Letters to the Editor.

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The Tendency of Elongated Bodies to Set in the East and West Direction.

PERHAPS readers of NATURE will recognise the principle of the Eötvös torsion balance in the communication of Sir Arthur Schuster published in NATURE of October 20 (p. 240) entitled "The Tendency of Elongated Bodies to Set in the North and South Direction." The calculation there given is, however, incomplete, and this causes the sign of the effect to be reversed. For the hypothetical "normal case" a complete calculation shows that the tendency is rather for an elongated body to set itself in an east and west direction. The missing element in the calculation is the difference in the directions of the centrifugal force on the different portions of the rod. If we call λ the longitude, reckoned from the meridian of the centre of the rod, of an element ds of the rod at distance s from the centre, then approximately $\lambda = s \sin\phi / a \sin\theta$, where a is the radius of the earth and the remaining notation is the same as in the original communication. Since λ is small, we may write for the horizontal force perpendicular to the meridian of the centre of the rod $\sigma\rho\omega^2\lambda ds$; its moment is $(\sigma\rho\omega^2\lambda ds)(s\cos\phi)$, or, finally, since $\rho = a\sin\theta$, the moment of an element of length ds is

$$\sigma\omega^2 s^2 \sin\phi \cos\phi \, ds.$$

It is easily seen that the horizontal component of the centrifugal force is always directed outward from the central meridian, and therefore tends to bring the rod into the prime vertical. The above expression combines with the moment given in the original communication, namely, $\sigma\omega^2 s^2 \cos^2\theta \sin\phi \cos\phi \, ds$ (after correcting an obvious typographical error), giving

$$\sigma\omega^2 s^2 \sin^2\theta \sin\phi \cos\phi \, ds.$$

By integration along the rod we get for the entire turning moment

$$I\omega^2 \sin^2\theta \sin\phi \cos\phi,$$

where I denotes the moment of inertia, as in the original communication.

As a matter of fact, we must consider not only the effect of the change in direction and amount of the centrifugal force, but also the changes in gravity due to the departure of the earth from a spherical form. We have, in effect, treated the earth as a spheroid having an ellipticity due only to the direct effect of the centrifugal force—that is, an ellipticity of $\omega^2 a/2g$, where g is the acceleration of gravity. We may get the complete expression by writing instead of $\omega^2 a/2g$ the actual ellipticity of the earth, e. (This is not offered as a proof.) The result is

$$(2egI/a) \sin^2\theta \sin\phi \cos\phi.$$

In an article of mine published in the September issue of the *American Journal of Science*, and briefly noticed in NATURE for October 6 (p. 192), I have described the Eötvös balance from a different point of view, and have shown how the rod may be thought of as falling while turning about its axis of suspension, because, owing to the different curvatures of the different vertical planes, it actually diminishes its potential energy in turning. The prime vertical is the vertical plane of minimum curvature in the normal case, and it is towards this vertical plane that the body tends to turn.

Now experiments with the Eötvös balance have shown that the actual condition at any particular point is generally very far from normal, so much so that it is quite conceivable that at the place of Mr. Reeves's experiment the tendency should be more nearly towards the meridian than towards the prime vertical.

The body tends to set itself in the vertical plane of minimum curvature, wherever that may be, and if we reckon the angle from this plane the moment of the force acting is numerically

$$gI(1/R - 1/N) \sin\phi \cos\phi,$$

where R and N are the minimum and maximum radii of curvature of the level surfaces of the earth's gravity field at the point of observation. For the "normal case" this expression readily reduces to the one already given. Observations with the Eötvös balance enable us to determine for any point the value of $1/R - 1/N$ for the level surface passing through the centre of the rod and the directions of the principal planes of curvature of the level surface. There is also a second type of Eötvös balance in which a mass at one end of the rod is balanced by a weight suspended from the other by a fibre of some length.

To illustrate the erratic nature of the curvatures of the level surfaces near the surface of the earth when these are studied in detail, I take from the work of Prof. Soler ("Prima Campagna con la bilancia di Eötvös nei dintorni di Padova," Venice: Reale Commissione Geodetica Italiana, 1914) the following values of the angle β, which is the angle between the meridian and the direction in which gravity is increasing most rapidly. The normal value of β is zero. The actual values at a number of successive stations, all near Padua, were found to be 189°, 147°, 282°, 306°, 274°, 33°, and 304°. The balance used here was of the second type.

Although the curvature of any level surface near the earth is very irregular in detail, it is fairly regular on the average. That is, we may consider the level surface as made by superposing on a fairly smooth surface a number of undulations, short and sharp, but of small amplitude. The Eötvös balance picks up mainly the curvatures of the sharp undulations, while in ordinary geodetic work we get only a sort of average curvature of the surface on which the undulations are superposed.

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Washington, D.C., November 21.

Japanese Culture Pearls.

A NOTICE has recently appeared in the daily Press, signed by a number of jewellers, with reference to Japanese "culture" pearls. This notice, besides endorsing the opinion expressed by the diamond, pearl, and precious stones section of the London Chamber of Commerce that "the insertion of foreign matter placed in the oyster" disqualifies the culture pearl from competing with the pearl produced without the aid of man, declares that "cultured" pearls can be distinguished from Indian pearls.

The first of the above statements was justly ridiculed at the time it was made by Sir Arthur Shipley in a letter to the *Times* (May 7, 1921), and is not likely to be taken seriously by the more intelligent members of the pearl-purchasing public.

The second statement is, however, sufficiently inexact to be liable to mislead the public. The only established difference between the culture pearls now on the market and "Indian" pearls, a difference revealed by their different fluorescence under ultra-violet light, is one that holds good also for "naturally produced" pearls from the Japanese pearl oyster, and is due to minute differences in the optical properties of the nacre of the Persian Gulf and Japanese oysters. An attempt is thus made to depreciate culture pearls by confusing them with naturally pro-