by Sir Isaac Newton in his experiments diffused a white rav, which was incident on its posterior surface in an angle of 30°, in such a manner that the extreme red ray emerged into air, making an angle of 50° 211/5' with the perpendicu­lar ; the extreme violet ray emerged in an angle of 51° 153/5'; and the ray which was in the confines of green and blue, emerged in an angle of 50° 481/3'. If the sine of the angle 30° of incidence be called 0∙5, which it really is, the sine of the emergence of the red ray will be 0∙77,, that of the violet ray will be 0∙78, and that of the intermediate ray will be 0∙771/2, an exact mean between the two extremes. This ray may therefore be called the mean refrangible ray, and the ratio of 771/2 to 50, or of 1∙55 to 1, will very pro­perly express the mean refraction of this glass ; and we have for this glass *m* = 1∙55. The sine of refraction, being measured on a scale of which the sine of incidence occu­pies 100 parts, will be 154 for the red ray, 155 for the mean ray, and 156 for the violet ray. This number, or its ratio to unity, is commonly taken to represent the refractive power of the glass. There is some impropriety in this, un­less we consider ratios as measured by their logarithms ; for if *m* be 1, the substance does not refract at all. The refrac­tive power can be properly measured only by the refraction which it produces ; that is, by the change which it makes in the direction of the light, or the angle contained be­tween the incident and refracted rays. If two substances produce such deviations always in one proportion, we should then say that their refractive powers are in that proportion. This is not true in any substances ; but the sines of the angles contained between the refracted ray and the per­pendicular, are always in one proportion when the angle of incidence in both substances is the same. This being a cognisable function of the real refraction, has therefore been assumed as the only convenient measure of the refractive powers. Although it is not strictly just, it answers ex­tremely well in the most usual cases in optical instruments. The refractions are moderate, and the sines are very nearly as the angles contained between the rays and the perpen­dicular; and the real angles of refraction, or deflections of the rays, are almost exactly proportional to *m—*1. The most natural and obvious measure of the refractive powers would therefore be *m —* 1. But this would embarrass some very frequent calculations; and we therefore find it best, on the whole, to take *m* itself for the measure of the refrac­tive power.

The separation of the red, violet, and intervening rays, has been called *dispersion;* and although this arises merely from a difference of the refractive power in respect of the different rays, it is convenient to distinguish this particular modification of the refractive power by a name, and we call it the *dispersive power* of the refracting substance.

It is susceptible of degrees ; for a piece of flint-glass will refract the light, so that when the sine of refraction of the red ray is 77, the sine of the refraction of the violet ray is nearly 781/2 ; or if the sine of refraction of the red ray, mea­sured on a particular scale, is 1∙54, the sine of refraction of the violet ray is 1∙57. The dispersion of this substance, being measured by the difference of the extreme· sines of refraction, is greater than the dispersion of the other glass, in the proportion of three to two.

But this alone is not a sufficient measure of the absolute dispersive power of a substance. Although the ratio of l·54 to 1∙56 remains constant, whatever the real magnitude of the refractions of common glass may be, and though we therefore say that its dispersive power is constant, we know that by increasing the incidence and the refraction, the absolute dispersion is also increased. Another substance shows the same properties, and in a particular case may produce the same dispersion ; yet it has not for this sole reason the same dispersive power. If indeed the incidence and the refraction of the mean ray be also the same, the dispersive power cannot be said to differ ; but if the inci­dence and the refraction of the mean ray be less, the dis­persive power must be considered as greater, though the actual dispersion be the same ; because if we increase the incidence till it becomes equal to that in the common glass, the dispersion will now be increased. The proper way of conceiving the dispersion therefore is, to consider it as a portion of the whole refraction ; and if we find a substance making the same dispersion with half the general refraction, we must say that the dispersive quality is double, because by making the refraction equal, the dispersion will really be double.

If therefore we take *dm* as a symbol of the separation of the extreme rays from the middle ray, *dm*/*m*-1 is the natural measure of the dispersive power.

It is not unusual for optical writers to take the whole separation of the red and violet rays for the measure of the dispersive power, and to compare this with the refracting power with respect to one of the extreme rays. But it is surely better to consider the mean refraction as the mea­sure of the refracting power ; and the deviation of either of the extremes from this mean is a proper enough measure of the dispersion, being always half of it. It is attended with this convenience, that being introduced into our computa­tions as a quantity infinitely small, and treated as such for the ease of computation, while it is really a quantity of sen­sible magnitude, the errors arising from this supposition are diminished greatly by taking one half of the deviation and comparing it with the mean refraction. This method has, however, this inconvenience, that it does not exhibit at once the refractive power in all substances respecting any particular colour of light ; for it is not the ray of any particular colour that suffers the mean refraction. In com­mon glass it is the ray which is in the confines of the yel­low and blue, in flint-glass it is nearly the middle blue ray, and in other substances it is a different ray. These cir­cumstances appear plainly in the different proportions of the colours of the prismatic spectrum exhibited by differ­ent substances. This will be considered afterwards, being a great bar to the perfection of achromatic instruments.

The way in which an achromatic lens is constructed is, to make use of a contrary refraction of a second lens to destroy the dispersion or spherical aberration of the first. The first purpose will be answered if *dm/n* be equal to

*dm'/n'*. For, in order that the different coloured rays may be collected into one point by two lenses, it is only neces­sary that—, the reciprocal of the focal distance of rays re­fracted by both, may be the same for the extreme and *m* -L *dm —* I *m'* 4- *dm' —* 1 mean rays, that is, that ! -4 :

*j n n'*

, 1 , -, 1 . , *m —* I 1 »»' —11 1

-I be of the same value with -, h —,

*, r n , n τ*

which must happen if — 4- be = 0, or — ≡ — *1 r n 1 n' η*

This may be seen in another way, more comprehensible by such as are not versant in these discussions. In order that the extreme colours which are separated by the first lens may be rendered parallel by the second, we have shown already that *η* and n' are proportional to the radii of the equivalent isosceles lenses, being the halves of these radii. In these small refractions they are therefore in­versely proportional to the angles formed by the surfaces