circles will be produced within that of the spot, succeeding one within another as the instrument rises, but in the inverted order of the object, the reason of which has been given.

EXPERIMENT XIX.

FIG. III.



417. Let a spiral, fig. 3, be formed of any

number of involutions; then adjust the chromascope to its centre, as in Experiment I., and, looking through the instrument, gradually elevate it, when the spiral will appear refracted into *two involved spiral irides*; and if the figure be barbed, or arrow-headed, at either end of the spiral, a like arrow-head will be found at the central end of one of the involved irides, and another at the external extreme of the other, the reason of which is apparent from the double incidence and refraction adduced, Experiment V.

Experiment XX.

418. Again; if a spiral of any diameter exceeding that of the chromascope be viewed at a proportionate distance, as in the last experiment, a *single* spiral iris only will be seen, as in Experiment VI., and if a head be formed at the outward extremity of the figure, it will be seen at the centre of the spectrum; and if the figure be drawn to represent a serpent as large as the boa-constrictor, it will seem, as it were, to uncoil itself as the instrument recedes from it, and will be beautifully variegated with prismatic colours.

Experiment XXI.

419. On a clear evening, when the moon is at the full, remove the small tube of the chromascope, and so adjust it with the open end toward the

moon that it may be viewed through it by placing the eye close to the lensic prism, when the moon will be refracted into a beautiful lucid orb, the colours of which will not be at all inferior in brilliancy to those of the solar spectrum, Experiment II.

A plano-convex, or conical lensic prism, with the plane toward the eye, is the most convenient for close vision, and the eye being close to the plane, and the apex toward the object concentrically, a wider field of vision is commanded.

Experiment XXII.

420. On a dark night, when the sky is clear, the planets and fixed stars may be viewed in manner of the above experiments, when the light of either will be refracted into coloured orbs, differing from that of the moon only in the breadth and brilliancy of its colours; proving that the light of the heavenly bodies differs not by the analysis of refraction.

In the same manner may be examined the lights of the glow-worm, lightning, phosphori, &c; but when these lights are faint, the yellow is difficultly distinguished in their spectra.

Experiment XXIII.

421. If day-light be admitted into a darkened chamber through a small round aperture in the window-shutter, or a sun-beam be received on a

ground glass, or tissue-paper, which covers the opening; and it be then viewed, as in the last experiments, at any convenient distance, a brilliant circular iris will be produced, as in those experiments. For this purpose a circular card, or piece of thin sheet-lead, or other metal, perforated with the aperture required, and fitted to the socket of the scioptic ball, is well adapted.

422. REMARKS.—In the same manner many of the preceding experiments, by reflection from opaque and coloured objects, may be performed by means of figures perforated in the manner of stain-foils, in card or thin sheet metal, and adapted to the socket of the scioptic ball, or opening in the window-shutter; and these experiments have the advantages of superior brilliancy, &c. If the sun, as seen through a dense fog of a deep orange colour, be viewed through a plano-convex lensic prism, an iris will be produced of a *green* colour, at the interior circumference of the circle, and of a *purple* at the exterior, with a bright *orange* between them. Similar appearances may be obtained from coloured glasses by means of the scioptic apparatus, confirmatory of the theoretic relations of colours.

EXPERIMENT XXIV.

423. Into the short small tube, or eye-piece of the chromascope, fit a small lensic prism, of a plano-convex or other required shape, at the interior extremity. At the opposite, or prism end of

the principal tube of the chromascope, fit a plane white ground glass, perforated metal plates, coloured glasses or lenses, &c., as may be required: or the whole may be managed by a sliding apparatus, fixed at the end of the chromascope, in manner of the magic lanthorn.

Thus provided, the instrument will be adapted for a variety of the preceding and other experiments in a light apartment, in the sun, or in artificial light,—the large tube supplying the place of a darkened chamber or screen. Thus, *e. g.* to demonstrate the refrangibility of the coloured rays of the prismic spectrum, as in Exp. XIII., having fitted the large tube of the chromascope with a colourless ground glass and a perforated plate, cast either of the original pure colours of the prismic spectrum on the object glass, or perforated plate at the end of the chromascope, and view it through the lensic prism of the small tube at the opposite end, &c.

424. GENERAL REMARKS.—To describe all the experiments to which these instruments conduct, whether for use or amusement, is impossible. The foregoing are sufficient to shew some of their applications, and to indicate others. What is therein performed by the refraction of lensic prisms may, in many instances, be accomplished by the reflection of similar specula; add to which the various compound figures of these prisms and lenses, before pointed out, a similar variety of annular prisms and their com-

binations, together with the variations of which the chromascope itself is susceptible, from the simple hand-glass to its connexions with other optical instruments, and a new and extensive field is opened to the ingenious inquirer, adapted equally to instructive amusement and the advancement of science. Of other applications of these instruments none is more obvious than the facility with which they may be adapted to the magic lanthorn, so as to exhibit their effects by artificial light.

CHAPTER XIV.

DIOPTRICAL CHROMATICS.

THE METROCHROME.

425. In the preceding chapter we have treated of colours produced by the refraction of light, chiefly by means of lensic prisms and the chromascope; in the present we describe the METROCHROME and the relations and affections of colours deduced therefrom by transmitted light and vision, both of which subjects might have been greatly enlarged upon had we considered it expedient to the philosophy of pictural art, to which our inquiries are principally directed; so wide, however, is the reference of colouring, that we know of no art or science which is totally without interest in its philosophy.

426. Whatever, therefore, can contribute to the demonstration and establishment of the precise relations and analogy upon which the true understanding and application of colours depend, is neces-

sary to the completeness of the present work, and desirable and important throughout art. Hence an accurate and determinate mode of measuring and denominating colours, so as to convey precise ideas of their hues, shades, and relations, has hitherto been a *desideratum*, not only in fine art, but also to the chemist and geologist, the botanist and anatomist, the optician and astronomer, and in every department of natural philosophy. Nor has it been less desirable in commerce—to the cultivator, and to the manufacturer; not to enumerate also the many utilities and appliances of such a standard in various other concerns of taste and science.

427. In painting, in particular, it has the important office of establishing definitively the proportional powers of colours upon which their equivalence, or faculty of harmonising each other, in every possible case, depends, the accomplishment of which has been the principal object of the METROCHROME described, and applied, in the following experiments.

EXPERIMENT XXV.

428. Fig. 5, pl. x. represents part of the above-named instrument, in which A, B, C, D, is a hollow prism or wedge, in each side of which is cemented, and secured by a brass frame and screws, a colourless plate glass, *e*, *f*, *g*, *h*, which glasses

Fig. 5.

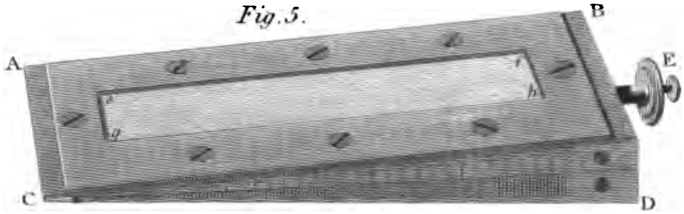


Fig. 6.

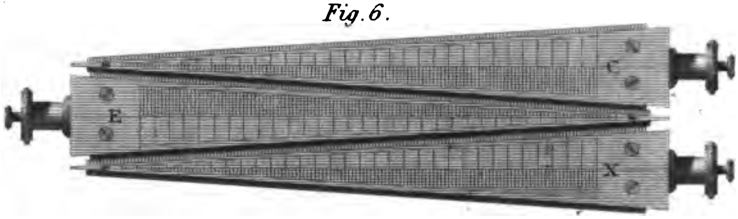


Fig. 7.

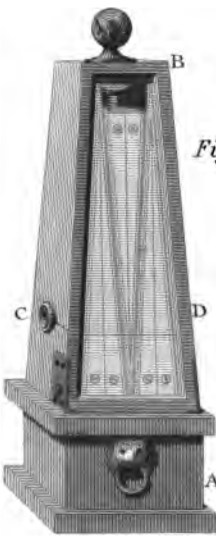


Fig. 8.

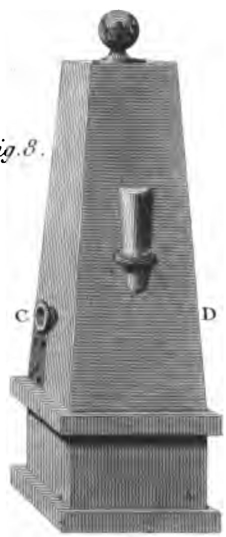
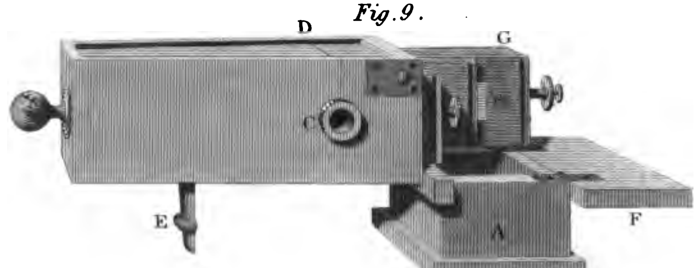


Fig. 9.



G. Field. Invr.

touch each other within at the end *e*, *g*, and diverge or separate at the other ends, to the thickness of the wedge at *f*, *h*. We thus obtained a hollow prism, pervious to light and vision, which is to be filled with a transparent coloured liquid by means of an opening and screw stopper in the end, B, D. To prevent compression of the liquid, the stopper should be perforated lengthwise, that the air may escape, and the perforation be secured by the screw or plug E.

It is evident this wedge, being so charged with a coloured liquid, and viewed opposite the light, will, throughout its broad face, present a perfect gradation of colour, from the utmost diluteness or minimum, at the convergent extreme *g*, *e*, where the glasses touch, to the utmost depth or maximum, at the divergent extreme, *f*, *h*, where they are at their utmost separation.

429. Therefore on one side of the wedge, C, D, is screwed a brass scale of the exact length of the cavity within the glasses *e*, *f*, *g*, *h*, geometrically divided into thirty-two degrees, each subdivided into four others, forming evidently an accurate measure of thickness, increasing at each division, from the point of contact of the glasses, and is consequently also a true numerical measure of the intensities of transparent colour throughout the wedge. Such a prism, charged with a *blue* liquid, will form a *cyanometer*, or measure of blue; with a *red* liquid, an *eruthrometer*, or measure of red;

and with a *yellow* liquid, a *xanthometer*, or measure of yellow, the colours of such liquids being adjusted to a given intensity.

Experiment XXVI.

430 Again, C, E, X, fig. 6, pl. x., represent in combination three of the above-described prismic wedges, or colour gauges, accurately formed and graduated to the same scale; for which having prepared liquids of the three true primary colours of equal powers or intensities,* charge the cyanometer C with the *blue* liquid, the eruthrometer E with the *red*, and the xanthometer X with the *yellow*.

431. The gauges thus prepared may be combined in pairs alternately to produce the *secondary* colours *purple*, *green*, and *orange*, similarly graduated, of all *shades;* or, by changing them endwise, of one uniform shade of all *hues*, and the proportions of the compound of any hue will be denoted by comparing the numbers opposed to it on the two scales.

By similar management of the three gauges may be produced of the same originals, blue, red, and yellow, the *tertiary* colours, *olive*, *russet*, and *citrine*, and all other compounds, with a like power of measuring and computing their proportions.

* This is as easy to a correct and practised eye as the tuning of musical strings is to a musician; nevertheless mechanical aids may be resorted to.

Thus used in conjunction the three gauges constituted a METROCHROME, or general measure and standard of colours.

EXPERIMENT XXVII.

432. For a convenient mode of managing the graduated wedges in conjunction, a tube or case, fig. 7, pl. x., has been adopted; consisting of a pedestal, A, which forms a foot or stand for the instrument when in use, and an obelisk, B, to receive the wedges. The case has a glass front, through which the graduated sides of the wedges may be seen, and the sides of the obelisk are perforated with two small openings opposite each other C, D; through which and the wedges a direct view may be had, or a beam of light be thrown. The obelisk is connected with its pedestal by hinges, enabling it to fall back at right angles therewith; in which situation it is further supported by a falling leg, E, in the back view of the apparatus, fig. 8, as appears in its horizontal position, fig. 9.

In using the metrochrome, place it in its horizontal position across the light to be viewed or transmitted; turn out the lid of its pedestal, F, for the wedges, charged with their respective colours, to slide on, into, or out of the obelisk, as appears at G.

433. Parallel with the axis of vision, and over

the centre of the two openings in the sides of the metrochrome C, D, is an index formed by a line drawn with a diamond pencil across the face of the front glass. If now, for example, the blue gauge be slid in, till its scale reaches 24° beneath the index, the red gauge till it reaches 15°, and the yellow till it reaches 9°, or any analogous numbers, a beam of light being cast through the whole by the openings C, D, will pass achromatic or colourless, provided the coloured liquids with which the gauges have been charged are of pure colours and equal intensities. The light viewed through them in the opposite direction will also, of course, appear colourless. It is not necessary that the blue gauge be placed at 24° in this experiment; any other position of the scale will equally afford the achromatic compound of yellow, red, and blue, upon properly adjusting the other two wedges to such other position, when it will invariably result that the approximate proportions of the three colours will be as 9, 15, 24, or in the ratio of 3, 5, 8, in remarkable coincidence with the harmonic analogy of the *common chord*, or triad of the musician, which is the foundation of all harmony in sounds, as deduced by Tartini and others from the string trumpet and monochord. In the three primary colours combined thus in achromatic unity, or accordance, the power of yellow is proportionally as 3, that of red as 5, and that of blue as 8; and their analogous relations to the triad of harmonic sounds, are as *Blue* to the note C, *Red* to E, and *Yellow* to G; as exemplified in our Analogous Scale of Sounds and Colours, p. 79, pl. III., &c.

EXPERIMENT XXVIII.

434. Having adjusted the colour-gauges in the position of the metrochrome, fig. 9, as in the last experiment in the complementary proportions, $3° + 5° + 8° = 16°$; if the blue be then withdrawn, a *perfect orange*, composed of 3 yellow and 5 red, will remain, and become visible either by transmitting a beam of light, or looking through the gauges in the metrochrome, as before described; and this orange of 8° is consequently the equal contrast or equivalent complementary of blue of 8°; 16° being the amount of neutrality.

If now the blue gauge be restored to the exact position in the metrochrome, from which it was removed, and the red gauge be withdrawn in its stead, *a perfect green*, composed of yellow of 3° and blue of 8°, will remain visible in manner and place of the orange; and this green of 11° will be the equivalent of red of 5°, their numbers amounting also to 16°, which represents neutrality.

Finally, by restoring the red gauge to its position in the metrochrome, and withdrawing the yellow gauge, a *perfect purple*, composed of red of 5° and blue of 8°, will remain in like manner; and this purple of 13° will be the equivalent of yellow of 3°, which again amount also to 16°, or the neutral in colour.

435. Remarks.—From these data may be deduced the relative powers of other colours, for the tertiaries are regular compounds of the secondaries, as the latter are of the primary colours, as denoted by the following table:—

		Primary.						
		Blue.	Red.	Yel.				
	16° Neutral . . .	8°	5°	3°	WHITE and Light.			
Secondary.	Orange . . 8°=	0	5	3				
	Green . . 11°=	8	0	3				
	Purple . . 13°=	8	5	0				
	Neutral	16	10	6	GREY.			
					Blue.	Red.	Yel.	
Tertiary.	Orange . . . 8=	0	5	3	=8	5	6	Citrine.
	Green . . . 11=	8	0	3				
	Orange . . . 8=	0	5	3	=8	10	3	Russet.
	Purple . . . 13=	8	5	0				
	Green . . . 11=	8	0	3	=16	5	3	Olive.
	Purple . . . 13=	8	5	0				
	Neutral	32	20	12	BLACK.			Tertiary.

It appears above, that the amounts of the primary colours which constitute the secondaries are proportionally $6 + 10 = 16$, and that those of the secondary colours, which constitute the tertiaries, are $12 + 20 = 32$; but both these are the same in ratio, as $3 + 5 = 8$, or that mixture of the primaries which compensate or neutralise each other equivalently; accordingly, the neutrals, black, white, and grey, may be compounded of secondary, primary, or tertiary colours, as we have shewn elsewhere.

	Blue	Red	Yel.	
436. If we add to	16	5	3	which constitute *olive*,
the	0	5	3	which constitute *orange*,
they amount to	16	10	6	which constitute

the neutral *grey ;* accordingly orange is the contrast and complementary of olive.

	Blue	Red	Yel.	
So if we add to	8	10	3	which belong to *russet*,
the	8	0	3	of green,
we again obtain the	16	10	6	the equivalent of

grey ; and green is the contrast of russet.

	Blue	Red	Yel.	
And if we add to the	8	5	6	of citrine,
the	8	5	0	of purple,
we also obtain	16	10	6	the equivalent of

grey ; and purple is the contrast of citrine. The tertiaries have, therefore, similar relation to black or shade that the primaries have to white or light. Hence the relations and proportionals of colours terminate circularly, or at the point of commencement. They are therefore complete, and admit of systematic arrangement.

437. Accordingly we have constructed the Scale pl. II. from which may be deduced the equivalent relations of colours to infinity. This scale comprehends six circles, constituting three

stars, each having six radials, or branches, with black at the centre, but of which we need not repeat the description already given in Chapter III., and of which we have now supplied the principle and rationale. Any one so disposed may refine mechanically upon this plan, by giving motion to the outward scale of figures, so as to work with the inward fixed scale, all possible relations and combinations of colours numerically, and in other ways. It is evident, also, that all colours and contrasts may be determined upon the same principle of mensuration, so that the artist may not only know and name his hues, but also form a correct judgment of the proportions in which they will neutralise, and the quantities, either of surface or intensity, in which they harmonise each other; — and carrying therewith a fine eye to his performances, he may the more readily satisfy the demands of a pure and cultivated taste. All the rules of poetry will not, however, make a poet; nor will the utmost refinements of mechanism or science give genius to the painter, however they may correct and aid him as important means in his art, and help him to realise the conceptions of a poetical imagination.

438. To treat of the innumerable uses to which the metrochrome may be adapted in the various affairs of life and literature, would be little to the purpose of the present work, and they are, perhaps, sufficiently obvious. To give to the instrument

itself the utmost simplicity and perfection would render a much more important service to art. And as the triangular prisms first employed by natural philosophers were formed of glass planes and filled with water, &c., ere prisms of solid glass were constructed, so it is perfectly practicable to form coloured gauges of solid glass to supply the place of the hollow wedges of the metrochrome. For this purpose it may be suggested that clear flint glass may probably be tinged by the sulphuret of gold of a *red* colour, by the sulphuret of silver, *yellow*, and by the sulphuret of cobalt, *blue*; or, otherwise, by the various precipitates of these metals, or the same metals minutely divided.

439. It is not necessary that massy coloured glass wedges should be formed for the above purpose, on the contrary, a new mode of perfect adjustment of the colours of the glasses would arise if wedge-shaped pieces of flat glass, of the eighth of an inch uniform thickness, polished at the edges, were employed, because the glasses, being of uniform thickness, might be chosen of equal intensities, and a perforation of the obelisk of the metrochrome, for light and vision, of the diameter of the thickness of the glass, would be sufficient for all the purposes of the instrument; and these means would render its construction as easy as that of most other metrical instruments.

The same may be accomplished in other ways, as by uniformly thin transparent plates of the required primary colours with which hues and shades may be compounded, and the proportions of the compounds denoted by the number of plates employed; and also mechanically and chemically, as in the following experiments.

Experiment XXIX.

440. Divide a circular white card of three inches diameter by a line across, into two equal semicircles, one of which paint of a light blue colour; again, divide the other half-circle from the centre, in the proportion of five to three, and paint its larger portion of a light prismatic red colour, and the smaller portion of a bright yellow, so that the three colours shall be of equal pureness and intensities. The face of the card will then be divided and coloured in the proportions of three yellow, five red, and eight blue, as represented in the annexed plate xi., fig. 2, agreeably to *the primary scale of nature.* Pass a pin through the centre of this card, which spin rapidly thereon, with its face toward the light, when the three colours of the circle will blend and vanish, and the card will be seen of a dull white colour, which is most apparent when contrasted by some dark object behind it.

441. Remarks.—Upon comparing *the primary scale of Nature,* fig. 2, with *the primary scale of Newton,* Part II., Prop. vi., prob. 2, of his "Optics," as in fig. 1, their coincidence in several respects will be apparent, particularly in the relative

Fig 1. Primary Scale of Newton

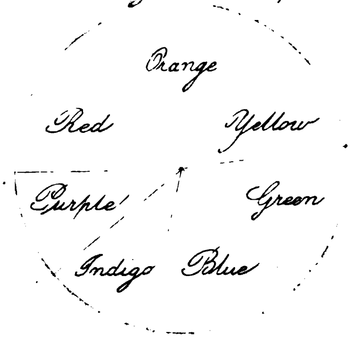


Fig. II. Primary Scale of Nature.

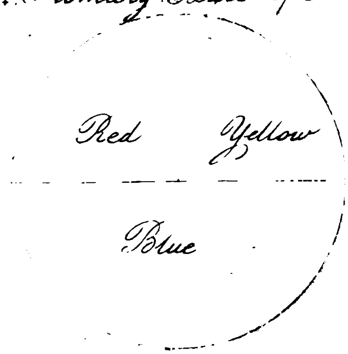
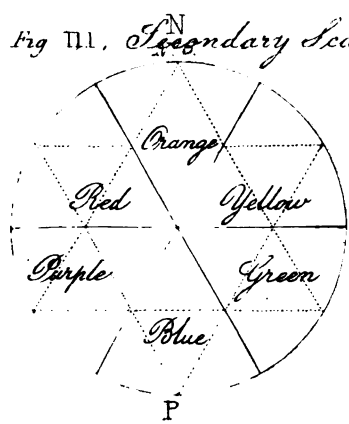


Fig III. Secondary Scale



Drawn by Geo. Field. Engraved by David I

Fig I. Primary Scale of Newton.

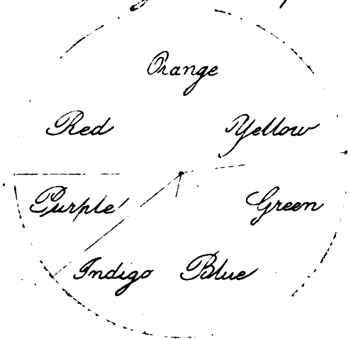


Fig II. Primary Scale of Nature.

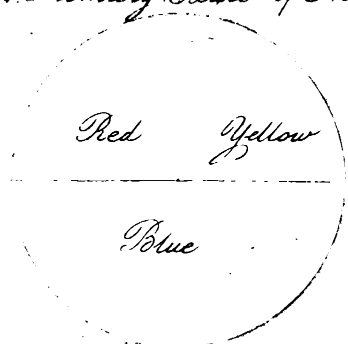
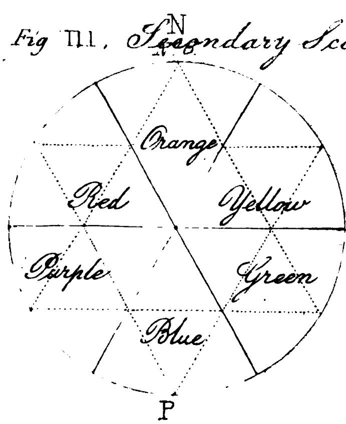


Fig III. Secondary Scale.



Drawn by Geo. Field. Engraved by David Lucas.

places of the primary colours, blue, red, and yellow, in each, and in the equal division of both circles into warm and cold colour. Each circle, duly coloured, &c., spun on its centre, as in this experiment, affords a neutral hue, or disappearance of all colour. Further, by dividing the natural scale, fig. 2, triply, first by a line separating the upper from the lower semicircle, secondly, by continuing the radius which separates the red and yellow, in like manner across the circle, and thirdly, by bisecting the red space with a like diametrical line, the six divisions of *the secondary scale*, fig. 3, are obtained, which again coincides, in many respects, with Newton's scale, and according to the dotted lines, affords the ichnography of our *scale of equivalents*, plate II., and the rationale of many other schemes of colours.

Experiment XXX.

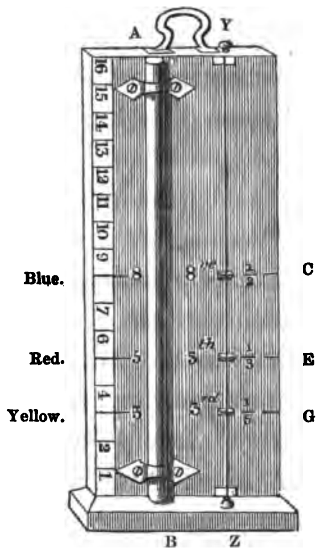
442. Three cylindrical glasses, of equal diameters and equal height, were filled with aqueous tinctures, the one blue, another red, and the third yellow, of pure colours, and reduced by diluting with water to equal intensities. Then into a glass tube, nine inches long and half an inch in diameter, accurately graduated lengthwise, portions of each of the above coloured liquids were poured alternately till the mixture, upon shaking, became neutral or colourless. Upon measuring the quantities of the

coloured liquids remaining in the cylindrical glasses, the proportions wanting were eight blue, five red, and three yellow, which formed the proportions of the neutral liquid in the tube within a fraction.

443. This experiment was repeated many times with the same result, by pouring the coloured liquids into the graduated tube in the above proportions, and shaking; more of either colour then added to the mixture gave its own hue. The colours of the liquids should not be so deep as to disturb their transparency; the eye is also a better judge of the hues and intensities of light or pale than of deep or dark colours.

444. This glass tube is represented in the subjoined figure A B, on a scale divided into sixteen equal parts, parallel with a similar musical string, or *monochord*, Y Z, marked at the $\frac{1}{5}$, $\frac{1}{3}$, and $\frac{1}{2}$, which are the nodes or stops at which the string yields the third, fifth, and octave, or notes C E G of the gamut; whence it appears that one-half of the tube coincides with the proportion of the musical *octave* on the string, that somewhat more than five parts correspond with the musical *third*, and that three parts, with a like small excess, correspond to the *fifth*, constituting the musical triad or harmonic chord. Now, from the preceding experiments, it appears that three parts *yellow*, five parts *red*, and

eight parts *blue*, afford, approximately, the primary triad of chromatics; whence the coincidence of the two systems as exemplified throughout this work.



EXPERIMENT XXXI.

445. The last experiment lies under the disadvantage of the permanent combination of the three liquids, so that we cannot be assured that the disappearance of the colours in the mixture is not the effect of chemical change; if, therefore, we were to tinge clear saturated aqueous solution of *potash* of a *blue* colour, *oil of turpentine*, or other colourless oil, of a pure *yellow* colour, and *alcohol red*, and, with these coloured liquids, repeat the above experiment, the colourless mixture, being left at rest, would soon separate, and the three liquids detach

themselves in their proper colours, demonstrating at once the proportional powers of the primary colours, synthetically and analytically.

This experiment may be adapted to the various other compounds and relations of colours; *e. g.* for exhibiting the contrasts complementarily, by variously tingeing these liquids, as the case may require.

446. REMARKS.—A tube employed, as in the above experiments, becomes a MONOCHROME, so to call it, in which the three primary colours are united harmonically, under invariable natural proportions, analogous to the harmonics of the *monochord and trumpet marine* of the musician, upon which simple instrument the natural theory or science of this beautiful art is grounded;* so also may be developed, by this monochrome, the entire scale of colours analogically as numbers to unity.

447. Notwithstanding the simplicity of this latter instrument, the metrochrome has a wider range, and many obvious advantages of which the monochrome is deficient; and this, in particular, that a more perfect neutralisation of the colours can be effected without even a suspicion of chemical change by the action of contact and mixture in the liquids: these instruments, however, help to confirm each other's results by coincidence, and to shew the universality of our principles.

* See Stillingfleet's "Principles and Powers of Harmony," p. 22, § 35.

448. To the same end other means may be resorted to, and such also as are not liable to chemical exception, by mingling *measured* quantities of *coloured powders* of equal purity and intensities, or by *numbers* of *coloured glasses*, or other more tenuous transparent coloured substances, of equal thickness, pureness, and intensities; by which the general laws of chromatic accordance may be established upon a wider induction.

449. It may, perhaps, be objected against the metrical accuracy of these instruments that they have not an indisputable or invariable standard; but the same objection holds against the barometer, thermometer, hydrometer, and all other metres, the most perfect of which afford but approximations to truth; and this, in the present instance, is all that can be of use to the artist; and relative perfection is all that we claim for the metrochrome. Indeed, *a perfect metre* would be anomalous throughout science, in which there is no *absolute* position, point of departure, or terminus; and all the attempts of the world for an absolute standard have been, and ever will be, abortive.

450. The eye must be the judge and test of purity and depth of colour, as the ear is of sounds; and as many musicians are to be found who could tune strings and instruments in respect to pitch, tune, and temperament, to the acquiescence, if not entire satifaction, of every good ear; so few artists, perhaps none, would dispute the relative depth or

purity of any two or more colours equalised by a good eye; and upon this principle depends the adjustment of the gauges of the metrochrome, though other aids may be resorted to if required. This instrument is therefore qualified in principle and practice to become a universal standard of colours, by which the philosopher, the artist, and the merchant may register and communicate accurate records of colours from the most distant places, and from age to age.

451. Having now established the relations of colours by refraction of Lensic Prisms and the Chromascope, analytically, and confirmed them by transmission of the Metrochrome synthetically, it remains only that we demonstrate the same of the colours of reflected light, or specular colours, by means of the Catoptron, described and illustrated in the following chapter.

CHAPTER XV.

CATOPTRICAL CHROMATICS.

THE CATOPTRON.

452. To COMPLETE our outline of Optical Chromatics, we proceed, finally, to the investigation of *catoptrical* or *specular colours*, and the instruments we have employed therein; the principal of which latter we have denominated the CATOPTRON, or Catoptrochrome, it being a mirror for disclosing a new variety of colours by the reflection of specula.

453. The forms of specula vary as *plane*, *angular*, and *spherical*; they are also convex, concave, and compound, according to all the varieties of surface of the lenses and prisms, described at the beginning of Chapter XIII., and are also of all various colours.

EXPERIMENT XXXII.

454. The construction of the *catoptron* for the employment of such specula is extremely simple,

and will be readily apprehended from the ensuing description and the figs. 1 and 2. Its form is that of a small hand-mirror of about two inches in diameter, and half an inch deep, made to revolve on its axis B.

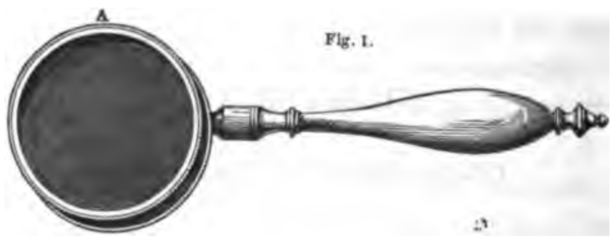


Fig. 1.

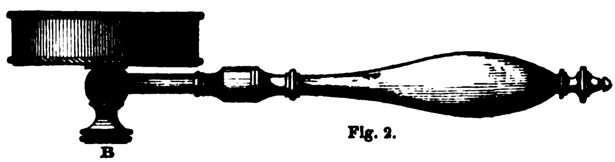


Fig. 2.

455. Figure 1 represents a front view of the instrument, and fig. 2 its side view, shewing the thumb-winch and socket B, in which it may be turned round by one hand while held by the handle with the other. The inside is blackened, and the bottom thereof lined with black velvet to receive various coloured disks, glasses, and other specula of rather smaller diameters, affording by an easy mode of management an infinite variety of chromatic effects, according to their applications, simply, or in combination, illustrative of the foregoing doctrine of colours, from among which we have observed and selected the following :—

EXPERIMENT XXXIII.

456. Fix upon the middle of a pane of glass in the upper part of a window, with paste or otherwise, a small disc or piece of card of a linear, angular, circular, or other figure, about an inch in length or diameter, so that it may appear as a dark object against the clear light of the sky. Let the spectator, with his back turned toward the light of the window, hold the catoptron in the left hand, so as to reflect the figure of the card to the eye from any speculum placed on the velvet bottom of the catoptron, when if a pale *yellow* flat glass, or plane lens, be employed as such speculum, the card or object will be reflected therefrom double, distinct, and of different colours, the one reflection being of a warm *yellow*, the other of its complementary blue; and if with the right hand the winch B of the catoptron be turned gently round, these coloured reflections will revolve round each other at different distances, according to the angle of viewing them. For distinction we will call the figure reflected of the colour of the speculum, *objective*, or the reflection of the *object*, and the other *spectral*, or its spectrum, from the like distinction of ocular spectra.

EXPERIMENT XXXIV.

457. If two cards or figures, instead of one, be fixed upon the pane of glass not quite contiguous to each other, the speculum will reflect them as four figures,—two of the colour of the speculum,

and two of their complementary colour, and in causing them to revolve by the winch of the catoptron, one of the reflected objects will cross the spectrum of the other, neutralising their colours; and reduce the number of reflected colours to three, one of which will be of the colour of the speculum, one of its complementary colour, and the third achromatic or colourless. If instead of *discal* objects on the window, *annular* ones be employed, their spectra will appear double, although the image remain single only.

458. Remarks.—Any number and variety of figures may be employed, which, with the bars of the window, flies running thereon; birds accidentally flying in the air, trees, clouds, and every object intercepting the light of the sky, will be reflected double, of different and contrasting colours, affording altogether a simply harmonious and pleasing appearance, capable of great variation and diversity. The same experiments may be performed by the spectator facing the light and holding the catoptron horizontally or otherwise; or it may be employed in the open air in producing entertaining pictural variety and novelty of effects without end.

459. In all experiments with the catoptron a bright day is favourable to its effects, and on such a day, when making the following experiment, we remarked a *black* crow flying at a distance reflected as two crows, the one of which was *red*, the other *green*.

EXPERIMENT XXXV.

460. If a plane PALE, COOL RED, or pink-coloured speculum, be employed instead of a yellow, as in Experiment XXXIII., the same phenomena will ensue, with this difference only, that the objective reflection will be *red*, and the spectral will be of a *green*, complementary to the colour of the red. And, in like manner, if a PLANE PALE BLUE speculum be substituted for the red, its object will be *blue*, and the spectrum of an *orange* colour.

461. This experiment was varied with pale SECONDARY-coloured plane specula; the *orange* speculum affording a *blue* spectrum, the *green* speculum a *red* spectrum, and the *purple* speculum a *yellow* spectrum to their objects. Other specula of *pale* COMPOUND OR BROKEN COLOURS were substituted successively in like manner, and afforded, invariably, reflected objects of their specific colours, accompanied by spectra of their complementary colours; whence we may justly induce that a like invariable law of chromatic compensation holds of all pale-coloured plane specula.

EXPERIMENT XXXVI.

462. Upon repeating Experiment XXXIII. with a *colourless plate-glass* speculum one-eighth of an inch thick, instead of the yellow speculum, it afforded only a single colourless image or reflection of the object, which, on turning the winch of the catoptron, indicated a second paler image,

partially issuing from it. Upon substituting for this colourless speculum a similar plate-glass speculum, having *a green tinge* apparent on looking through it edgewise, two distinct images, objective and spectral, of faint complementary green and red colours, were obtained. The same resulted upon employing similar *differently tinged* plate-glass specula, in which the images varied only according to the law of chromatic compensation.

463. *Two colourless specula* of the first kind, so perfectly flat as to adhere by atmospheric pressure, turned on each other till the position at which their refraction was either coincident or compensatory, afforded only a single colourless image, but on turning one of them on its axis half round, they afforded two distinct images.

464. An *achromatic flint-glass speculum*, which had been prepared by fire for polarising light, afforded two separate and distinct images, which traversed circularly, on turning the winch of the catoptron, like those of the coloured specula, and precisely according to the law of polarisation.

Experiment XXXVII.

465. In the same manner, THREE YELLOW SPECULA being placed successively on the velvet of the catoptron, the first, of a *pale yellow*, afforded two images of nearly equal strength of contrasting colours, and separate from each other about *three-eighths of an inch*; the second, of a *deep yellow*,

afforded two images, separate about *three inches*, of which the objective one was dark in colour, and the spectral one faintly discernible; and the third speculum, being of an *intermediate yellow*, afforded the two complementary images *at one-half of an inch or five-eighths'* distance. Whence it appears that the dispersive powers of these specula are proportionate to the depths of their colours, and that their spectral chromatism is the inverse thereof.

Experiment XXXVIII.

466. Of *three blue specula* employed, as in the last experiment, the first, of *a pale blue* colour, afforded the two images distinctly and of perfectly complementary colours; the second speculum, of an *intermediate blue*, gave a powerfully blue object, with its faint orange complementary spectrum; and the third speculum, of a *deep blue*, yielded only a single dark blue or black image, without any visible spectrum. It appears, therefore, that the spectra are neutralised or absorbed in proportion to the depth of colour of the specula, and that beyond a certain depth they afford no visible spectra whatever. And, also, that the paler the colour of the speculum is, the more perfectly it reflects the complementary colours of the two images.

Experiment XXXIX.

467. Upon varying the foregoing experiments by placing the coloured specula in the catoptron

upon card, *discs of various colours*, instead of the black velvet bottom of the instrument, their results were little varied. The appearances were, in general, more evident over the *lighter and more advancing colours*, still more so upon a *white* disk, and most of all so *upon black*, of which velvet affords the deepest.

Experiment XL.

468. It had appeared, from Experiment XXXVIII., and several others with different-coloured specula upon black and coloured grounds, that *pale-coloured specula* alone afforded the *second coloured image or spectrum*, and that specula of *deep-coloured glasses* were totally inefficient in this respect, returning only a *single image* of the object. We now, therefore, placed upon the velvet bottom of the catoptron a plane *colourless, foliated, or quicksilvered mirror*, as a ground for the coloured glass specula of the preceding experiments, which were thus repeated with improved effects and brilliancy, and with new powers, among which was the revolution of the two-fold images of complementary colours from *coloured specula of every degree of depth*, which could be alone obtained in the previous experiments from *pale-coloured* specula. But in these experiments with the metallic mirror, the colours of the images and spectra of the objects were reversed interchangeably.

Experiment XLI.

469. Two of the flat-coloured transparent specula, one of which was *pale yellow*, the other *pale red*, were placed together upon the quicksilvered mirror in the catoptron, and afforded, in the manner of Experiment XXXIII., three images, one of which was *blue*, and the other two *red* and *yellow*, making together the complement of neutrality in the *three primary colours*. The same result succeeded if either of the other two pairs of primaries were substituted; *yellow and blue* supplying the *red*, and *blue and red* affording the *yellow*.

470. So, again, if single *secondary colours* were employed, they severally gave out their complementary primary. In like manner, pairs of the secondaries supplied their tertiaries alternately, &c.

Remarks.—These experiments illustrate the remarkable consonance of the musical notes of the harmonic triad, any two of which produce their third as a spectral sound, making up the complement of the triad or harmonic chord, which is the fountain of all musical harmony. A coincidence we have remarked in other cases, and it has been observed in musical consonance when those notes, namely, thirds and fifths, &c., have been sustained by two good voices in singing, that the third harmonic element of the chord has been distinctly heard. For this latter remark we are indebted to a friend eminent in moral as in musical harmony.*

Experiment XLII.

471. If *a pale yellow speculum* be placed upon the quicksilvered mirror of the catoptron as before, it will yield two faint images, one of which will be yellow, the other blue. With *two like yellow specula* together, a *reddish* spectrum will, in the same manner, arise with the *blue* and yellow ones; which reddish spectrum will be deepened in colour by adding a third yellow speculum to the two others in the catoptron; and if a fourth yellow speculum be also added, images of the whole scale of primary and secondary colours present themselves simultaneously, on turning the catoptron, in beautiful compensation and harmony, according with the *key of yellow.* In like manner, similar appearances, in *other keys of colouring,* may be produced by substituting other pale-coloured specula for those of yellow.

Experiment XLIII.

472. Two *dissimilar specula,* coloured complementarily, employed in the manner of the last experiment, will afford variously the *three primary coloured images* simultaneously; as will, also, either

* J. W. Windsor, Esq.

of the primary coloured, with its proximate secondary coloured speculum. For example, a pale yellow speculum over an orange-coloured one, &c.

473. Remarks.—The two latter experiments afford an admirable illustration and solution of the manner in which reflected light, by a polarising agency, [503a,] effects the beautiful iridescent colours of the opal, mother-of-pearl, and other lamellar transparent bodies; specula of undular surfaces affording their appearances precisely. These experiments may serve also to explain the variety of colours apparent by reflected light in the anatase, a mineral found in Norway and Dauphiny.

Experiment XLIV.

474. In these experiments with the catoptron we have hitherto employed only *dark objects upon a ground of light*, the window; but if, reversing our process, we employ *light objects upon a dark ground*, the field of experiment is doubled, in which all the foregoing experiments may be repeated with great brilliancy by inversion and transposition of the colours and images of the object and spectrum. This we have also accomplished by closing the window-shutters and admitting the light of the sky through linear, angular, circular, and other openings, of the size and forms required, in place of the dark objects fixed on the glass of the open window in the preceding experiments, and also by *colouring the light* admitted by means of coloured glasses and

a scioptic ball; we need not, therefore, run over the ground of the foregoing experiments under a variation sufficiently obvious to the reader who may be disposed to repeat them.

EXPERIMENT XLV.

475. But with regard to the transposition of light and dark of the ground and object, their effects may be combined, so as to exhibit at once the appearances of a light and dark object in all the preceding experiments, by employing an intermediate ground. For example, upon reflecting from coloured specula, by means of the catoptron, a circular *dark object* on the window, and the *light disc* of the sun shining through a fog, each afforded two images, having the object and spectra of corresponding colours, as in all the preceding experiments, but transposed according to the law of light and dark refraction, exemplified in the last experiment. In like manner, during moonlight, the moon may supply the place of the sun, and intermediate and coloured grounds may be obtained by perforated screens, &c.

EXPERIMENT XLVI.

476. Another and very effective manner in which the experiments of the catoptron may be exhibited and extended, is by a second reflection of opaque objects from light, dark, neutral, and coloured grounds, instead of employing the light and shade of the window. Accordingly, by fixing a

black wafer upon a *white* card, six or seven inches square, such as described, Experiment I., for use with the chromascope, and placing it in sunshine opposite the window, and receiving the reflection thereof on the specula of the catoptron, in manner of Experiment XXXIII., &c., or by substituting a *white* wafer on a *black* card for the former, all the foregoing experiments were repeated and varied with great facility and beauty by employing cards and figures of a great variety of shades and colours, variously adapted and contrasted. And in this way all the cards and figures employed for experiment with the chromascope are available for those of the catoptron.

EXPERIMENT XLVII.

477. Not only are the experiments and effects of the catoptron variable according to the variations of the grounds and objects, as already detailed, but a new variety of effects is producible by as great a variation of the *forms* as of the colours *of the specula* employed. Thus, a pale warm yellow speculum of the meniscus concavo-convex form afforded a blue spectrum with the yellow image, whichever side of the speculum was presented to the eye; but that with the anterior *side convex* was much deeper and larger, and, on turning the speculum with its *concave side* anterior, the blue spectrum was smaller in size and fainter in colour.

EXPERIMENT XLVIII.

478. With a *plano-convex deep-blue speculum* on the silvered mirror in the catoptron, the dark object on the window afforded a diminished blue image from the anterior surface, and a magnified spectrum of its complementary colour from the posterior surface, whichever side of the speculum was presented to the eye. But on repeating this experiment with a light object of the closed window-shutter, or the moon, or the sun in a fog, &c., the colours of the image of the object and spectrum were transposed, the spectrum appearing blue and magnified, and the image of its contrasting colour, &c., diminished.

EXPERIMENT XLIX.

479. Having etched with a diamond pencil on one side of a plane, thick, light-green speculum, a small circular figure, thus, O, and a straight line thus, ———, and reflected the light of the window therefrom by means of the catoptron, at the proper angle, the circle and line appeared from the *anterior* surface of the speculum in images of their proper green colour, and their spectra were reflected from the *posterior* surface of the speculum of their complementary red; but on turning the speculum with its etchings downward, the line and circle appeared singly of the complementary red only.

480. REMARKS.—The spectra did not revolve

round their images on turning the catoptron in this experiment, as in those preceding (Experiment XXXIII., &c.), but kept their positions unvaried, opposite the light; and as the interior green image disappeared on turning the speculum, it is apparent that the spectrum in this experiment arose from the shadow of the objects, and as specula of all colours return complementary coloured spectra from etched figures in the manner of other objects throughout these experiments, we may reasonably infer that *all catoptric spectra are reflected shadows of their objects, and their colours are determined as such according to our law of coloured shadows (Exp. XVI.), as complementary contrasts of the lights by which they are produced, or in which they are generated.*

These spectra or shadows of etched figures may be rendered more apparent by employing convex specula.

Experiment L.

481. The latter experiment may be varied by sticking on the posterior surface of the speculum employed a small piece of wet paper or a wafer, when these also will appear as spectra of the complementary colours of the speculum, whatever the colour of the wafer or paper may be.

Experiment LI.

482. The inference from Experiment XLIX. concerning catoptric spectra and the general law by

which their colours are determined, may be confirmed by breathing on or steaming the posterior surface of either of the coloured specula so as to obscure it, when, on repeating Experiment XXXIII., &c., therewith, the coloured image of the object will alone appear, and the spectrum of its contrasting colour will remain invisible, till it gradually reappears as the steam and obscuration disperses, and, on the glass becoming perfectly dry, it recovers its entire force. But the first effects may be rendered permanent by grinding the polish from one side of the speculum, or otherwise destroying its reflective power by paste or paint.

GENERAL REMARKS.

483. The principal source of difficulty and imperfection in the various experiments with the foregoing instruments arises from the defects of the glasses employed as lenses, prisma, or specula. To remedy this in the coloured specula of the catoptron, we adapted it to the employment of coloured liquids, in the place of imperfectly coloured glasses, by fitting to the open face of the catoptron a plane, colourless plate-glass, and charging the instrument with coloured liquids by means of a perforation through its side; and in this way we repeated, with entire satisfaction, all the preceding experiments, to which simple, plane specula are adapted, and with full confirmation of the phenomena already recorded.

Upon the same principle, hollow specula, charged with coloured liquids, may be employed in the first form of the catoptron; but having accomplished our object, we leave it to the ingenuity of those who have leisure and inclination to extend the inquiry, there being no end to the aptitudes of nature and art.

The subject of the present chapter is, therefore, an infinite one, and we might proceed to the investigation of catoptric colours by the media of coloured lights, the endless variation of the specula and objects, and innumerable combinations and expedients; but the foregoing experiments will be sufficient to denote the powers of the catoptron and conduct the inquirer; while our principal intention has been accomplished by the confirmations of chromatic theory afforded by the phenomena detailed, and the demonstrations they afford of the uniformity of regulation by which the whole science is governed, under whatever mode it may be investigated.

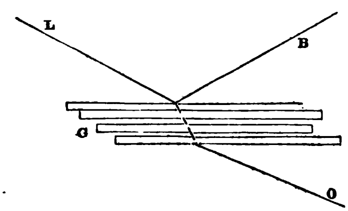
484. It is sufficiently apparent throughout these experiments, that, in every instance in which colour is produced, it is by an agency and reagency of light and dark objects and media, and that the double images from single objects are effected by double reflection and refraction of the spectra. Their colours are therefore to be explained upon the same principle as those of prisms and lenses; if *light* be refracted from, into, or upon *dark*, a

blue or cool colour is produced, and if, *vice versâ*, dark be refracted from, into, or upon light, a warm compound of yellow and red, complementary of such blue, is induced; but if the medium be coloured, then the light receives the colour of the medium, and the dark becomes complementary, as will also be found when coloured prisms and prismic lenses are employed.

485. In the appearance of a double image of the object reflected from coloured specula, the one, which we have called *the image of the object, is from the anterior surface of* the speculum employed, and is of the colour of the glass; the other, *its spectrum, is from the posterior surface of the speculum*, and is of the complementary colour of the glass; and these images are refracted in different degrees and directions, according to the law of refrangibility for the colour of the speculum, and when, on turning the catoptron on its axis, the image and spectrum cross each other in part, such part becomes of the neutral colour of the object, and in the proper direction of the object refracted.

486. All such colours conform to the relations of coloured shadows and ocular spectra. If the objects viewed be *light* ones, the images and spectra take correlative colours, which, on changing the objects for *dark* ones, or doubling the specula, become transposed, and the law of *dichroism* throughout these experiments is invariable.

486A. If a ray of light, L, as in the following figure, be thrown on a lamelar transparent substance, or a bundle of plane glasses, represented in section at G, as in Experiment XLII., it will be partly transmitted and divided into a *positive or photogenic* ray, B, by reflection, and a *negative or*



sciogenic ray, O, by refraction; and when in place of the bundle of glass a plane-coloured lens is substituted, and a light or dark object is viewed by double reflection therefrom, as in the preceding experiments, the reflections will be positive and negative, or complementary. Thus, from a *blue* glass the object reflected from the anterior surface will be blue, and that by transmission from the posterior surface *orange*, in correspondence with B and O, of the divaricated ray L, of which they are the polarised equivalents, and being thrown together would reconstitute the neutral light, L.*

* The reader desirous of information concerning polarised light will find it amply detailed in the "Encyclopedia Metropolitana," art. *Light*, by Sir J. F. W. Herschel; and those who wish assistance in their experiments may best obtain it from the intelligent and obliging Mr. W. H. Darker, of Paradise Street, Lambeth.

487. Whether the chromatic phenomena of *polarised light*, so called, may not be wholly interpreted upon the principle of catoptric colours, as similar effects of more compounded reflections and refraction, according to uniform laws, may merit the further consideration of the natural philosopher and optician, since it is evident that all polarised colours by reflection belong to this division of optical chromatics; all light and colours being, as we have shewn, polar, analogously to the galvanic, electric, and magnetic elements. Chap. XII.

488. Although the specular colours here treated of have not engaged the attention of natural philosophers, they have not so entirely escaped the scrutinising eye of the poet. Thus Spencer, in his "Elegy on Sir Philip Sidney," before quoted, has this apposite simile,—

> "The sky, like *glass of watchet hue*,
> REFLECTED Phœby's *golden* haire."

But the earliest records of philosophy have usually been those of the poets, and we have had many occasions of remarking that our earlier poets were attentive observers of Nature, and drew many of their most beautiful comparisons and figures from her abundant analogies.

489. The foregoing experiments and observations, selected from our occasional and desultory investigation of this delightful branch of optics, might have been widely extended had it been the

leading subject of this work; but as it may be thought by some that we have already exceeded the bounds of a proper subordination, we will add a few more words only, and have done.

490. The *chromascope* is evidently capable of great variation in its construction and application, and much remains to be done in the formation and adaptation of the *lensic prisms*. When similar solid wedges of coloured glass, of pure hues and adjusted intensities, shall have been constructed, they will contribute to the simplicity, permanence, and perfection of the *metrochrome*. And as to the *catoptron*, although it need hardly have greater simplicity, it is capable of a much more diversified combination and application than that to which we have subjected it. For all these instruments also, a suitable chamber, resembling the magic lantern, for employing them with artificial lights, should be constructed, all of which would improve their application and facilitate research in the hand of an ingenious inquirer.

491. The chief intentions of these contrivances have been, 1st. by giving new powers to the prism in the chromascope and augmenting refraction, to analyse light and colours more effectually, and to determine upon what evidence the infrangibility of the homogeneal colours of Newton rests. 2d. By adapting prisms to a mode of measurement by graduated transmission in the metrochrome, to confirm our doctrine of the specific powers, relations, and harmony of colours, by a standard, and, finally, to illustrate the whole of chromatic science

by natural analogy through the coincident phenomena of reflected colours in the catoptron.

492. Upon the whole it has appeared, that whether we experiment upon the inherent colours of pigments, the transient reflected colours of specula, the like refracted colours of prisms, or the transmitted colours of transparent liquids, &c., they present the same uniform relations, in the disclosing of which our design terminates; nevertheless, we have not ceased to intend, during the last thirty years, to pursue our inquiry in a way that might carry these instruments to such relative perfection as to qualify them for more general use, but having accomplished our primary intentions by the foregoing experiments, our ulterior design has given way to more urgent avocations. The field of research is, however, open, and all who may have leisure and inclination for such inquiries will find ample space for the exercise of ingenuity, with a fair prospect of beautiful and instructive developements, while laudably cultivating a philosophic taste. It has happened, indeed, that many intelligent friends have taken great interest in these inquiries, some of whom have passed away, while others have joined in our pursuit with a zeal truly gratifying, in mentioning whom we cannot deny ourself the pleasure of recording a distinguished patron of science in a kindred nation, Charles N. Bancker, Esq., of Philadelphia.

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N.B. The figures refer to the No. of the paragraphs.

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