

slipshod character of some of the forms of experiment recommended. The book will supply suggestions which will be found useful by some teachers, but the reference to apparatus unfamiliar on this side the Atlantic may be a slight bar to its adoption here. W. A. T.

### OUR BOOK SHELF.

*Elementary Geography of the British Colonies.* By George M. Dawson, LL.D., F.R.S., and Alexander Sutherland, M.A. With Illustrations. (London: Macmillan and Co., 1892.)

THIS volume forms one of the well-known geographical series edited by Sir Archibald Geikie. The part of it for which Dr. Dawson is responsible is that which deals with the British possessions in North America, the West Indies, and the southern part of the South Atlantic Ocean. Mr. Sutherland describes the British colonies, dependencies, and protectorates in the northern part of the South Atlantic, Mediterranean Sea, Africa, Asia (exclusive of India and Ceylon, which are described in a separate volume of the series, by Mr. H. F. Blanford), Australasia, and Oceania. Both writers have enlightened ideas as to the needs of those for whom such books are prepared. They have carefully avoided the bringing together of masses of uninteresting detail, their chief object being to convey a good general idea of the physical features and resources of the British colonies, and of the various ways in which these have affected the distribution of the population and the growth of industry and commerce. The facts are presented simply and clearly, and every page contains statements which an intelligent teacher would have no difficulty in using as texts for pleasant and profitable instruction. Most of the illustrations are from photographs, but there are also several very effective engravings from original drawings by Mr. Pritchett.

*Farmyard Manure.* By C. M. Aikman, M.A., B.Sc. (Edinburgh and London: Blackwood, 1892.)

WE are told in the preface that this little work is in substance a chapter from a larger work on "Soils and Manures," on which the author is at present engaged. Perhaps we may be excused if we fail to see the necessity of publishing this chapter separately in advance. It certainly contains much information from German works, such as Heiden's "Düngerlehre," but the book is written mainly from the chemist's point of view and not from the farmer's. The pamphlet gives one the impression of having been hurriedly prepared, but no doubt its deficiencies will be remedied in the larger book.

### LETTERS TO THE EDITOR

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*Peripatus* from St. Vincent.

SOME of the readers of NATURE will doubtless be interested to learn that, while collecting in St. Vincent on behalf of the Committee appointed for the investigation of the fauna and flora of the Lesser Antilles, Mr. H. H. Smith obtained five examples of the genus *Peripatus*.

The importance of the discovery, or rather rediscovery, of this Arthropod in St. Vincent rests upon the fact that the Rev. L. Guilding procured the first recorded examples of the genus in this same island. A description of these, under the name *juliformis*, was published by this naturalist in 1826, in vol. ii. of the

*Zoological Journal*. But from that time until now, a period of 66 years, no additional specimens have been brought to light in this locality; and since Guilding's types have been lost sight of, and his description of them is wanting in detail, the identity of *juliformis* has been involved in considerable obscurity. There can, however, be little if any doubt that the examples collected by Mr. H. H. Smith are specifically identical with those that Guilding described. Nevertheless this assumption receives more support from identity of locality than from the agreement that obtains between the description of *juliformis* and the specimens before me. The largest of these measures 43 mm. in length and 6.5 in width; the smallest, on the contrary, is only 13 mm. long. One example has 34 pairs of legs, two of them 33, one 30, and one 29. The colour of the lower surface may be described as fawn; that of the dorsal side varies from fawn to blackish grey.

Those who are familiar with Mr. Smith's qualifications as a collector need hardly be told that the specimens are on the whole in a satisfactory state of preservation. I consequently hope to be able to prepare a detailed description of the species, to be incorporated in the report upon the Myriopoda of the Lesser Antilles, the identification of the species of this group, together with that of the Scorpions, Pedipalpi, and fresh-water Decapoda, having been kindly intrusted to my care by the members of the Exploration Committee. R. I. Pocock.

Natural History Museum, May 27.

### The Line Spectra of the Elements.

I QUITE agree with Prof. Stoney that Fourier's theorem can be applied to motions which approximate to non-periodic motions in any assigned degree, and for any assigned time. And so the co-ordinates of any arbitrary motion may approximately in any assigned degree and for any assigned time be represented by formulas of this kind:—

$$a_0 + a_1 \sin\left(\frac{m_1 t}{j} + a_1\right) + a_2 \sin\left(\frac{m_2 t}{j} + a_2\right) + \dots + a_n \sin\left(\frac{m_n t}{j} + a_n\right),$$

where  $m_1, m_2, \dots, m_n$  are positive integers, and  $j$  must be chosen sufficiently large to suit the length of the assigned time. This is not the point in Prof. Stoney's reasoning to which I object.

What I want to say is this: If the motion is not periodical, the periods of the circular functions, as well as the amplitudes and phases, are not necessarily definite. That is to say, if we choose a larger value of  $j$ , to get a closer approximation for a longer time, the values of  $a, \frac{m}{j}, a$  do not necessarily approach definite values, but may become totally different.

Take, for instance, the equation—

$$t = 2j \left[ \sin \frac{t}{j} - \frac{1}{2} \sin \frac{2t}{j} + \frac{1}{3} \sin \frac{3t}{j} - \dots \right],$$

which holds good for all values of  $t$  between  $-j$  and  $+j$ . Prof. Stoney may say that Fourier's theorem can be applied to the function  $t$ . So it can, certainly, if an interval is assigned. But the amplitudes and periods of the single terms are not independent of the length of the interval, and do not approach definite values when the interval increases indefinitely.

The time during which the approximation is to hold good need not be indefinitely long. But the time must be long in comparison with the longest of the periods. Motions of the ether that are represented by such functions will be resolved by a diffraction grating into different rays, but others will not. Prof. Stoney has not noticed that a distinct property of the function is wanted in order to get a proper resolution into a sum of circular functions. His reasonings in chapter iv. of his memoir on the cause of double lines, &c. (Transactions of the Royal Dublin Society, 1891), refer to all functions with or without this property, and therefore do not seem to me to be correct. But I admit that my expression in the passage quoted by Prof. Stoney might have been clearer. C. RUNGE.

Techn. Hochschule, Hannover, May 19.

### Maxwell's Law of Distribution of Energy.

IN the current number of the *Philosophical Magazine*, Lord Kelvin describes a dynamical system in which when in stationary

motion Maxwell's law of distribution of energy would fail, assuming that law to consist in the ultimate equality of the energy of different parts of the system. He has thus shown the necessity for more accurate language than is commonly employed in the enunciation of that law, and a consideration of his problem may help to determine the limits to which it is subject.

The following statement, whether co-extensive with Maxwell's law or not, will probably be accepted as true as far as it goes—

If there exist a very great number of material systems, the state of each being defined by certain co-ordinates and momenta, and if at a given instant all combinations of the co-ordinates and momenta are represented among them with frequency proportional to  $e^{-h(x+T)}$ , then that distribution will be permanent—that is, will not be disturbed by the mutual action of the systems, or by any forces in the field of which they are placed, provided all the forces concerned be conservative.

The further question as to how far the solution thus found for the permanent state is unique, has been treated by Boltzmann. He shows that a certain function, which in stationary motion must be positive and constant, necessarily diminishes with the time, so long as any small deviations exist from the above described state. It is obvious that this proposition of Boltzmann's cannot be applicable to all cases of stationary motion. Periodic motions are exceptions, and so is the system described by Lord Kelvin. The question is what assumptions underlie Boltzmann's demonstration. It will be of great advantage if one speaking with Lord Kelvin's authority will assist in defining the limits to which the proposition is subject.

Maxwell, although he may at times have expressed himself incautiously, was aware that the theory was subject to limitations. The statistical, as distinguished from the historical, method was from his point of view of the essence of the theory. A distinction may be drawn between systems, such as Lord Kelvin's, to which the statistical method is inapplicable, and those in which the stationary motion, when attained, is what is called thermal motion—that is, the relative motions are in all directions indifferently, and of that irregular character in which heat is supposed to consist.

It may be that we shall be driven to the conclusion that Maxwell's law has no application except to this class of systems; that it is, in fact, only the limiting state to which a material system approaches as we increase indefinitely the number of its degrees of freedom.

It does, at all events, appear that in cases where the law fails, its failure is due to the introduction of some restrictions on freedom of motion, especially as regards direction. Maxwell pointed out that demons—or, shall we say, beings endowed with free will—might by directing the courses of individual molecules cause a system to violate, not only the law of distribution of energy, but even the second law of thermodynamics. What these beings might be supposed to do, that Lord Kelvin in fact does once for all for his system, by prescribing *a priori* the directions of motion and other conditions of the problem to suit his purpose.

H. W. WATSON.  
S. H. BURBURY.

#### The Former Connection of Southern Continents.

WITH reference to the very interesting question treated in Mr. Mellard Reade's letter of your issue of May 26 (p. 77), as to the former connection of southern continents, it may be worth while calling attention to the fact that a great circle, which I may call the Kaffraria Great Circle, connects that coast line with the Falkland Island and the South Georgia Island. It may be presumed that these two islands are the remaining summits of what was once a chain of mountains in connection with the continent of South America. Some of the points through which or near which this great circle passes are as follow—the above-mentioned islands, Port de Sta. Cruz, Patagonia; it traverses the Pacific, runs parallel to the southern branch of the Aleutian Islands, and cuts Kamtchatka somewhat south of Klienchewskaja Volcano, and traversing Asia emerges by the Island of Cutch, so interesting on account of the earthquakes which occurred there. It is of interest to note that South Georgia Island is antipodal to the northern extremity of Saghalian Island.

J. P. O'REILLY.

Royal College of Science for Ireland,  
Stephen's Green, Dublin, May 30.

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#### ON THE RELATIVE DENSITIES OF HYDROGEN AND OXYGEN.<sup>1</sup>

IN a preliminary notice upon this subject (Roy. Soc. Proc., vol. xliii. p. 356, February 1888), I explained the procedure by which I found as the ratio of densities 15'884. The hydrogen was prepared from zinc and sulphuric, or from zinc and hydrochloric, acid, and was liberated upon a platinum plate, the generator being in fact a Smee cell, inclosed in a vessel capable of sustaining a vacuum, and set in action by closing the electric circuit at an external contact. The hydrogen thus prepared was purified by corrosive sublimate and potash, and desiccated by passage through a long tube packed with phosphoric anhydride. The oxygen was from chlorate of potash, or from mixed chlorates of potash and soda.

In a subsequent paper "On the Composition of Water" (Roy. Soc. Proc., vol. xlv. p. 425, February 1889), I attacked the problem by a direct synthesis of water from weighed quantities of the two component gases. The ratio of atomic weights thus obtained was 15'89.

At the time when these researches were commenced, the latest work bearing upon the subject dated from 1845, and the number then accepted was 15'96. There was, however, nothing to show that the true ratio really deviated from the 16:1 of Prout's law, and the main object of my work was to ascertain whether or not such deviation existed. About the year 1888, however, a revival of interest in this question manifested itself, especially in the United States, and several results of importance have been published. Thus, Prof. Cooke and Mr. T. W. Richards found a number which, when corrected for an error of weighing that had at first been overlooked, became 15'869.

The substantial agreement of this number with those obtained by myself, seemed at first to settle the question, but almost immediately afterwards there appeared an account of a research by Mr. Keiser, who used a method presenting some excellent features, and whose result was as high as 15'949. The discrepancy has not been fully explained, but subsequent numbers agree more nearly with the lower value. Thus, Noyes obtains 15'896, and Dittmar and Henderson give 15'866.

I had intended further to elaborate and extend my observations on the synthesis of water from weighed quantities of oxygen and hydrogen, but the publication of Prof. E. W. Morley's masterly researches upon the "Volumetric Composition of Water" (*Amer. Journ. Sci.*, March 1891) led me to the conclusion that the best contribution that I could now make to the subject would be by the further determination of the relative densities of the two gases. The combination of this with the number 2'0002,<sup>2</sup> obtained by Morley as the mean of astonishingly concordant individual experiments, would give a better result for the atomic weights than any I could hope to obtain directly.

In the present work two objects have been especially kept in view. The first is simplicity upon the chemical side, and the second the use of materials in such a form that the elimination of impurities goes forward in the normal working of the process. When, as in the former determinations, the hydrogen is made from zinc, any impurity which that material may contain and communicate to the gas cannot be eliminated from the generator; for each experiment brings into play a fresh quantity of zinc,

<sup>1</sup> "On the Relative Densities of Hydrogen and Oxygen. II." Abstract of a paper by Lord Rayleigh, Sec.R.S., read at the Royal Society on February 18, 1892.

<sup>2</sup> It should not be overlooked that this number is difficult to reconcile with views generally held as to the applicability of Avogadro's law to very rare gases. From what we know of the behaviour of oxygen and hydrogen gases under compression, it seems improbable that volumes which are as 2'0002:1 under atmospheric conditions would remain as 2:1 upon indefinite expansion. According to the formula of Van der Waals, a greater change than this in the ratio of volumes is to be expected.