and the pressures are larger on the warmer side of the needle. It follows therefore that one can eliminate the radiation discrepancies by work done in partial vacuum. In fact with the exhaustion somewhat below 70 cm., I heated the ball M (restored) as far as was safe, 60°–70°, without obtaining any appreciable effect on the needle. This suggests the method of obtaining trustworthy static data.

Exhaustions of even 40 cm. give very good results. In Fig. 3 for instance, obtained with the new apparatus (scale distance 265 cm., therefore less sensitive), there is no drift and the whole motion soon becomes steady, so that the triplets (data given on the curve) become repetitions of each other. Between the turning points the motion is uniform.

A further important result was substantiated. The size of the triplets, or better the speed of uniform motion between the turning points was the same, independent of pressure, from a plenum up to 70 cm. In Fig. 3 some of these speeds are given as displacements per 5 minutes inscribed on the lines prolonged. Improvement would not be difficult. Hence these resistances independent of the pressure or density of the air must be due purely to the viscosity of the medium and it must be possible to express the gravitational attraction in terms of the viscosity of air. This project is further elucidated tentatively, in the next paragraph.

5. *Tentative Estimate.*—The resistance experienced by a sphere of radius, r moving in a viscous fluid (η) with the velocity $v = l\omega$, is well known to be $6\pi\eta rv$. I do not happen to be familiar with the corresponding expression for a cylinder of radius r, semi-length l and with hemispherical ends, moving broadsides on. To get a mere order of values, however, I will postulate, that for equal frontal areas,

$$\pi r^2 = 2r \cdot \Delta l$$

the resistances are alike. Thus the element of resistance is

$$dF = 6\pi\eta rv = 6\sqrt{\pi}\eta l\omega\sqrt{\pi r^2} = 6\sqrt{\pi}l\omega\sqrt{2r \cdot \Delta l} = \omega\eta\sqrt{24\pi r\Delta(l^3)}$$

and this is to be integrated for the double length of the needle ($2l$). To carry out the integration put $l = n \times 2r$ where n is a serial number. The equation becomes

$$\Delta F = 8\omega\eta r^2\sqrt{3\pi\Delta(n^3)}$$

and the problem is reduced to the summation of a series of cubes

$$2\sqrt{\Sigma n^3} = n(n+1),$$

the length being $2l$. Hence finally for two masses M, m, at a distance R apart, disregardin corrections,

$$\gamma = 8\sqrt{3\pi}\eta\omega(R^2/Mm)n(n+1).$$

The constants of the second apparatus were:

$$M = 1602 \text{ grams}, \; m = .563 \text{ grams},$$

$$R = 5.1 \text{ cm.}, \; 2r = .4 \text{ cm.}, \; 2l = 22.8 \text{ cm.}, \; \eta = .00019, \; n = 28.5.$$

In Fig. 3, the last three scale rates have the mean value 2.17 per 5 minutes, or

$$\omega = 2.17/300 \times 530 = .00001364$$

radians per second, the scale being off 265 cm. Inserting these data into the equation, $\gamma = .10^{-8} \times 6.2$, which is much closer to the standard value than, from the improvised apparatus and inadequate theory, I had expected to get. It sufficiently substantiates, I think, the assumed purely viscous character of the resistance and moreover shows that the constant of gravitation may probably be found, with precision, in terms of the resistance, in air, to the uniform motion, broad-sides on, of a cylinder with hemispherical ends.

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SCIENCE

A Weekly Journal devoted to the Advancement of Science, publishing the official notices and proceedings of the American Association for the Advancement of Science

Published every Friday by

THE SCIENCE PRESS

LANCASTER, PA. GARRISON, N. Y.
NEW YORK, N. Y.

Entered in the post-office at Lancaster, Pa., as second class matter