attributed to deformation oscillation of the benzene rings against each other. Further discussion of the results is not possible at present for want of data concerning the Raman spectrum of cadinene.

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August 2, 1949.

1. Sukh Dev Lala, "Thesis for Ph.D.," East Punjab University, 1948.

AN EQUATION FOR THE COMPARISON OF SURFACE TENSIONS BY UNSTABLE PENDANT DROPS

WORTHINGTON[1] has shown that whatever the liquid, if the quantity $\beta = 2b^2/a^2$ (where b is the radius of curvature at the apex, and a^2 is the capillary constant) is the same for two drops coming from tips of different radii r_1 and r_2, then the conditions for similar shape of the two drops are that

$$\frac{2b_1^2}{a_1^2} = \frac{2b_2^2}{a_2^2}.$$

When drops have similar shape, all corresponding linear dimensions of the two drops will be proportional to one another so that

$$\frac{b_1}{b_2} = \frac{a_1}{a_2} = \frac{r_1}{r_2}$$

and for a given shape, the equatorial diameter de of a drop is proportional to b.

$$\text{i.e.,}\quad \frac{b_1}{b_2} = \frac{\frac{de_1}{r_1} \times r_1}{\frac{de_2}{r_2} \times r_2} = \frac{de_1}{de_2}; \qquad \text{(i)}$$

where the subscripts 1 and 2 refer to similar drops of two different liquids. Recently R. C. Brown and H. McCormick[2] in considering the detachment of drops from a conical tip, have shown that, provided the angle of contact between the liquid and the surface of a conical tip is the same, *all* drops forming on a cone of given angle are similar in shape at the unstable stage. The condition of constant contact angle is, of course, achieved in practice by ensuring that the angle is zero, *i.e.*, that the liquid wets the tip.

Therefore for a given shape (say S)

$$\beta = \frac{g\,\sigma_1 b_1^2}{\gamma_1} = \frac{g\,\sigma_2 b_2^2}{\gamma_2},$$

where σ_1 and σ_2 are the effective densities and γ_1 and γ_2 are the surface tensions of the two liquids respectively.

$$\text{i.e.,}\quad \frac{\gamma_1}{\gamma_2} = \frac{\sigma_1 b_1^2}{\sigma_2 b_2^2}$$

and using equation (i),

$$\frac{\gamma_1}{\gamma_2} = \frac{\sigma_1\, de_1^2}{\sigma_2\, de_2^2}. \qquad \text{(ii)}$$

Equation (ii) permits one to calculate the ratio of surface tensions of two liquids, if it is possible to photograph hanging drops at the unstable stage.

This work arose as a result of my similar experimental investigations on surface tension problems under the direction of Dr. N. R. Tawde of this Institute to whom I offer my grateful thanks.

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June 22, 1949.

1. Worthington, *Proc. Roy. Soc.*, 1881, **32**, 362.
2. Brown, R. C., and McCormick, H., *Phil. Mag.*, 1948, **39**, 420.

THE MILLERIAN DIRECT SINE FORMULA AND THE CONVERSE COTANGENT FORMULA

THE Millerian Direct Sine Formula

$$\frac{\sin AB}{\sin AC} \times \frac{\sin DC}{\sin DB} = \frac{\begin{matrix} h\,k\,l \\ h'k'l' \end{matrix}}{\begin{matrix} h\,k\,l \\ p\,q\,r \end{matrix}} \times \frac{\begin{matrix} p'q'r' \\ p\,q\,r \end{matrix}}{\begin{matrix} p'q'r' \\ h'k'l' \end{matrix}}$$

and its converse cotangent equivalent, $p \cot AB - q \cot AC = (p - q) \cot AD$ (for anharmonic cases) and $\cot AB + \cot AD = 2 \cot AC$ (for harmonic cases) is without

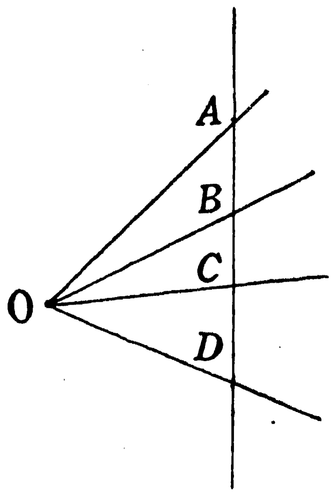

FIG. 1

proof in text-books of crystallography, possibly because it is simple. Tutton[1] remarks, "it is readily capable of proof"