The object of writing m for w/g, or of changing to the absolute unit of force and writing m for w, is merely to get rid of g in the dynamical equations, which concern the problems which alone are capable of direct human measurement.

But this quantity g, so treacherous as Dr. Lodge can testify, should always be kept carefully in sight; any attempt to get rid of it merely causes it to reappear elsewhere in an unexpected place (*expelles furca*, &c.).

The engineer can be left to take care of himself, and does not require to be instructed in an art with which he is perfectly familiar. Considering that he has been compelled to create for himself, without professorial assistance, the whole theory of the internal stresses of rapidly reciprocating machinery as causing vibration, it cannot be correct to say that *acceleration* does not come under his notice.

Certainly he often ignores acceleration in his dynamical equations, but that is because he prefers to use the principles of Energy and Momentum; and our elementary text-books would do well to imitate him.

As for Dr. Lodge's hint to the sailor, it is useless and even dangerous for navigation, because it gives the distance of the offing in military land miles; instead of geographical nautical miles, as required, of sixty to the degree.

I am reminded of another delicious hint from a theorist to practical men, taken from a recent text-book of Theoretical Mechanics; the gunner is instructed not to use his favourite whip-on-whip tackle, nor the sailor to set up the backstay in the usual manner, because the theoretical writer finds the Third System of Pulleys practically useless, the strings of his model always becoming twisted.

An engineer can generally be provided with some quiet enjoyment in looking through the pages, and especially the diagrams, of our numerous treatises on Elementary Mechanics, and he will smile at the mental pabulum chopped up small for the benefit of the rising pedagogue.

In this discussion, Prof. T. W. Wright's excellent Mechanics has been lost sight of; it is a complete contrast to our ordinary elementary text-book.

I thoroughly agree with Prof. Wright that the introduction of the *poundal* has done more harm than good, and that it will never be employed, even by Electricians always working in absolute units, who will confine themselves to the Metric System.

The world will never take kindly to saying that the weight of a pound weight is 32·1912 poundals, so long as it is at rest on the table; but that the weight changes immediately to 32·2382 poundals when we toss the weight in the air.

February 6. A. G. GREENHILL.

Symbols of Applied Algebra.

I AM sorry to trouble you with one more letter on this subject. Prof. Lodge objected to the energy formula $wv^2/2g$, and stated that he could only bestow his approbation on a formula which was "independent of every system of units." His example of such a formula involved three quantities of the same kind—namely, three lengths. Being invited to give a formula involving three different quantities—*e.g.* weight, volume, and specific gravity—which should come up to his standard, he gives $W = sV$. Now this formula is certainly independent of every system of units, in the sense that it cannot be used with any known system of units (not even accurately with the C.G.S. units).

To bring out this point, I inquired how this formula is to be used with the poundal. Prof. Lodge observes, in reply, that density is not a mere number, and that specific gravity may be measured in pounds per cubit foot. The former statement is irrelevant; the latter not true if "specific gravity" is taken with the meaning with which it is invariably used.

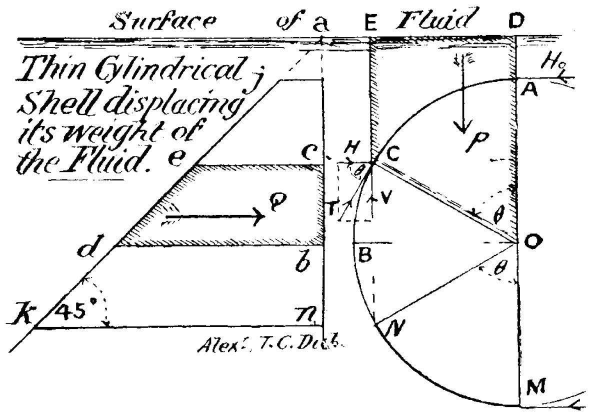
Dr. O'Reilly overlooks, I venture to think, the difference between postponing the consideration of the idea of "mass," and confusing it with "force." Of course, his comment on the formula $P/Q = f/\alpha$ is perfectly correct. C. S. JACKSON.

Equilibrium of a Cylindrical Shell.

AMONG some work on the design of arches which Dr. Thomson, of the Science College, Poona, and myself are preparing for publication in the engineering journals, the following elegant case of the equilibrium of a circular rib occurs. As it admits of a simple physical enunciation and a simple geometrical proof, I think it may interest your readers.

A thin hollow cylinder with a uniform circular shell is submerged in a fluid, and is lying with its axis horizontal. The fluid is excluded from the cylinder by smooth face-plates of the same density as the fluid. The weight of the shell is such that the cylinder displaces its own weight of the fluid. It is evident, then, that the cylinder, as a whole, is in neutral equilibrium, at any depth below the surface. But, further, if the shell be supposed to be perfectly flexible and incompressible, it is still in equilibrium under its own weight and the fluid pressure.

Let the figure represent a ring of the cylinder one foot long, normal to the paper, and let the unit of weight be that of a cubic foot of the fluid. Consider the equilibrium of the arc A C, and it will be seen that V, the vertical component thrust at C, is given by the area of the shaded trapezium E D O C, made up of the superincumbent mass of fluid E D A C, and the weight of the arc A C, which is exactly equal to the fluid mass O A C it displaces.



Again H, the horizontal component thrust at C is given by the area of the shaded trapezium $b\,c\,e\,d$, for H_0 has to balance the whole figure $b\,j$ when the equilibrium of the quadrant A B is considered, and has to balance H together with $c\,j$ when the equilibrium of the arc A C is considered.

Now the two shaded trapeziums have their parallel sides equal each to each, so that their areas are proportional to the distances between their pairs of parallel sides. Hence

$$H : V :: Q : P :: bc : ED :: \cos\theta : \sin\theta,$$

and it follows that the thrust at C is along the tangent to the circle there. In the same way the horizontal and vertical component thrusts at N are given by $n\,d$ and N D, and are again proportional to cosine θ and sine θ. THOS. ALEXANDER.

Engineering School, Trinity College, Dublin, February 9.

Oysters and Copper.

As Prof. Herdman, in his interesting letter on the oyster question, appears to doubt the occurrence of copper in oysters, it may be of interest to mention that, quite recently, I examined some oysters containing this metal in considerable quantity, a single oyster yielding ·04 grammes (about $\frac{5}{8}$ grain) of copper.

Some of the oysters were light blue in colour, and others were a dark olive-green, and copper was found in both.

These oysters had been obtained from the Mumbles, near Swansea. W. F. LOWE.

Assay Office, Chester, February 4.

I AM interested to hear of Mr. Lowe's case, where he considers the oysters from near Swansea owe their colour to a very considerable amount of copper. As I stated in the concluding paragraph of my last letter (p. 293), "It is evident that there are several distinct kinds of greenness in oysters." Amongst these I cited Dr. Thorpe's recent demonstration of notable amounts of copper in oysters from Falmouth; so it can scarcely be said that I "appear to doubt the occurrence of copper." Dr. Charles Kohn has kindly re-investigated the matter for me