

VI. *On certain Peculiarities in the Double Refraction and Absorption of Light exhibited in the Oxalate of Chromium and Potash.* By Sir DAVID BREWSTER, K.H. LL.D. F.R.S.

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THIS remarkable salt was put into my hands about the end of the year 1832, by Dr. WILLIAM GREGORY, of Edinburgh, to whom I have been indebted for much kind assistance in carrying on my inquiries respecting the action of coloured bodies in absorbing definite rays of the spectrum. A very brief examination of its optical properties was sufficient to indicate its more obvious peculiarities, and a short notice of these was published at the time. Having received, however, from Dr. GREGORY a very fine group of well formed crystals, and having had an opportunity in the spring of 1833 of observing their action upon the spectrum, both in their solid state and in the state of aqueous solution, I am now able to present to the Society a general view of the results which I obtained.

The oxalate of chromium and potash occurs in flat, irregular, six-sided prisms. The two broadest faces are inclined to each other like the faces of a wedge, whose sharp edge is the summit of the crystal. These faces are considerably rounded, being parallel near the base, and inclined to each other about three degrees at the apex of the prism. The incidence of the broad faces upon the adjacent faces of the prism is about 140° , and therefore these faces are inclined to one another at an angle of $180^\circ - 148^\circ \times 2 = 64^\circ$. The crystal is terminated by four minute planes equally inclined to the broad face and the axis of the prism, but two of these faces often disappear, and the crystal terminates in an oblique edge in place of a triangular apex.

If we call $A A'$ the broad faces of the crystal, m, m', m, m' the other four faces of the prism, and o, o', p, p' the faces on the summit, the following are the angles which they form with each other.

Incidence of A upon A in a line passing through the axis of the prism	$5^\circ 10'$
————— A upon m , and A' upon m'	$148 \quad 0$
————— m upon m	$64 \quad 0$
————— A upon o , and A' upon o'	$112 \quad 10$
————— A upon p , and A' upon p'	$112 \quad 10$
————— o upon o' , and p' upon p'	$50 \quad 10$
————— A upon A' over o, o' or p, p'	$4 \quad 36$

The crystals of oxalate of chromium and potash are, generally speaking, opaque; and at thicknesses not much greater than the twenty-fifth of an inch they are abso-

lutely impervious to the sun's rays. In this state their colour, seen by reflected light, is nearly black; but their powder is *green* in daylight, and of a *French grey* colour by candlelight. In the smaller crystals, which are generally the best formed, the colour both of reflected and transmitted daylight is *blue*, but that of candlelight is *purple*. I have not been able to find any distinct traces of cleavage.

This salt possesses a powerful double refraction, which is no doubt related to two axes. In reference to the axis of the prism the double refraction is *negative*, like that of calcareous spar. The greatest refractive index is about 1.605, and the least about 1.506, reckoning from a line near the boundary of the blue and green rays.

One of the most remarkable properties of this salt is the difference of colour in the two images formed by double refraction. At a certain small thickness the *least* refracted image is *bright blue*, and the *most* refracted image *bright green*, in daylight, or *bright pink* in candlelight. The *blue* contains an admixture of green when analysed by the prism, and the green an admixture of red, the red predominating over the green in candlelight. At greater thicknesses the blue becomes purer and fainter, and the green passes into red; and at a certain thickness the least refracted blue image disappears altogether, and the most refracted image is olive green. At still greater thicknesses this image disappears also, and absolute opacity ensues.

When the crystal is exposed to polarized light, with its axis in the plane of polarization, the transmitted light is *green*; but when the axis of the crystal is perpendicular to that plane, the transmitted light is *blue*.

When the oxalate of chromium and potash is dissolved in water its double refraction disappears, in consequence of the particles being released from the force of aggregation by which they are held together in the solid state, and by which double refraction is produced. The solution, however, exhibits the same general action upon light as the solid. At moderate thicknesses its colour is a dark blueish green by daylight, and a bright blood red by candlelight; but when we increase the thickness of the fluid it becomes of a *blueish pink* by daylight, and of a deeper *blood red* by candlelight, the *red* rays continuing to increase both in day- and candle-light, as we lengthen the path of the ray through the solution.

The most remarkable property of the oxalate of chromium and potash, and the one on account of which I have submitted this paper to the Royal Society, is its specific action upon a definite red ray lying near the extremity of the red portion of the spectrum. This is a property which is not possessed by any solid or fluid body with which I am acquainted, although I have submitted some hundreds of coloured bodies to direct experiment. Like all coloured bodies, the oxalate under our consideration exercises a general absorbent action on the spectrum. The smallest thickness of it, in which colour is scarcely discernible, attacks the *yellow* rays of the spectrum on the more refrangible side of the line D of FRAUNHOFER. As the thickness of colour of the solution increases, the *violet* rays are absorbed, and also all the *yellow*, *orange*, and less refrangible *green*, till the whole space D E, and part of the spaces on the other

side of the lines D, E, are wholly destroyed. In this state the prism gives two distinct images of objects, viz. a *red* and a *greenish blue* image, which are considerably separated. As the absorption advances, the *green* on the blue side of E, and the *blue* on the violet side of F, gradually disappear, till a *pure blue* image about F alone remains, and this too wholly vanishes by an increased thickness of the solution, leaving the red rays unabsorbed.

While these changes are going on throughout the spectrum, a specific action is exerted upon a red ray between A and B of FRAUNHOFER, and in that very part of the spectrum over which the solution exercises no general absorptive action. The sharp and narrow black band which is thus formed constitutes a *fixed line in all artificial lights*, and also in solar and day light, which will enable philosophers to measure the refractive powers of all bodies in reference to this line with an accuracy which could not otherwise be obtained, unless by the use of fine prisms of the refracting substances, which in most cases are unattainable.

In order to render this line or band of real use in practical optics, I have endeavoured to fix its place with as great accuracy as possible. Between the lines A, B of FRAUNHOFER there is a group of lines nearly bisecting the space A B, which he has marked *a* in his map. The dark band lies in the space B *a*; and if we designate it by the letter X, its position is such that $BX = \frac{1}{3} Ba$, or the index of refraction in the *Water spectrum*, of the rays which are absorbed at the band X is almost exactly 1.330701, the temperature of the water being 65° of FAHRENHEIT.

The relations of this salt to common and polarized light may be readily examined and finely exhibited by placing upon a plate of glass a few drops of a saturated solution of it in water. If the crystals are slowly formed they will be found of various thicknesses, each thickness exhibiting a different colour, varying from perfect transparency, through all shades of *pale yellow*, *green*, and *blue*, in daylight, and through all shades of *pale yellow*, *pale orange*, *red*, and *blue*, in candlelight.

BELLEVILLE, by *Kingussie*,
March 21st, 1835.