in an unsuccessful attempt to wrestle with the novelties submitted to consideration. The only possible consolation or reward is the thought that a brief notice may prevent others from a similar distress and dissatisfaction. To say that the author does not accept the first law of motion, will perhaps serve to indicate the kind of man with whom we have to deal. After this one will be prepared to believe that any amount of curiosities and world-worn paradoxes will be met with in this collection of some two hundred quarto pages.

The feature, however, which distinguishes this production from all other works of the same character is the numerous suns which the author is obliged to introduce in order to explain the motions of the earth and moon. For those who are so benighted as to accept the gravitational theory, as developed by Newton and his school, one sun suffices; but the new Principia requires at least four. First, we have a central sun occupying "the eccentric centre of an ideal sphere." This phrase is hard to understand. It is suggested that it may mean that an imaginary sphere rotates about a point not its centre. Round this "ideal sphere" we have a so-called polar sun, circulating with its cortège of solar bodies and their satellites. This sun is called a polar sun because it revolves in a plane approximately parallel to the axis of the earth; but in what the peculiar necessity of its creation consists, we have failed to fathom with distinctness, and fear to misrepresent the ingenious author. On the surface of this ideal sphere another sun, called the equatorial, also revolves, this time from west to east, in a "mean equatorial plane." These three suns are necessarily made to be non-luminous bodies, only recognisable by the effects their "eccentric attractions and orbital revolutions" exercise on the earth and moon. Finally we have the visible sun. Of these four, the central sun is the master-key of the whole system, from which energy radiates in every direction, upholds all the members of the system, while simultaneously holding them apart. And any one who is at all accustomed to this kind of literature will conclude, without any further warning, that electricity is the energy invoked to sustain this system. It would have been distinctly disappointing not to have had electricity introduced as the mainstay.

Those who wish to see how this complication can be made to explain the precession of the equinoxes, the motion of the lunar nodes and apsides, nay, the predominance of land and water in the northern and southern hemispheres of the earth respectively, and many other strange things, must be referred to the book itself. There is, in fact, only one sentence in the book with which we can cordially and entirely agree, and that is the first "Who," says the author, "Who will believe the theory of astronomical motion set forth in the following pages? Not the astronomers, certainly." We venture to assure him that he is perfectly correct in this conjecture.

W. E. P.

A Manual of the Geology of India. Second edition. Revised and largely re-written by R. D. Oldham, A.R.S.M., (Calcutta: Geological Survey Office. London: Trübner and Co., 1893.)

THE first edition of this book has been out of print for some years; meanwhile, Indian geology has greatly advanced, so that a revised and extended issue, bringing the work in line with the new results of the Geological Survey, has long been needed. Few are more capable of doing this re-writing and revision better than Mr. Oldham. He has had a wide and varied experience of survey work in India, and his acquaintance with the literature pertaining to the subject is evidenced by the "Bibliography of Indian Geology," compiled by him in 1888. Mr. Oldham has entirely altered the arrangement of the book. The original edition consisted of a series of descriptions

of separate districts; but in the present volume the rocks are described in chronological order. All references to economic geology are excluded, being relegated to the works specially devoted to it, while this deal with stratigraphical and structural geology. In the detailed table of contents, the excellent plan has been followed of indicating by a different type the matter which is new or entirely re-written in the present edition. A glance at this shows at once that Mr. Oldham has produced almost a new book. Especially interesting is the chapter on the "Homotaxis of the Gondwana System." Most geologists will remember the bitter controversy that once raged over the age of this system, but which has now died out. Mr. Oldham has made a detailed study of the rock-groups of the Gondwana system, and has compared them with their representatives in Australia and Africa. He has thus been able to show the relation of the Upper Palæozoic and Lower Mesozoic rocks of India, Africa, and Australia to those of Europe. The two last chapters in the book are entirely new. One deals with the age and origin of the Himalayas, and the other with the geological history of the Indian peninsula. In both of these a number of important questions are discussed in a scientific manner. Wherever Mr. Oldham has interpolated new matter, he has done it well. Unlike many other revisers, therefore, he has produced a restoration which really improves the old structure. The result is that the manual is once more the standard work on the present state of knowledge of the geology of India.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

The Weight of the Earth.

IN a letter in this week's NATURE, signed "The Reviewer," the writer does not notice that in the English language, and in all legal and common usages of it, including that of all scientific men in speaking of their weightings by ordinary balances, *weights* mean *masses*. The fact that the weight of the earth is 6.14×10^{21} tons is as clear as that the weight of a parcel of tea is 3 lb. It is the *heaviness* of a weight or mass that is a property accidental to its position, being less at the equator, greater at the poles, and nothing at the earth's centre. I have never yet heard a "box of weights" called a box of masses. I don't believe even "The Reviewer" calls it a box of masses. If carried to the centre of the earth it is still a box of weights, though the heaviness of the weights is zero.

The word "weight" is often used to denote the heaviness of a weight or mass. No dictum, either of "The Reviewer" or of myself can eliminate this ambiguity from the English language. But scientific men may greatly diminish the inconvenience of it, and may even tend to eliminate it altogether, if they persistently use the word "heaviness" when they mean heaviness.

May 12.

K.

"THE REVIEWER" makes a number of statements which he does not stop to prove; as, for instance, when he says that "the weight of a body would be practically nothing if the body was removed to a few million miles from the earth." But an appeal to experiment will show that the weight is unaltered. To fix the ideas, consider an astronomical or astrological chart, in which the earth is at the centre of a Zodiacal circle. Now, if a 100-ton gun is weighed in the scales of Libra, the weights required for equilibrium, as given by the lumps of metal in the other scale pan, will amount to exactly 100 tons; so that the weight of 100 tons at the distance of the Zodiacal circle, or at any other distance, is exactly 100 tons.

But if "The Reviewer" takes a ball of the mathematician's imaginary fine, weightless string, which he lets down from Libra to the surface of the earth, to the end of which weights can be attached, so as to equilibrate the 100-ton gun at the dis-

tance of the Zodiacal circle; now it is certainly true that a much smaller weight will suffice to produce equilibrium. Suppose, for instance, that the Zodiacal circle has a radius equal to the distance of the moon, or sixty times the earth's radius; then $22,400 \div 3600$, say, 6 lb., suspended near the earth's surface at the end of the string, some 240,000 miles long, will suffice to balance 100 tons in the other scale pan, close up to the Zodiacal circle. But if the 100 tons is also lowered down by another mathematical string to the surface of the earth, then 100 tons is required to equilibrate it; and so it will for any intermediate position, when the lengths of the strings are equal; so that it does not tend to any clear or useful end to say that the weight of 100 tons at the distance of the moon is only about 6 lb. On the contrary, the weight of 100 tons is everywhere 100 tons.

The *wright* of a body is the *that which* is measured in lb., tons, kilogrammes, or other standards of weight; and these standards are certain lumps of metal licensed by Acts of Parliament, and carefully preserved against change or degradation.

The weight of the Earth, for instance, as determined by the Cavendish experiment, is about 6×10^{21} tons; and it is not necessary to dig up the Earth and to weigh the fragments at the surface of the Earth for the determination of this weight.

It is too late now to change the meaning of a word that has been in immemorial use in all languages; such a quasi-Gothic revival would have to restore all literature, as, for instance, the lines of Quod (Art. Am. 3, 319):—

"Quæ nunc non neni habent operosi signa Myronis
Pondus iners quondam duraque massa fuit."

A. G. GREENHILL.

The Niagara River as a Geologic Chronometer.

WHEN we quote an author whose views coincide with our own, we are apt to speak of him as an authority on the subject; but when we dissent from the views we quote, we are not so apt to recognise the high authority of that author. This reflection on a phase of mental bias is suggested by a personal experience with reference to the age of Niagara Falls. The geologists and others who have discussed the length of post-glacial time may be rudely classed as minimists, maximists, and agnostics. Within the past five years I have been frequently and approvingly quoted by the minimists as estimating the portion of time consumed by the Niagara River in cutting its gorge at 7000 years, and the reputation thus acquired has not been noted without personal appreciation. But self-complaisance in that regard has been somewhat impaired by the thought that the honour is ill-founded, and that the insecurity of its foundation would sooner or later be discovered. Not less disturbing was the fear that when the maximists or agnostics took their turn at writing, I should be classed with the goats instead of the sheep. There can be no doubt that the manly and in every way proper course would have been followed had I years ago disclaimed the glory accidentally thrust upon me; but it is easy to bask in the sunshine of even unmerited applause, and conscience was too weak to determine action until another motive was added by a blow from the agnostic side. In his recent book Dr. James Geikie, after quoting me as an authority for the 7000-year estimate, adds that "all such estimates are in the nature of things unreliable." I now hasten to declare that I never said or thought that the period in question was about 7000 years. What I did incautiously say was, in effect, that the time allowance for the cutting of the gorge would be about 7000 years if the rate of the cutting were uniform, but that there was good reason to believe the rate had not been even approximately uniform.

Dropping personalities, which lack interest for your readers unless they involve principles, I beg to say a few words on the actual value of Niagara Falls as a chronometer. In 1844 James Hall made a map of the brink of the Falls, and established bench marks to which changes could be referred. Within a few years several other surveys had been made and connected with the first bench marks. It has thus become known, first, that in the middle of the Horseshoe Fall, where the principal body of water descends, the brink retrogrades at the rate of four or five feet per annum; second, that the American Fall, carrying a much thinner sheet of water, retrogrades so slowly that its rate is concealed by errors of survey. The gorge, which has been cut since the ice sheet retreated from the region, is six miles long, and the division of this distance by the annual rate determined for the Horseshoe Fall yields a period agreeable to the

minimists. Had the conditions remained uniform, no fault could be found with this estimate, but there is reason to believe that the conditions have varied enormously in nearly every particular. The thickness of the resistant bed at the crest of the Falls is far from uniform, and it was altogether wanting for part of the distance. During the period of gorge-cutting, the height of Lake Ontario, which gives base-level to the river, has varied through a range of several hundred feet. The volume of the river has doubtless varied somewhat through climate, but it has probably varied enormously by reason of changes in drainage systems, resulting chiefly from differential uplift. The Niagara now carries surplus water from the basins of Lakes Erie, Huron, Michigan, and Superior. There was probably a post-glacial epoch during which three of these lakes discharged their water in other directions, and only the basin of Lake Erie fed the Niagara River. During that epoch the volume of the river was so small that canyon-cutting was effected only by the feeble process now illustrated by the American Fall, instead of the vigorous process illustrated by the Horseshoe Fall. These considerations, which the inquiring reader may find more fully set forth in the annual report of the Smithsonian Institution for 1890, tend strongly to sustain the agnostic view of the Niagara River as a geologic chronometer.

G. K. GILBERT.

Washington, April 30.

The Teeth and Civilisation.

ON the 8th inst., Dr. Wilberforce Smith read a short communication before the Anthropological Institute on the teeth of ten Sioux Indians attached to the Wild West Show. His investigation showed that in regard to molars and premolars (the only teeth examined), these Indians were wholly free from caries. In the discussion which followed the reading of the paper, it was mentioned that the same fact was revealed in the skulls of the Fourth Egyptian Dynasty brought to England by Dr. Flinders Petrie, and in some skulls examined by Dr. Wilberforce Smith himself, which were derived from the ruins of Pompeii. The teeth of the Indians, both old and young, and those in the skulls just referred to, all showed more or less wear of the cusps, which is a most unusual circumstance in the teeth of modern civilised people, and it was thought that some difference in the food, or its mode of preparation, would be required to account for the absence of signs of wear in our time.

Now, it has never been proved that the increasing prevalence of caries is due to weakness of the teeth owing to comparative disuse, but there is nevertheless great probability in the inference, especially as signs of wear and freedom from caries appear to occur together, and *vice versa*. There is, however, a further point in regard to the existing liability to the attacks of caries which I think can be best explained by a transference of nourishment to other parts governed by the same nerves. On inquiry of several dentists, I find that the teeth most subject to decay are the molars, and of these the upper molars are more often attacked than those in the lower jaw. The molars of the upper jaw are fed by a branch of the fifth nerve, and in modern life this nerve has, perhaps, more strain put upon it than any other in the body. We use our eyes, partly supplied by the ophthalmic branch of this nerve, not at intervals, but often closely throughout a long day. And it seems, therefore, that with so many increasing calls on this bundle of nerve fibres, the filaments sent to the teeth are, by an automatic economy of expenditure, robbed of the energy necessary to perform their functions properly. The teeth through lack of use may not excite the nerves to natural action, and thus from both sides there is a failure of function, and the teeth are consequently more and more unable to resist the attacks of caries. I am disposed to attach some importance to this explanation, as I find that those who have great calls on their nervous energy are more liable to caries than people of quieter habit and slower temperament. Dr. Wilberforce Smith mentioned the alarming increase of dental decay amongst hospital nurses, whose occupation is certainly one demanding a constant drain on their nervous energy. It was also noted that people in towns lose their teeth more rapidly than those living in the country, which also bears out the idea here suggested. On the other hand, the savage is seldom required to strain his facial nerves continuously for any length of time, and in reference to general nervous expenditure he enjoys long periods of rest which are wholly denied to the civilised man in towns. No doubt in consequence of the excessive calls on our nervous energy the distribution of it is