LETTERS TO THE EDITOR

A Note on the Kinetic Theory Expression for the Viscosity of a Gas

BY an elementary application of the kinetic theory, the expression for the viscosity of a gas works out to be 1/3 $nm\bar{c}\,\Lambda$ where n is the number of molecules per c.c., m is the mass of a molecule, $\bar{c}$ the mean velocity and Λ the mean free path. This expression is approximate and differs from the accurate expression proposed by Chapman[1] by a numerical factor. A modified elementary procedure is suggested herein, which leads to an expression practically identical with that of Chapman. In the elementary derivation of the formula for viscosity, it is assumed that the number of molecules crossing a unit area from a lower layer to an upper layer (and *vice versa*) in one second is equal to 1/6 $n\bar{c}$. If one replaces this approximate expression by the correct one, *viz.*, $n\sqrt{\frac{RT}{2\pi M}}$ (where R is the gas constant, T is the absolute temperature and M the molecular weight), the final expression for viscosity is found to become,

$$\frac{1}{\pi}\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2} \text{ or } 0\cdot3185\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2}$$

where N is the Avogadro number and d is the diameter of the molecule. The accurate expression for viscosity derived by Chapman is

$$\frac{5\times1\cdot018}{16}\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2} \text{ or } 0\cdot3175\sqrt{\frac{MRT}{\pi}}\cdot\frac{1}{Nd^2}$$

A comparison of the two formulæ shows that by the modified procedure suggested herein, the expression obtained is practically identical with that got by Chapman, the difference between the two being barely 0·3%.

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[1] *Phil. Trans.* (A), 1916, **216**, 337.

A Note on the Effect of Finite Breadth of the Hammer Striking a Pianoforte String

IN a theoretical paper (*Bull. Cal. Math. Soc.*, 1937, **28**, 187) it has been shown by me that the finite breadth of the hammer has an effect on the duration of contact. In the said paper duration of contact ϕ is given by

$$\phi \quad \pi\sqrt{\frac{M(a \quad b)}{T_1}}.$$

where M stands for the mass of the hammer, a for the length of the shorter segment of the string measured from the mid-point of the struck portion, b for half the length of the contact and T_1 for the tension of the string. As in none of the previous experiments by other workers could this result be checked, fresh experimental study of the problem has been made by the standard photography-method.[1] The camera slider with the paper facing upward moves horizontally along the groove of a massive wooden piece; a rigid pendulum, at the end of which glass projectors of lengths ranging from 0 to 3 cm. are clamped, serves as the hammer; a carbon arc lamp illuminates a fine slit vertically down; a long tuning fork of frequency 100, gives delicate wave traces of considerable length and amplitude thus admitting high precision in time-recording; the slider moves under the weight of a mass and as it moves its other end drags a ball through water contained in a long vertical chamber to ensure constancy of velocity; the photographic paper passes under the illumined slit only during the interval from the time the hammer begins to strike the string to the time the hammer leaves it,—such synchrony being achieved by means of an electromagnetic automatic operator. The final photographs are measured with the help of a long-focus travelling microscope. As M, in the present case of a rigid pendulum, is tedious to find, the durations of contact are expressed as ratios of Φ_0—the duration when $b = 0$.

$a = 10$ cm.

Length of contact	$\frac{\Phi}{\Phi_0}$ (Experimental)	$\frac{\Phi}{\Phi_0}$ (Theoretical)
1·0 cm.	0·985	0·974
2·0 ,,	0·970	0·948
3·0 ,,	0·957	0·922

There is an agreement in the order of magnitude but the experimental results show the decrease of Φ with the increase of b to be smaller than what the theory predicts. A detailed analysis together with the effect of curved hammer is in progress and will be published elsewhere in due course.

I take this opportunity to acknowledge my indebtedness to my father Mr. K. K. Bose, M.A., for facilities he has offered to me to carry out this work and also to Prof. K. C. Kar, D.Sc. for his keen interest in the same.

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[1] M. Ghose, *Ind. Jour. Phys.*, 1932, 7, 365.

The Origin of the Tetraploid *Nicotiana* from Bathurst

In 1936 I received seeds from Dr. H. Wenholz, Australia, of Australian tobacco species. One package was labelled as "Wild tobacco, *Nicotiana* sp., Coll. R. G. May, Bathurst, N.S.W., immune or highly resistant to Blue mould, *Perenospora tabacina*". In the list of tobacco species sent kindly to me by Dr. Roy E. Clausen, California, *Nicotiana suaveolens* from Bathurst with doubled chromosome number ($n = 32$) was included. The plants that grew from the seeds sent to me by Dr. Wenholz originating from Bathurst were in many respects similar to *Nicotiana suaveolens* Lehm., and fit to the description given by Wheeler (1936) for the tetraploid *N. suaveolens* from Bathurst. They had 64 somatic and 32 gametic chromosomes, which means that they were tetraploids in respect to the Australian species having $n = 16$. A large number of Australian tobacco species as for example *N. suaveolens*, *N. maritima, N. velutina, N. excelsior,* etc., have 16 gametic and 32 somatic chromosomes.

Tetraploid *Nicotiana* species from Bathurst grew very vigorously. In favourable conditions it reached in height of about 180 cm., while *N. suaveolens* Lehm. in the same conditions reached a height of ca. 70–90 cm. The flowers of the tetraploid species were in many respects like those of *N. suaveolens,* the leaves were, however, much larger, somewhat broader and with uneven surface. The flowers of *N. suaveolens* have a very agreeable odour, while those of the tetraploid *Nicotiana* smell disagreeably like the flowers of *N. maritima,* though not as sharp as those of the latter species. The capsules of the tetraploid species are similar to