A diagram for use with the total-reflectometer.

(*With Plate VIII.*)

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THE accompanying diagram (Plate VIII) has been prepared in order to facilitate the determination of indices of refraction with the Kohlrausch total-reflectometer,[1] by affording a means of rapidly working out the results by a graphical method.

The Kohlrausch instrument enables measurements to be made of the critical angle θ, at which total reflection begins, when monochromatic light is reflected at the plane surface of a solid of refractive index μ immersed in a liquid of higher refractive index μ'. The relation between these quantities is given by the equation

$$\frac{\mu}{\mu'} = \sin\theta.$$

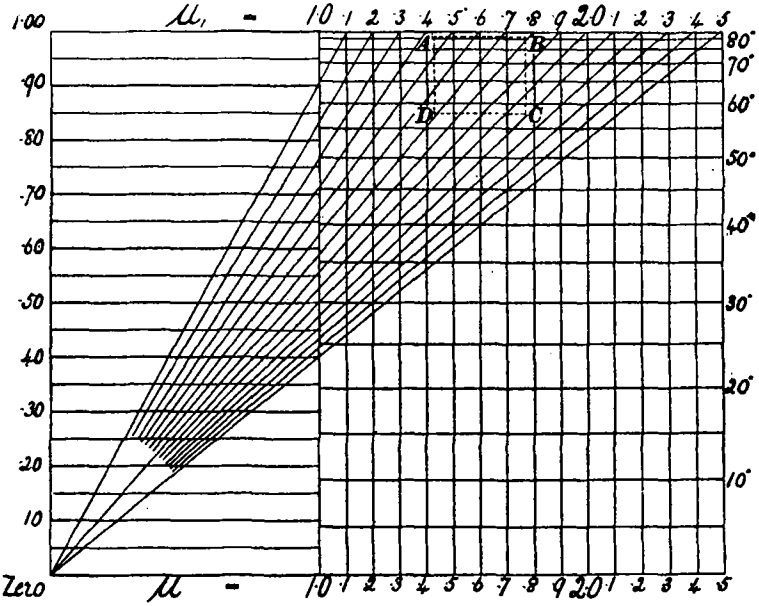
For any given value of μ', the relation between μ and θ may be expressed graphically by plotting as ordinates the values of θ in degrees, and as abscissae the corresponding values of μ; it is, in fact, given by a sine curve passing through the origin, and terminating on the line of 90° at the point corresponding to the value of μ', for when μ is zero, $\sin\theta$ and θ are also zero, and when $\mu = \mu'$, $\sin\theta = 1$, and $\theta = 90°$.

A diagram can, therefore, be made by constructing a series of these curves for different values of μ', by the aid of which any one of the three quantities μ, μ', θ, can be determined by inspection, if two of them are known. It is, however, difficult to draw these sine curves with the requisite degree of accuracy, and the calculation and plotting of the points necessary to determine them involves much labour. It is, therefore, better to use the values of the natural sines as ordinates rather than the angles themselves. When this is done, the curves become a series of straight lines radiating from the origin and intersecting the upper

[1] Compare A. Hutchinson, 'A universal goniometer,' Mineralogical Magazine, 1911, vol. xvi, pp. 100–108.

boundary of the diagram at points corresponding to the successive values of μ'.

The text-figure annexed shows a diagram constructed in this manner. On inspection it will readily be seen that only a small portion of it has any practical significance for our purpose. On the one hand, we do not require to determine indices of refraction lower than that of fluorite (1·433), and, on the other hand, the application of the method is limited to substances having a refractive index not greater than 1·83, owing to the non-existence of suitable liquids possessing refractive



indices above the latter figure.[1] The only part of the diagram actually needed in practical work is the area *ABCD*, bounded by the dotted lines. Plate VIII represents this area drawn to a scale about 17½ times as great as that employed in the text-figure. This amount of enlargement enables readings of θ to be made direct to 10′ over the greater part of the diagram and by estimation to 1′ or 2′; from 75° onwards the direct reading is to 15′.

[1] The possibility of preparing liquids of higher refractive index than 1·88 has recently been indicated by F. E. Wright, 'The methods of petrographic-microscopic research' (Carnegie Institution of Washington, Publication No. 158), 1911, p. 98.

The values of μ extend from 1·430 to 1·770, and thus include fluorite and corundum within their range. They can be read direct to 2 units of the third decimal place, and by estimation to 5 units of the fourth place or less, a degree of accuracy quite sufficient for many purposes. The curves are drawn for values of μ' ranging from 1·50 to 1·90; they thus include the index of refraction (1·89 about) of the highly refractive glass used for the hemisphere of the Abbe-Czapski total-reflectometer. The values can be read direct to 5 units of the third decimal place and by estimation to one unit..

In constructing the diagram, the values of θ and μ were first marked off, the positions at which the diagonal lines would cut the boundaries were then calculated, and the lines ruled in.

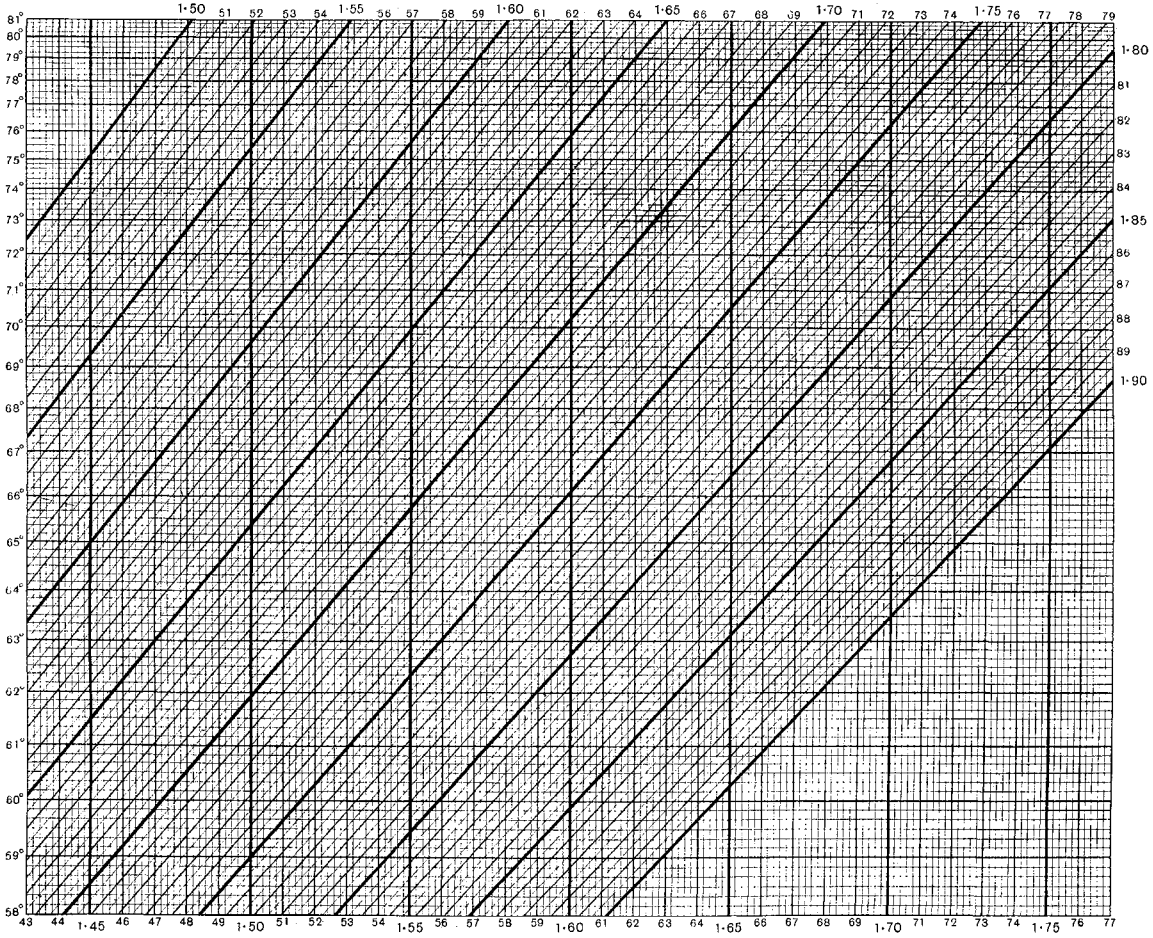
To illustrate the application of the diagram we will in conclusion give one example of each of the three cases which may arise:

Given $\mu = 1{\cdot}5105$, $\mu' = 1{\cdot}6545$;
θ by diagram $= 65° 55'$, calculated $65° 55'$.

„ $\mu = 1{\cdot}5105$, $\theta = 59° 13'$;
μ' by diagram $= 1{\cdot}7590$, calculated 1·7582.

„ $\mu' = 1{\cdot}7830$, $\theta = 65° 22'$;
μ by diagram $= 1{\cdot}6205$, calculated 1·6207.

In all three cases the calculated figures were worked out after those obtained from the diagram had been read.



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A. HUTCHINSON: TOTAL-REFLECTION DIAGRAM.