ing to this definition, the answer is "Zero," but ordinary people would calculate the result in millions of tons, from the data of the mean radius and the mean density.

Take again a question of a similar nature: "Prove that 288 pounds at the pole weigh the same as 289 pounds at the equator." To realise this question we must imagine a balance constructed of which the arm is curved into a quadrant of the earth, reaching along a meridian from the pole to the equator, and supported by a fulcrum in latitude 45°; then 288 pounds at the pole will equilibrate 289 pounds at the other end of the balance at the equator. Without requiring a balance with so long an arm, we can have 289 pounds at the bottom of the shaft of a mine weighing the same as 288 pounds at the surface, provided the shaft is of sufficient depth.

Some years ago, being troubled myself with this confusion of language, I wrote to Prof. Maxwell to ask him for a good illustrative example of the correct and incorrect use of the word "weight," and received the following characteristic reply on a postcard:—"Compare St. John xix. 39, ὡσεὶ λίτρας ἑκατόν, with the A.V. (authorised version), and keep to the original Greek." The translation in the authorised version is "about a hundred pounds *weight*."

Here we see that Maxwell recognised the ambiguous nature of the word "weight," and advised its omission wherever possible; but the exigencies of language compel us to use it; and in fact we shall generally find writers, even after the above incorrect definition of weight, proceed subsequently to use the word in its ordinary meaning of daily life.

I wish to repeat that writers on dynamics only create confusion in appropriating the word "weight" to the sense of the force of attraction of the earth on a body, as we never speak of "a force *weighing* so many pounds"; and I wish to support the language in ordinary use by engineers and practical men as perfectly correct in using the words "pound" or "ton" side by side in two senses, first as meaning the weight (or mass) of a body, and secondly as meaning the force with which the body is attracted by the earth; one being sometimes distinguished as a pound weight, and the other as a pound force.

If we use Prof. James Thomson's admirable word "poundal" for the British absolute unit of force, this slight confusion of terms will disappear, although engineers will still continue to think in gravitation units of force, as gravity is the one universal force from which there is no escape; and I fear it will be impossible ever to persuade them to think in C.G.S. units like the centimetre, gramme, dyne, erg, &c., which, though admirably adapted for the minute measurements of experiments in physics, are unsuitable for large magnitudes.

In conclusion, let the equation $W = Mg$ be dismissed from the text-books, as leading to statements such as "The mass of a body weighing W pounds is $\frac{W}{g}$;" the true equivalent equation being $W = M$, and therefore unnecessary; and with it let the confusing "astronomical unit of mass" disappear, and introduce instead the "constant of gravitation" in our equations. Let us also recognise that the primary idea of "weight" is the same as "mass," and form our dynamical definitions on the usages of ordinary language.

A. G. GREENHILL

Woolwich, February 28

Mr. Herbert Spencer's Definition of Life

I HAVE read with much interest the report in NATURE of Prof. Judd's address to the Geological Society, in which he attempts to show that Mr. Herbert Spencer's definition of life is not restricted to those cases only which display the ordinarily acknowledged characteristics of vitality; a certain correspondence between internal and external changes being displayed by minerals.

I write to draw attention to what I think tends to show that the mass of evidence brought forward really tells *in favour* of the definition; bearing in mind that the hypothesis of evolution "implies insensible modifications and gradual transitions, which render definition difficult—which make it impossible to separate absolutely the phases of organisation from one another" ("Principles of Biology," vol. ii. p. 10), and that consequently there can be no "absolute" commencement of life.

The fact, treated by Mr. Spencer when seeking a definition of life, that there is a correspondence between life and its circumstances gives the clue showing us that the "vitality of minerals" is a misnomer; a fallacy he himself exposes when he treats of the internal actions—the feathery crystallisation—displayed by the misnamed storm glass in correspondence with external changes. Using his own words, we see that:—

"Subtle as is the dependence of each internal upon each external change, the connection between them does not, in the abstract, differ from the connection between the motion of a straw and the motion of the wind that disturbs it. In either case a change produces a change, and there it ends. The alteration wrought by some environing agency on an inanimate object, does not tend to induce in it a secondary alteration, that anticipates some secondary alteration in the environment. But in every living body [in a living body, mark!] there is a tendency towards secondary alterations of this nature; *and it is in their production that the correspondence consists.* The difference may be best expressed by symbols. Let A be a change in the environment; and B some resulting change in an inorganic mass. Then A having produced B, the action ceases. Though the change A in the environment, is followed by some consequent change *a* in it; no parallel sequence in the inorganic mass simultaneously generates in it some change *b* that has reference to the change *a*. But if we take a living body of the requisite organisation, and let the change A impress on it some change C; then, while in the environment A is occasionally *a*, in the living body C will be occasioning *c*: of which *a* and *c* will show a certain concord in time, place, or intensity. . . . ." (vol. i. p. 78).

"That the word *correspondence* will not include, without straining, the various relations to be expressed by it," is best met by the reply "that we have no word sufficiently general to comprehend all forms of this relation between the organism and its medium, and yet sufficiently specific to convey an adequate idea of the relation; . . . The fact to be expressed in all cases, is, that certain changes, continuous or discontinuous, in the organism, are connected after such a manner that, in their amounts, or variations, or periods of occurrence, or modes of succession, they have a reference to external actions, constant or serial, actual or potential—a reference such that a definite relation among any members of the one group, implies a definite relation among certain members of the other group; and the word *correspondence* appears the best fitted to express this fact." (vol. i. p. 79).

In deer-stalking we see a realisation of these symbols. In the deer the primary internal change—the perception of odour, or, as I believe it is called, "winding"—is followed by that secondary internal change which induces a desire to increase the distance between the living organism and the inferred source of danger, a change differing not only in degree, but in kind, differing *toto cælo* from any of those actions which take place in minerals and crystals.

That the address contains many valuable facts furthering not only Mr. Spencer's view of life, but also his views of evolution, becomes apparent when we consider how it carries out and develops these ideas to an extent which would have been impossible at the time when the "Principles of Biology" were first published, now twenty years since. I say "furthering," for I wish now to touch upon a very important point, which I cannot but think has been much enlarged and amplified by Prof. Judd. It is to the much more expanded meaning which can now be attached to the fact *that the degree of life varies as the degree of correspondence between internal and external relations.*

For the correspondence displayed by a crystal or mineral is shown to be of a very much lower degree than that displayed by the simplest plant or animal. These latter present correspondences of greater complexity, greater rapidity, and greater length in the series of them than the former, which, during its long "millions of years," can respond only to the two or three forms of molar and molecular forces alluded to. The changes in the mineral simply respond to changes in the environment; whereas in an organism it is a *relation* between changes in it which responds to a *relation* between changes in the environment.

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An Equatorial Zone of almost Perpetual Electrical Discharge

THE recent reference in your columns to Edlung's theory of the aurora borealis, recalls a very curious observation that I