we thereby determine an area, and we express this shortly by saying: "Area is derived from length." This is all we mean by the conventional term "derivation," and in stating the dimensions of a derived quantity we do not make use of any hypotheses.

Now there is no known process by which, having available only standards of mass, length, and time, we can fix and reproduce any temperature such as the ice point. To do that we require something more—for instance, that the mass shall be a mass of some particular substance having other properties than mere inertia, some one of which may serve as a fourth standard. There is no uncertainty in answering the question referred to at the beginning of this section; whatever Maxwell's demons might do, *we* cannot derive temperature from any three purely mechanical magnitudes. There can therefore be no doubt of the validity of Lord Rayleigh's deduction.

(3) Though the question suggested by M. Riabouchinsky's note is thus answered immediately by an appeal to facts, it may not be amiss to add a few words for those who have fallen into the habit of setting proportionality constants equal to unity and then forgetting all about them.

If we accept the molecular theory, the information it affords on the subject now in hand is that the numerical value of any temperature, on Kelvin's scale, is proportional to the mean molecular kinetic energy of an ideal gas which is at that temperature. We may describe this relation by writing $\theta/\theta_0 = T/T_0$, in which T and T_0 are the molecular kinetic energies at the temperatures θ and θ_0 respectively. Both members are pure ratios, and it is obvious that the equation does not furnish any dimensional relation between θ and T; and yet this equation embodies *all* the knowledge which the molecular theory affords on the matter under discussion. To say that the molecular theory authorises us to "define" temperature as the mean kinetic energy of the molecules, would be quite on a par with saying that a peach may be defined as a shilling because the number of peaches we can buy is proportional to the number of shillings we spend upon them, and, in some states of the market, not only proportional but equal. On our ordinary scale, an interval of time is proportional to the angle through which the earth rotates during that interval; but no one thinks of saying that we may define time as angle, or of assigning to time the dimensions of angle. Proportionality of numerical values does not imply qualitative identity.

As Lord Rayleigh remarks:—"It would indeed be a paradox if the further knowledge of the nature of heat afforded by molecular theory put us in a worse position than before in dealing with a particular problem." In reality, the worse position in which M. Riabouchinsky suggests that we place ourselves, would be due not to utilising further knowledge but to ignoring what we already have.

(4) Cases do occur, though the foregoing is not one of them, in which it seems doubtful, at first sight, how many independent units we ought to use. Such a doubt may arise when we ask ourselves if we ought not to use the law of gravitation to eliminate one of our three mechanical units, or the constancy of the speed of light to derive time from length. The discussion of this subject, which involves the question how we are to interpret "universal constants," must be postponed to a future occasion, but the following hint may be given of the conclusion to which such a discussion will lead.

Suppose that we have n independent simultaneous equations, involving $n+k$ quantities, and that we reduce them to a single equation. Each equation represents a single known fact, and when a given equation has been used once, there is nothing further to be gained by using it again; for only a formal and not a real change in the result can be thus produced. If one of the quantities is known to be constant, it may be removed from the list of variables before starting the reduction. But as regards the final result, it is immaterial whether the constancy of a particular quantity is recognised explicitly at the start or not until the end; the conclusion to be drawn regarding the quantities which do vary is the same in either case.

If, for example, the phenomenon under consideration involves the operation of the law of gravitation, as in Lord Rayleigh's problem of the vibration of liquid globe (NATURE, March 18), one of the facts of the problem is expressed by the equation $f=\gamma mm'/r^2$. We may treat the gravitation constant γ as one of the physical quantities involved in the problem, and use this equation to find its dimensions $[\gamma]=[m^{-1}l^3t^{-2}]$; or we may treat γ as a pure number and use the equation to eliminate one fundamental unit by setting $[m^{-1}l^3t^{-2}]=[1]$; but we cannot do both. The final result is in either case that given by Lord Rayleigh.

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Washington, November 23.

Grime's Graves Flint Mines.

PREHISTORIC archæologists will be grateful for the excellent account given in NATURE of November 18 of the report recently published by the Prehistoric Society of East Anglia on the excavations conducted in 1914 at Grime's Graves, Norfolk. It is evident that your reviewer regards the flint implements found at this site as referable to the Neolithic period, and while this view may possibly be correct, the present writer is of the opinion that a close and dispassionate study of the specimens recovered, and of the exhaustive report prepared by Mr. Reginald A. Smith, will not tend to foster any feeling of certainty on this point.

The question of the age of the flint implements found at Grime's Graves is of great importance, and can only be fully and adequately dealt with by experts in prehistoric archæology. The contributor of the article in NATURE is evidently a geologist, and I venture to enter a protest against his taking an authoritative part in the discussion on a technical subject altogether outside the realm of geology. Unfortunately, it does not seem to be generally recognised that the study of flint implements is of a highly complex and difficult nature, requiring as much, if not more, detailed knowledge than is required in many other sciences. The geologist would object, and rightly so, to a prehistorian giving an authoritative opinion upon a question of geology; the archæologist simply asks for a like immunity from inexpert criticism of his particular subject. Your reviewer has every right to give an opinion on the geological problems presented by the excavations at Grime's Graves, and there can be little doubt but that his opinions must carry weight. But the flint implements present a problem that can only be discussed with any profit by experts in prehistoric archæology.

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I inferred from the report of the "experts in prehistoric archæology," that if the various flint implements met with at Grime's Graves had been found separately in different localities, they would have been referred "authoritatively" to several successive periods of human culture. To aid them in dealing with this strange admixture of supposedly distinct industries, I merely pointed out that the geological evidence, so far as discovered, is perfectly harmonious and conclusive, showing that the deposits cannot be older than the Neolithic period.

A. S. W.