THURSDAY, MARCH 5, 1908.

THE EVOLUTION OF ASTRONOMICAL INSTRUMENTS.

Zur Geschichte der astronomischen Messwerkzeuge von Purbach bis Reichenbach 1450 *bis* 1830. By Joh. A. Repsold. Pp. viii+132. (Leipzig: Wilhelm Engelmann, 1908.) Price 16 marks.

IN all that relates to the mounting of telescopes or the construction of instruments intended for accurate measurements, in all that increases their convenience or adds to their efficiency, the firm of Repsold has won a world-wide reputation, and the book before us indicates in some measure the reason for this marked success. The head of the firm has been a keen and interested student of the history of past construction. For more than forty years, the author reminds us, he has been engaged in furthering the progress of instrumental construction, and in this time he has given close study to all that has effected the gradual development of this branch of engineering technique. He has assimilated all that experience can teach, has learnt the strength and the weakness of the work of past masters, and has profited by their example and their attainments. We now in our turn have the opportunity of benefiting by the results of this close study, perfected by much examination and sifting, and in addition to tracing the evolution of modern instruments we get glimpses of the history of astronomy, viewed from a new and interesting standpoint. Obviously, the connection between the progress of astronomical science and the improvement in instrumental equipment must be continuous and intimate, but how close the tie is can hardly be apprehended until we make a historical survey of the principles of instrumental construction, on a plan which reveals the part played by successive makers, and makes us understand to what extent astronomy has been forwarded by their endeavours.

Although the author limits his review from 1450, when Purbach strove to give expression to his mechanical ideas, to 1830, when Traughton in England and Gambey in France were representatives of the art of instrument making, the survey cannot be restricted to precise dates. At one end we listen again to the description of the contrivances of Ptolemy, which served for models through so many centuries, and at the other we are permitted to see the beginnings of the famous house of Repsold, destined to influence the methods of future artists.

The author passes in review the mechanical efforts of the Arabians, whose claims to consideration have been extravagantly championed by Sédillot and as stoutly disputed by Delambre. He acknowledges the skill of the devices which enabled them to solve approximately a particular class of problems by mechanical means, but cannot find much to praise in their measuring instruments. The astrolabe and the so-called "sextant" meet with adequate recognition, but a careful consideration of the facts, which are set out with the clearness bespeaking the practical expert, leaves the impression that the Arabians did very little to advance the means for making accurate observation. They imitated, they did not invent, and none of the generic improvements which have facilitated the subdivision of small intervals of time and space—the main problem which has engaged the attention of successive generations of instrument makers—on which accurate astronomy depends, can be placed to their credit.

Frequent reproduction has made us familiar with the forms of the instruments used by Copernicus and Tycho, who with Hevel may be regarded as the last representatives of a pre-telescopic age. But here, in addition to very complete illustration, we have from the pen of a competent authority a full technical description of those contrivances, accompanied by acute and illuminating remarks on the adequacy of the design to secure the end contemplated, the faults of construction, and oftentimes the reason for the adoption of particular methods. Down the stream of time this discriminating but generous criticism is pursued, necessarily affording a clearer insight into the difficulties and successes of individual artists.

The introduction of the telescope offered a new set of problems for solution. The continual increase in focal length compelled makers to abandon the sector form of instrument, such as the quadrant, and forced upon them the necessity of devising more appropriate means for measurement, though Halley and Bradley both used 8-feet quadrants. The employment of complete circles and the designing of instruments of greater symmetry in their several parts were the consequence, and no one displayed more ingenuity or foresight than did Römer. With justice, the author carefully discusses the work of this astronomer, whose claims to recognition have been very tardily admitted, mainly owing to Delambre's jealous partisanship of Picard. But Dr. Repsold has known how to do justice to the one without injury to the other. Römer in various ways anticipated modern design. His *machina domestica* was the prototype of the present transit instrument, his *rota meridiana* of the meridian circle, while his azimuthal instrument foreshadowed the introduction of the convenient universal instrument. The use of two bearings to carry a long axis of rotation, increased symmetry of structure, the adaptation of the reading microscope, the practice of determining instrumental errors by suitable mechanical means, were all as fully appreciated by Römer as they are to-day.

Considering how indispensable a micrometer is to a telescope, and how materially it increases the scope and usefulness, its evolution proceeded slowly, but the study of its many transformations is of singular interest. The urgency of the demand for the means of measuring the diameter of a planet seems out of proportion to its importance, but the solution of the general problem, containing as it does that of the accurate and convenient subdivision of small spaces, taxed the ingenuity of instrument makers severely. Huyghens proposed a thin wedge, which could be moved in the focal plane until the planet was exactly occulted, when the measurement of the breadth of the wedge at that point gave the diameter. A net-work of small squares in the focus of the eyepiece was another favourite device which might have answered very well if the object to be measured exactly fitted the side of the square. Picard seems to have first imagined the use of the screw to move two plates of metal, similar to the slit of a spectroscope, but to measure the distance, if we correctly understand the description, he had to detach the micrometer from the telescope and place it under an ordinary microscope. Hooke supplied the movable wires as an improvement to Gascoigne's micrometer, and Auzout introduced the divided head. Römer gave us the spring to take out the "loss" of the screw, Traughton added the position circle, and so the tale goes on, showing the variety of processes and the slowness of growth necessary to ensure the perfected form that receives general acceptance.

The processes followed in dividing the limbs of graduated instruments is another subject which the author's practical knowledge and great experience can render peculiarly interesting, but we can say no more than that in this treatise, with its admirable illustrations, will be found a valuable collection of facts from which one can trace that growth of mechanical skill and improved technique, which have ministered so materially to the progress of astronomical science.

NATURE AND NURTURE OF THE CHILD.

An Introduction to Child-study. By W. B. Drummond, M.B., C.M. Pp. iii+348. (London: Edward Arnold, 1907.) Price 6*s*. net.

The Child's Mind: its Growth and Training. By W. E. Urwick, M.A. Pp. xi+269. (London: Edward Arnold, 1907.) Price 4*s*. 6*d*. net.

MR. DRUMMOND, who is already well known as the author of a useful primer on the nature and nurture of the young child, has written a more ambitious book, which "aims at supplying a fairly comprehensive introduction to child-study." His work, therefore, necessarily covers a wide field, ranging from facts of growth, defects of the special senses, and school hygiene, by way of the instincts, habits and interests of children, to their forms of expression and their moral and religious characteristics. On all these he writes interesting chapters prefaced by sections dealing with methods of investigation and other introductory topics.

On p. 87 the student is wisely warned against the over-enthusiasm exhibited by "a number of workers especially in America," some of whom "start with no definite object in view and not unnaturally arrive nowhere." It would doubtless be unfair to suggest that this severe criticism applies not inaptly to the child-study movement as a whole. Nevertheless, on turning the last page of this book one is tempted to ask whether it is possible to secure "the chief end of child-study," which is, we are told, "not only to collect facts about children," but also "to formulate them in such a way as to make them available for science and for the use of those who need them for application to practical problems," so long as even such able exponents as Mr. Drummond give us little more than a mass of materials of widely different values, not always submitted to adequate criticism, and illuminated from no general point of view. This complaint should, however, be qualified by recognition that the author can scarcely fail to encourage sympathetic observation of children—a result with which he would, apparently, be satisfied.

By contrast with Mr. Drummond's book, the systematic unity of treatment that follows from adherence to a clearly conceived point of view is the most prominent characteristic of Mr. Urwick's. The author of "The Child's Mind" sees clearly that:—

"It is not sufficient for the purpose of education merely to collect and state facts drawn from these sciences [Biology, Physiology and Psychology] which seem to be relevant. . . . The rays of light coming from the different sciences must be focussed, passed, as it were, through a common lens, in order that the light thrown may be cumulative and concentrated rather than sporadic."

It may be said at once that he has performed the task thus indicated in such a way as to make his modestly announced "study" one of the most useful pedagogical treatises of recent years. He has given what is much more helpful than the best "psychology for teachers"—a consistent interpretation of the educative process as a whole as it presents itself under the more or less conventional conditions which actually determine it.

Mr. Urwick's treatment is based upon the modern concept of connation. Human behaviour can be analysed largely into connative processes which set towards or away from objects of positive or negative "immediate value." In relation to these immediate values other objects of perception or thought may have "final value." Education consists in the (indirect) teaching of a certain range of immediate values and the (direct) teaching of final values with reference to these. Thus immediate and final value replace in Mr. Urwick's scheme the Herbartian notion of interest. His treatment is in a sense complementary to the older doctrine, of which he gives fragmentary but interesting criticisms. The student will find it a valuable exercise to study "The Child's Mind" together with a representative exposition of the Herbartian psychology such as that of Prof. Adams.

T. P. N.

OUR BOOK SHELF.

The Essentials of Cytology. An Introduction to the Study of Living Matter. With a Chapter on Cytological Methods. By Charles Edward Walker. Pp. viii+139. (London: Archibald Constable and Co., Ltd., 1907.) Price 7*s*. 6*d*. net.

THE need for an elementary text-book on cytology has been felt for some years, and Mr. Walker has sought to meet it in the volume before us. There is much in the book that is good. The details of nuclear division in the higher forms are clearly presented, and the student is enabled to gain a clear idea of the process by means of the admirable and ingenious stereoscopic photographs which accompany the volume.

A considerable space is devoted to a consideration of the reduction phenomena which form such a striking feature in the cellular life-cycle of the great majority of animals and plants. But we cannot forbear from protesting against the introduction of what seems to us to be a totally unjustifiable confusion into current terminology. The term "meiotic phase," used to cover the processes connected with "reduction," was introduced to embrace the *two* mitoses which are intimately connected. In the course of the first of these the reduction in the number of the chromosomes is accomplished. Mr. Walker, however, speaks of the second meiotic division as post-meiotic, thus obscuring the close relationship that exists between the heterotype and homotype division, a relationship that is, partly at least, due to the fact that in the prophase of the first meiotic (heterotype) division, a fission in the chromosome rudiments takes place which will be consummated during the *second* (homotype) mitosis; this explains the common, though not invariable, absence of the spireme from the second division, and probably is connected with the rapidity with which the two mitoses usually follow on each other. The term post-meiotic should be (as it hitherto has been) reserved for those mitoses, if any, which occur after the completion of the meiotic phase.

The description given of polar bodies is made, doubtless by inadvertence, to read as though these structures only represented nuclei and not cells, whereas, of course, they are each severally homologous with the egg.

The book would be improved by the substitution of a more comprehensive account of the nuclei of the lower organisms for the matter contained in chapters x. and xi., which seems to us to be somewhat out of place in a work of this kind, as well as open to criticism on other grounds.

The addition of an introductory chapter dealing with the development of our knowledge of the cell, and the recognition of its paramount importance, would be useful when there is a demand for a second edition, and at the same time the references which appear at the foot of some of the pages might also be completed.

We have criticised the work somewhat frankly, perhaps, but this has been done not with the intention of condemning it. On the contrary, it possesses many very good qualities, and with some little modification and correction, it will easily rank as an extremely useful text-book of elementary cytology. J. B. F.

Immune Sera. By Dr. C. F. Bolduan. Second edition, re-written. Pp. viii+154. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1907.) Price 6*s*. 6*d*. net.

THIS book has its origin in a monograph by Wasserman, a translation of which was published by the author in 1904. This second edition has been rewritten by the translator. The original chapters are dealt with more fully, and the scope of the book has been widened by the addition of chapters on venins and antivenins, agglutinins, opsonins, and serum-sickness.

The antitoxins are first dealt with, and brief outlines are given of the history of the subject and of the methods of preparing and testing antitoxins. Ehrlich's views on the origin of antitoxin, on the constitution of diphtheria antitoxin, and on the nature of the combination between toxin and antitoxin, are treated in a lucid manner. The views of Arrhenius and of Bordet receive less adequate treatment.

In handling the subject of the agglutinins, the bacteriolysins, the hæmolysins, and the precipitins, much discrimination has been shown in avoiding a discussion of the more difficult theoretical considerations, and in selecting the fundamental facts and experiments for exposition.

A good account is given of the application of hæmolytic and precipitin methods to practical purposes. Among these may be mentioned methods of great importance in medico-legal work, viz., the biological tests for bloodstains by means of which it is possible to differentiate human blood from the blood of other animals.

The least satisfactory chapters in the book are those on serum sickness, snake venoms, and opsonins. In regard to the last, the author states that the results obtained by most workers in America fail to bear out Wright's claims for his method.

On the whole, this is an excellent little book, and ought to be of service both to those who wish to keep abreast of the main advances in the subject and to those who are attacking these questions for the first time.

A Guide to the Study of Australian Butterflies. By W. J. Rainbow. Pp. 272; illustrated. (Melbourne: T. C. Lothian, 1907.) Price 3*s*. 6*d*.

THIS is a useful little book intended for beginners taking up the study of Australian butterflies, with special reference to their life-history. Indeed, the author not only tells us in his preface that "much of the material in the way of life-histories is now published for the first time," but also, "Only those species of which something is known of their life-history are included in the present volume." Surely this last resolution is a double mistake. On the one hand it will be a great disappointment to any collector who meets with one of the purposely omitted species not to be able to discover from this book (perhaps the only one on the subject to be found within hundreds of miles) whether his find is known, or probably new; and, on the other, if attention had been directed to imperfectly known species, it would have largely conduced to efforts being made to supply the deficiencies in our knowledge. The book otherwise, however, seems to be very well executed, and is remarkable for being written almost entirely from Australian sources.

The classification followed is taken from Mr. G. A. Waterhouse's "Catalogue of the Rhopalocera of Australia." The frontispiece represents two handsome species of Delias and two of Papilio, while most of the species mentioned in the book are excellently figured, figures of the earlier stages being frequently added. The introductory chapters deal with transformations, parasites, collecting and preserving, &c., and are also freely illustrated, the figures of wing-neuration on p. 23 being particularly good. Ninety species are included in this little volume, distributed among six families as follows:—Nymphalidæ (sens. lat.), 35; Libytheidæ, 1; Lycinidæ (*sic*), 16; Pieridæ, 12; Papilionidæ, 9; Hesperidæ, 17.

We notice a few peculiarities in the spelling of some of the names, which appear to be not misprints, but intentional, such as *Xenica kluggi*, and Lycinidæ.

W. F. K.

The Theory and Practice of Perspective Drawing. By S. Polak. Pp. viii+184. (London: University Tutorial Press, Ltd., 1907.) Price 5*s*.

THIS volume of the "Organised Science Series" has been specially compiled to meet the requirements of the Board of Education's syllabus in perspective, and covers the ground of both sections A and B of that syllabus with their direct and inverse problems.

The method of treatment adopted by the author is one likely to be very effective in teaching; new principles and processes, as they arise in the natural development of the subject, are illustrated and driven home by the use of models, diagrams, and repeated applications to suitable problems, so that the conscientious student is always fully conversant with the reasons for his geometrical constructions. The very excellent and suggestive questions from the examination papers of the Board of Education for the last five or six years are freely employed, both in the text and as sample test papers, affording a good criterion of progress.

In addition to the ordinary geometrical solids, many familiar objects the forms of which can be dissected into simple geometrical figures are used as examples. After the student has thoroughly mastered the fundamental principles as set forth in part i., he should experience comparatively little difficulty with the three succeeding parts, which extend the subject to lines and planes obliquely situated, to shadows by parallel and divergent rays, and to reflections in horizontal and vertical mirrors. The book will be very acceptable both to teachers and students of this interesting branch of applied geometry.

Strength of Materials. By W. C. Popplewell. Pp. x+180. (Edinburgh and London: Oliver and Boyd, 1907.)

This text-book, which is based on the notes of lectures given by the author to day and evening students at the Manchester Municipal School of Technology, deals with the fundamental principles which must be mastered by every student who wishes to have a sound knowledge of machine and structural design. Special attention has been devoted to the effects of unequal distribution of stress, and in chapter vii. the author gives details of his own experimental work in connection with this branch of the subject. The last three chapters give an account of the methods adopted and appliances required in making tests of the various materials used in constructional work, and the important subjects of limit of elasticity and of the influence of previous loading, &c., upon the limit are discussed. In an appendix is given a table of strengths and weights of a large number of different materials, and there is a collection of useful examination questions for each chapter.

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.]*

Lithium in Radio-active Minerals.

The recent results of Mlle. Gleditsch (*Comptes rendus,* cxlvi., p. 331) corroborating those of Prof. McCoy, viz. that lithium is generally, but not always, a constituent of radio-active minerals containing copper, and that there is no fixed proportionality between the copper and the lithium in these minerals, must not be taken to have the exclusive significance which their authors attribute to them. As explained in our original communication to the Chemical Society, we are inclined to believe that sodium, and perhaps also potassium, are products of the degradation of copper salts when in contact with radium emanation. As both these metals are constituents of ordinary glass, and as the experiments were carried out in glass vessels, the only argument which was used was that the weight of the residue from the treated was greater than that from the untreated copper salt. Lithium was mentioned because it is an unlikely constituent of dust, glass, copper, &c., which were tested specially to prove its absence; it was certainly contained in the treated residue. Inasmuch as the emanation in contact with water yields neon, on the probable supposition that monatomic gases are produced from the emanation, it would follow that the production of any particular one is dependent on surrounding conditions. It will be remembered that the gases from the action of the emanation on a solution of copper sulphate contained no helium, but probably argon. As sodium and potassium are much more widely distributed than lithium, it is more likely that they are the chief products from copper, and that some modifying circumstance has determined the formation of a trace of lithium. Experiments now in progress in silica vessels will settle this point. Numerous chemical analogies might be adduced in favour of this view. For example, the action of bleaching powder on ammonia solution is to give nitrogen for the most part; if much ammonia be present, and if glue or some other colloid be present, hydrazine is the chief product. One can only be guided by such analogies in determining the lines of future experiments.

W. Ramsay.

Formation of Ground-ice.

In Canada we have made an extended study of the formation of ground-ice, or anchor-ice as it is called here, and consequently I was interested to see a letter in Nature of January 30 from Mr. Hampson asking for information as to its origin.

May I at the outset refer Mr. Hampson to four papers published many years ago which are wonderfully interesting to anyone studying the formation of ground-ice? Two of the papers appeared in the *Edinburgh New Philosophical Journal*, one by M. Arago, vol. xv., p. 123, 1833, and the other by the Rev. Mr. Eisdale, vol. xvii., p. 167, 1834. The two other papers were published in the *Phil. Trans.*, vol. cxxv., p. 329, 1835, and vol. cxxxi., p. 37, 1841, by the Rev. James Farquharson, of Alford.

In reply to the questions raised by Mr. Hampson, I may say that (1) the essential conditions for the formation of ground-ice on the bed of a river are clear weather conditions at night with the water at or near the freezing point, excessively low air temperatures by day, with no sunshine and no surface ice or other cover such as overhanging weeds or a bridge to check the nocturnal radiations. The answer to (2) is covered by the above. (3) A flowing river becomes stirred by eddy currents, and hence the cold surface layers find their way to the bottom. We notice many of our large rivers flow with a rolling motion. (4) The water is such a bad conductor of heat that it is only by the mechanical action that the bed of a river becomes cold enough to form ice on it when aided by radiation, or, as I have shown, by a slight supercooling in the water. (5) Ground-ice will form in water of any degree of agitation provided either or both of the causes mentioned in (4) are operating. In the case Mr. Hampson cites of the mill, I should say the heat generated by the water flowing through the mill would tend to prevent the formation of ice on the lower side.

In Canada we have anchor-ice formed in very large quantities in all the waterways flowing too swiftly for surface-ice to form. In some parts of the St. Lawrence it grows 5 feet or 6 feet in depth, forming very rapidly during the periods of intense cold and clear nights. On bright days the sun's radiant heat brings large quantities of it to the surface with much noise and disturbance. The buoyancy of large masses of the ice is often great enough to raise huge stones and boulders and carry them along in the current, depositing by this means portions of the river bed further down stream in the quieter waters. Boatmen are very careful not to cross the river when anchor-ice is rising, for fear of having a large mass come up under them and carry the boat helpless into the rapids. Under surface-ice, with its covering of opaque snow crystals, anchor-ice does not form, and hence it causes no trouble under these conditions.

Anchor-ice is known and studied in every country in the world where ice is formed, and there is much that might be written about it. In Nature of January 17, 1907, a careful review of my book on "Ice Formation," with special reference to anchor-ice and frazil, was given, and may help to answer some of the questions in the "long list" mentioned by Mr. Hampson. My paper read before Section G at the Leicester meeting of the British Association, and published with illustrations in *Engineering* for August, 1907, will convey some idea of the ice problem as presented to the users of "white coal" in Canada. In Russia, M. Wladimirop has published several important papers on his studies of the ice conditions on the Neva, in connection with the Waterworks Commission of St. Petersburg. One thing is well established, and that is that the formation of natural ice such as ground-ice, whether in Great Britain, Canada, Russia, France, Germany or elsewhere, conforms to the known laws of nature. Not a single known case of natural ice formation has ever come under my notice which has not its possible duplication in a laboratory experiment. The two differ only in the magnitude of their effects.

H. T. BARNES.

McGill University, Montreal, February 10.

The Possibility of Life on Mars

MR. DINES's important letter on the "Isothermal Layer of the Atmosphere" has obviously an important bearing on the question of the gases that have been retained or lost by the atmosphere of Mars. If the temperature of our atmosphere ceases to decrease when a height averaging 35,000 feet is reached, and then remains practically constant at an average temperature of $-47°$ C. whatever height be attained, we may expect somewhat similar conditions to prevail in the atmosphere of Mars, and naturally ask what are the temperatures which will allow of the escape of the different gases.

This question can be easily answered by a brief calculation from the data furnished on pp. 113 and 325 of Jeans's "Dynamical Theory of Gases" (1904). We find that at a temperature of $-175°$ C. hydrogen will be "certainly retained," while at $-65°$ C. it will be "certainly lost." The corresponding temperatures for helium will be $-81°$ C. and 136° C., and for water vapour 599° C. and 1583° C. From these figures it results that if the temperature of the isothermal layer of Mars be the same as the temperature of that of our atmosphere, hydrogen will be lost, helium probably retained, and water vapour clearly retained. I should imagine that in the case of Mars the isothermal layer will be much colder, especially as the carbonic acid that is present in the atmosphere of that planet will be concentrated in the lower levels.

Neither Prof. Lowell nor Dr. Russel Wallace appear quite to have realised the importance of the influence of carbonic acid on the atmospheric temperature at the surface of the planet.

It is now a commonplace of geology that a variation in the small percentage of carbonic acid in the earth's atmosphere will have an important effect on the temperature of the latter, though authorities differ as to the numerical amount of the variation required to produce a given change of temperature under given conditions. If the atmosphere contains a relatively large amount of carbonic acid, a correspondingly greater proportion of the heat received will be retained, and the temperature will be higher. Such conditions will be marked by luxuriant vegetation, and at the same time rapid formation of carbonates by the action of water containing carbonic acid on silicates and other minerals. This will eventuate in a period when there is less carbonic acid in the air, and colder conditions will prevail. The growth of vegetation and the decomposition of minerals will be checked and confined to the warmer portions of the earth's surface. The supplies of carbonic acid from intratelluric sources will then gradually add to the amount of carbonic acid in the atmosphere, bringing an increase in temperature with it.[1] There are features in the geological record which lend support to the view that such a cycle of changes has occurred more than once in the earth's history.

If, now, we make the very reasonable assumption that the crust of Mars is composed of the same minerals as those with which we are familiar, and its atmosphere of the same gases as ours, and that accessions of carbonic acid are received from the interior of the planet, we may expect a similar automatic adjustment of the temperature so that it is never too cold for the chemical reactions of carbonic acid in solution to take place, and for vegetation, such as that believed to exist by Prof. Lowell, to maintain itself somewhere on the surface of the planet. The amount of carbonic acid required for the purpose will, of course, be greater than that in our atmosphere, but there is no reason to believe that it would reach an amount which would be injurious to the life of plants or animals, even if such were similar in nature to those on the earth.

Whether Prof. Lowell can be considered to have established his views is a question on which I do not feel called upon to express an opinion, but I confess that the arguments advanced against them do not strike me as convincing. They remind me of those of the engineers who satisfied themselves that a locomotive could not draw a train of trucks on smooth rails, and were not persuaded to the contrary until they saw that it did so.

Imperial Institute, February 28. J. W. EVANS.

[1] I have stated the theory in its simplest terms. There are other circumstances that affect the amount of carbonic acid in the air. Prof. Chamberlin believes that the sea plays an important part in absorbing or giving out the gas according to the conditions that prevail.

A Fundamental Contradiction between the Electrical Theory of Dispersion and the Phenomena of Spectrum-series.

THE electrical theory of dispersion is based on the hypotheses (1) that electric waves are due to motions of electric charges, and waves of light in particular to vibrations of charges inside the atom; and (2) that these vibrations are governed by linear equations. On this basis we obtain the usual dispersion formulæ, *e.g.* that of Drude:—

$$n^2 - 1 = \sum \frac{N_h e^2_h}{\pi m_h} \frac{\lambda^2_h}{1 - \lambda^2_h/\lambda^2},$$

where n is the refractive index for wave-length λ, λ_h one of the free periods of a set of electrons in the atom, e_h the charge, m_h the mass, and N_h the number per c.c. of the electrons of the set, while the summation is for all possible free periods of the atom. In particular, if λ be greater than every one of the free wave-lengths of the atom, we get

$$n^2 - 1 > \sum \frac{N_h e^2_h \lambda^2_h}{\pi m_h}.$$

Consider the contribution of all the lines of the well-known Balmer series to the dispersion of hydrogen; for this series

$$\lambda_h = \lambda_\infty \frac{m^2}{m^2 - 4}, \; m = 3, 4, \ldots \infty,$$

where

$$\lambda_\infty = 3646{\cdot}13 \text{ A.U.}$$

Its contribution exceeds

$$\sum_{m=3}^{m=\infty} \frac{N_h e^2_h \lambda^2_\infty}{\pi m_h} \frac{m^4}{(m^2-4)^2}.$$

If the theory is to account for the lines of the series at all, the factor $N_h e^2_h \lambda^2_\infty / \pi m_h$ cannot vanish for any line; let A be its least value. Then the contribution exceeds

$$A \sum_{m=3}^{m=\infty} \frac{m^4}{(m^2-4)^2}.$$

The sum is obviously infinite; but all experience shows that for long waves the refractive index of hydrogen is nearly unity, and finite even for *luminous* hydrogen.

The same result follows for any series formula which implies that a series has (1) a tail; (2) an infinite number of lines the wave-length of which exceeds that of the tail, that is, for all known formulæ which agree with measurements either of line or of band series.

Thus we must either reject the usual notion of a series, and with it all the formulæ which represent our experience best, or we must reject the hypothesis that series lines are due to small vibrations of electric charges governed by linear equations, and with it the usual theories of dispersion and absorption, of the Zeeman effect and of magnetic rotation for series lines. G. A. SCHOTT.

Physical Institute, Bonn, February 17.

NOTES ON ANCIENT BRITISH MONUMENTS.[1]

VI.—DOLMENS.

IN some previous notes I have given an account of some measurements of the so-called "cromlechs" of Cornwall. In referring to this subject in a more general manner, it will be well, I think, *pour préciser les idées,* to refer to the word itself. In English works on archæology it is used as a variant for dolmens, chambered barrows, chambered cairns, and kistvaens, while in France it is applied to the more or less irregular circles and groups of stones associated with avenues; and there the equivalents of the Cornish "cromlechs," which exist in great numbers, are invariably called dolmens.

FIG. 18.—Devil's Den, Avebury, looking towards November sunrise.

It is convenient, therefore, to use the word dolmen when such structures are considered separately from the circles.

With regard to the examples available for measurement in Cornwall, the important, and indeed striking, conclusion was arrived at that almost all those given by Lukis were erected so that the sunrises at the May-year or solstitial festivals could be plies to other localities, and referred to other similar structures in S. Wales which gave the same results.

I now propose to go further afield, with the view of inquiring whether this law applies to other localities, and I will begin with one I have myself measured, the Devil's Den at Avebury.

The conditions at Avebury are as follows:—Lat. N. 51° 25′. Magnetic variation, 16° 40′ W., 1906.

Theoretical value of May-year azimuths.

	May True	May Magnetic	November True	November Magnetic
$1\frac{1}{2}$° hill: refraction and semi-diameter	N. 64° 26′	81° 6′	S. 61° 50′	134° 50′

My wife and I visited the Devil's Den, in company with Mr. R. H. Caird, in July, 1906, and again in August, 1907. The compass bearing was N. 134° E. looking eastward through the aperture formed by the three stones, and the height of the horizon in this direction was 1° 25′, thus agreeing with the value of the November sunrise given in the table.

Here then, as in Cornwall, the November and February sunrises, when the sun has a S. declination of 16° 20′, are in question.

It is well known that two of the most famous long barrows in England with their included dolmens are close to Avebury; one of them, the "West Kennet Long Barrow," is described in Smith's "British and Roman Antiquities of N. Wiltshire," p. 154. I condense his reference:—

"The 'West Kennet Long Barrow,' indeed, is one of the most notorious, as well as one of the largest of the Long barrows in the kingdom; and although it is much cut about, with a waggon-track passing over the centre of it, a confusion of large sarsens tumbled together at the east end, and several big trees occupying its sides,

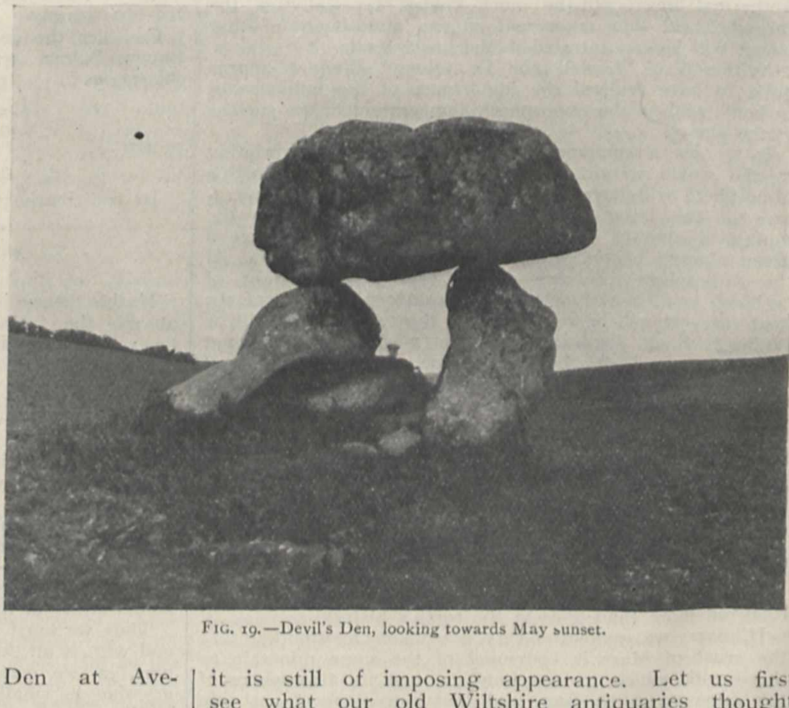


FIG. 19.—Devil's Den, looking towards May sunset.

it is still of imposing appearance. Let us first see what our old Wiltshire antiquaries thought of it, and then what it proved to be, when opened by Dr. Thurnam. Aubrey gives but a brief and very inaccurate description: 'On the brow of the hill, south

[1] Continued from p. 371.

from West Kynnet, is this monument, but without any name: It is about four perches long, but at the end only rude grey-wether stones tumbled together. The barrow is about half a yard high.' "[1]

Stukeley says of it[2]: "The other Long barrows are much exceeded by South Long Barrow, near Silbury Hill, south of it, and upon the bank of the Kennet. It stands east and west, *pointing to the dragon's head on Overton Hill.* A very operose congeries of huge stones upon the east end and upon part of its back or ridge, pil'd one upon another, with no little labour. . . . The whole tumulus is an excessively large mound of earth 180 cubits long, ridg'd up like a house."

Sir R. Hoare's account of it[3] is as follows:—"There are several stupendous Long barrows in the neighbourhood of Abury: one of the most remarkable has been recorded by Stukeley as situated south of Silbury Hill. It extended in length 344 feet: it rises, as usual, towards the east end, where several stones appear above ground: and here, if uncovered, we should probably find the interment, and perhaps a subterraneous kistvaen."

Dean Merewether states[4]:—"At the east end were lying, in a dislodged condition, at least thirty sarsen stones, in which might clearly be traced the chamber formed by the side uprights and large transom stones, and the similar but lower and smaller passage leading to it: and below, round the base of the east end, were to be seen the portion of the circle or semi-circle of stones bounding it."

I have given this somewhat long account because it shows that all information relating to orientation is omitted from it; it is generally, indeed, neglected by modern archæologists. Even Stukeley himself, though he was thoroughly acquainted with magnetic variation and at times used a theodolite, is caught napping in the case of this barrow. Fortunately, however, the apparently useless statement that the barrow points to the dragon's head on Overton Hill helps us, as this was a circle the site of which is known, though the stones have disappeared. This bearing (true) is N. 64° E. as determined from the 6-inch Ordnance map.

Here again, then, we deal with the May year and the May and August sunrises, still another argument in favour of Avebury and its region being connected with the May year.

I may next refer to some cromlechs near Dublin (lat. 53° 20′ N.), which were described by Prof. J. P. O'Reilly.[5] I give the results of his stated amplitudes in tabular form:—

Cromlech	Value given	Azimuth	Hill	Declination
	° ′	° ′	°	° ′
Glen Druid...	E. 24 30 N. ...	N. 65 30 E. ...	½ (assumed)	... 14 20 N.
Howth...	... E. 27 0 N. ...	N. 63 0 E. ...	½ (assumed)	... 15 44 N.
Mount Venus	E. 23 28 N. ...	N. 66 32 E. ...	0	... 13 5 N.
Shankill ...	,, ...	,, ...	,, ...	,,
Larch Hill ...	,, ...	,, ...	,, ...	,,

It will be seen that here again we are in all probability dealing with the May and August sunrises, when the sun has a declination of 16° 20′ N.

It is to be regretted that in Borlase's fine book on the dolmens of Ireland, the lack of all accurate statement touching the lie of the monuments renders its thousand pages and hundreds of illustrations quite useless for my purposes.

[1] From MS. in the Bodleian Library at Oxford, quoted in "Archæologia," vol xxxviii., p 407.
[2] "Abury Described," p. 46.
[3] "Ancient Wilts, North," p. 96.
[4] Proceedings of Archæological Institute, Salisbury volume, pp. 97, 98.
[5] Proc. R.I.A., iv., pp. 589–605 (1896–8).

After what I have suggested as to the probable use of dolmens, namely, that they were useful among other things as look-out places, it is not to be expected that only the rise of the sun would be found provided for. They should follow the precedent of the avenues, and be presented to star as well as to sun rise.

In two instances known to me the information is complete enough to enable a stellar use to be traced.

The first is at the Hurlers. Full details have been already given in my "Stonehenge."

The second is at Callernish (Turnsachan, lat. 58° 12′ N.). A good description of the stone monuments there, which include a circle, avenue and cromlech, is given in Anderson's "Scotland in Pagan Times" ("The Bronze and Stone Ages," p. 119).

They were, fortunately, also carefully surveyed by Sir Henry James.

We learn from Anderson that:—

"In 1858, Sir James Matheson caused the peat which had grown on the site of this monument to be removed. The average depth of the peat from the surface to a rough causewayed basement in which the stones were imbedded was 5 feet. In the process of the removal of this accumulation, the workmen uncovered the remains of a circular cairn, occupying the space between the centre stone and the east side of the circle. In the centre of the cairn was a chamber with regularly built internal walls, and a passage leading from it to the outside of the cairn, the opening being placed between two of the stones of the circle. The chamber was divided into two compartments by slabs placed across the floor, leaving an opening between their edges a little less than 2 feet wide. Beyond these slabs the inner compartment was formed of dry-walling in the sides, and a long slab set on edge at the back. The passage was about 6 feet in length, and 2 feet wide, entering the chamber between two slabs set on end facing the two on each side of the entrance to the inner compartment. The first compartment was 6 feet 9 inches from side to side, and 4 feet 3 inches from front to back, the second, 4 feet 4 inches from side to side, and 2 feet 1 inch from front to back on the floor, widening upwards in consequence of a slight inclination of the slab at the back. With the exception of a single stone, which was supposed to have been a lintel, there was no appearance of a roof, and there is nothing on the record of the excavation to show whether the roof of the chamber had fallen in, or whether it had been removed. It is not even stated what was the height to which the side-walls were found standing. But it is obvious at a glance that here we have a very peculiar construction,—a cairn containing a chamber divided into compartments, and furnished with a passage opening to the outside of the cairn."

From Sir H. James's plan we get the data necessary for orientation purposes. They are as follows for the sight-line from the chamber:—

Az.	Horizon (1″ map)	Decl.	Star	Date
° ′	° ′	° ′		
N. 74 30 E. ...	1 18 ...	8 54 N. ...	Pleiades ...	1330 B.C.

In 1330 B.C. and lat. 58° 15′ N. the Pleiades warned the May sun by about $1\frac{1}{4}$ hours; in 1901 B.C. the warning was of about 1 hour duration. Thus, taking into account the high latitude, with the consequently extended dawn, the Pleiades warning was more effective in 1300 B.C. than it would have been at the earlier epoch, at which, as I have previously shown, the stones of the long avenue were probably erected.

Prof. Morrow has recently sent me measures of the side walls of the curious structure on the N.E.

side of the circle of Keswick. These are doubtless to be considered in relation to the direction of the chambered cairn at Callernish. The rising of the Pleiades seems to have been in question.

Still another stellar dolmen I measured in S. Wales has already been referred to.

NORMAN LOCKYER.

EXPERIMENTS ON SCREW PROPELLERS.[1]

THE screw-propeller was practically applied to steamships by John Ericsson and Francis Petit Smith about seventy years ago. It speedily became a formidable rival to the paddle-wheel. Long ago it entirely superseded the latter for ocean navigation, and in more recent years it has to a large extent taken the place of the paddle, even in river steamers of the shallowest draught. Accumulated experience over this long period has proved of great advantage, and has enabled naval architects and marine engineers to meet new conditions in ships of much larger dimensions and higher speed; but notwithstanding this wealth of experience—largely based upon "progressive trials" of steamships and the analysis of the results—it is still true that we are on the threshold of exact knowledge in regard to the principles underlying the efficiency of screw-propellers.

Even in recent years, when the limits of experience have had to be surpassed, there have been many proofs of imperfect knowledge. On the whole, it is true that success has been achieved, but not infrequently as the result of numerous and sometimes costly experiments on propellers of different forms. Perhaps the most striking example of this general truth is to be found in the case of torpedo vessels and motor boats, driven at extraordinarily high speeds in proportion to their dimensions; it is also true that, in vessels of large size and of less speed in proportion to their dimensions, remarkable results have been obtained by a simple change of propellers. For instance, the *Drake* class of cruiser in the Royal Navy, which are the fastest cruisers afloat, had a guaranteed speed of twenty-three knots on an eight hours' trial. The guarantee was slightly exceeded in the first trials, but there was evidence that the propellers became relatively inefficient as the highest speeds were approached, and that the blade-area was insufficient. New propeller blades were made with greater blade area, and with these the ship was driven at a speed exceeding twenty-four knots, representing a gain of about 25 per cent. in efficiency. Obviously, incidents of this nature point to the possibility of very large economies if our knowledge of screw-propeller action and efficiency could be made more definite as well as more extensive. Trials in actual ships, especially those of large size, are necessarily costly, and are often impossible to make because the vessels are required on service. Hence, at a very early date, attempts were made to introduce a system of experiments with model screw-propellers, and from these useful information was obtained. It was left for the late Mr. William Froude to perfect the method of experiment in connection with his well-known system of "tank" experiments on models of varying ship forms; and his son, Mr. R. E. Froude, superintendent of the Admiralty experimental tank at Haslar, has carried on and developed the investigation so far as the pressure of other and more urgent experiments connected with the construction of ships for the Royal Navy has permitted.

The model propellers used by Prof. Durand were forty-nine in number, of 12 inches diameter, with bosses of uniform diameter (2·4 inches); all the models had four blades, and all the blades were elliptical in shape. Blade-areas and pitch-ratios were varied over wide limits, going beyond the range of variation occurring in actual practice. For example, the pitch-ratios tried extended up to 2·1 from 0·9 by differences of 0·2, and the blade-areas were carried down to unusually small proportions of the disc area. Great care was taken to shape the model screws truly and to measure the pitch accurately. For each propeller there was a determination of the power absorbed and the thrust developed for a given number of revolutions per minute, and a corresponding record of the speed of advance in undisturbed water. Practically uniform motion was ensured, and accurate measurements were made of time, distance and force. From these experimental data the actual and comparative efficiencies of the model-screws were ascertained, and the percentages of "slip" could be estimated. The facts are tabulated and graphically illustrated in the memoir. They require and deserve detailed study. In this brief notice it is not possible even to mention the most striking features. Prof. Durand briefly summarises his conclusions in regard to the character of the efficiency-curves of the different model screws, and supplements this section by a description of the method he recommends for applying experimental results to propeller design for actual ships.

One cannot peruse this memoir without regretting that, as yet, no British university, or public institution primarily devoted to scientific work, possesses an experimental tank such as is attached to Cornell University, the University of Michigan, and to the Technical High School at Charlottenburg. Its value for purposes of instruction is great; but its importance as a means of research can hardly be over-estimated. When tanks are closely associated with the detail-work incidental to the design of actual ships, the opportunities for research are less, and the interruptions of research-work more numerous and serious when undertaken in the intervals of ordinary employment. In other words, research has to give way to urgent demands connected with ship-designs, and the special apparatus required for research has to be removed or dismantled at short intervals. This has been the experience at the Admiralty tank, and at the two tanks attached to the shipbuilding yards at Dumbarton and Clydebank. A great need exists, therefore, in this the greatest shipbuilding and ship-owning country in the world, for an experimental tank in which research work on ship-forms and propellers can be undertaken systematically and uninterruptedly. This need has been recognised for a long time. The Institution of Naval Architects has made efforts to interest ship-owners and ship-builders in the establishment of such a tank at the National Physical Laboratory. Considerable support has been obtained from ship-builders and from a few ship-owners, but hitherto it has not been possible to secure the whole amount needed for the construction and equipment of the tank, estimated at 15,000*l.*, or for its maintenance, estimated at 1500*l.* a year. This failure is greatly to be regretted, and is not creditable to the community interested in shipping. It is certain that the investigations made at such an establishment would secure large economies and enable great advances to be made in the construction and propulsion of ships. In connection with screw-propellers alone there is a great opportunity for economies in coal-consumption, the benefits of which would be secured by ship-owners, and the amount of which in a single year's operations of our immense mercantile marine would far exceed the cost of the research-tank. Seeing that the United States and Germany already have a

[1] "Researches on the Performance of the Screw Propeller." By Prof. W. F. Durand. Pp. 61. (Washington: Carnegie Institution, 1907.)

distinct lead in this matter, it may be hoped that the scheme, which has been long delayed, will be realised before long, and the reproach wiped away that the country which equals all the rest of the world in its shipping and shipbuilding lags behind other countries in utilising the experimental methods due to that great English man of science William Froude.

Until recent years work done by the Froudes and published by permission of the Admiralty furnished the best information available for guidance in propeller design, especially when associated with progressive trials of steamships. The experimental methods introduced at Torquay and Haslar have been adopted and extended of late by other workers having command of specially equipped hydraulic laboratories or tanks. Amongst these the Washington tank, belonging to the United States Navy Department, has taken a leading position under the able superintendence of Naval Constructor Taylor, who received his training as a naval architect at the Royal Naval College, Greenwich. In addition to this establishment, the United States has the great advantage of possessing experimental tanks attached to universities; these tanks are necessarily more available for research-work than any establishment can be which is created primarily and regularly employed for experimental work bearing directly on actual ship-construction. Prof. Durand—whose investigations on screw-propellers specially claim attention in this notice—for ten years past has closely studied the screw-propeller problem. His later experiments have been made at the hydraulic laboratory of Cornell University; they are systematic and thorough within the limits of the scheme laid down. The method and results have been admirably described and summarised in a memoir of about sixty pages. The Carnegie Institution of Washington made a grant in aid of the experiments, and has published the memoir, thereby conferring great benefit on all who are concerned in the propulsion of steamships, and furnishing a fresh illustration of the encouragement given to scientific research in the United States.

NOTES.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election as fellows of the society:—Mr. W. Barlow, the Earl of Berkeley, Mr. Dugald Clerk, Prof. A. Dendy, Prof. H. H. Dixon, Mr. J. Stanley Gardiner, Prof. W. Gowland, Mr. J. H. Grace, Prof. D. J. Hamilton, Mr. C. I. Forsyth Major, Mr. E. N. Nevill, Mr. W. H. Rivers, the Hon. Bertrand Russell, Dr. Otto Stapf, and Dr. J. F. Thorpe.

A SPECIAL general meeting of the Geological Society will be held on April 1 to consider a resolution relating to the admission of women to full fellowship of the society.

IT is reported by The Hague correspondent of the *Globe* (March 3) that Prof. Kamerlingh Onnes, professor of physics in the University of Leyden, has succeeded in liquefying helium.

SIR OLIVER LODGE will deliver his presidential address to the Faraday Society on Tuesday, March 24. The subject of the address will be "Some Aspects of the Work of Lord Kelvin."

THE Paris correspondent of the *Times* reports that Prince Roland Bonaparte has placed at the disposal of the Academy of Sciences a sum of 100,000 francs (4000*l*.) to be employed in promoting discoveries by facilitating the task of investigators who have already given proof of their ability by original work, but who may lack the resources necessary for undertaking or pursuing their investigations.

PROF. J. R. BRADFORD, F.R.S., Sir T. H. Holdich, K.C.M.G., and the Duke of Northumberland, F.R.S., have been elected members of the Athenæum Club under the provisions of the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

DR. ARTHUR KEITH, lecturer on anatomy at the London Hospital Medical College, has been appointed conservator of the museum of the Royal College of Surgeons, in succession to the late Prof. C. Stewart.

PROF. MILNE's discourse at the Royal Institution on "Recent Earthquakes," announced for Friday next, March 6, has been postponed until March 20. The discourse on Friday next will be delivered by Prof. Love on "The Figure and Constitution of the Earth."

IN a footnote to Cowper's poem (Magnet edition, 1834), a remarkable meteor, August 18, 1783, and a fog which covered Europe and Asia during the summer of 1783 are mentioned, as well as an earthquake in Sicily of unusual severity. A correspondent asks for details of these occurrences, or a reference to records of them.

THE following officers of the Asiatic Society of Bengal have been elected for the ensuing year:—*President*, the Hon. Justice Asutosh Mukhopadhyaya; *vice-presidents*, Dr. T. H. Holland, F.R.S., Dr. G. Thibaut, Mahamahopadhyaya Haraprasad Shastri; *general secretary*, Lieut.-Colonel D. C. Phillott; *treasurer*, Mr. J. A. Chapman.

WE learn from the *Times* that the Russian Government is dispatching a research commission to investigate some recent discoveries of mammoth remains in the Yakutsk province of north-east Siberia. The commission consists of a doctor of zoology, of the Academy of Sciences, the senior curator of the zoological department of the academy, and six junior laboratory students. The expedition, which is expected to be absent for a year or more, is supplied with a grant of 16,000 roubles (1600*l*.).

THE report of the committee appointed by the Treasury to inquire generally into the work now performed at the National Physical Laboratory has been published as a Parliamentary paper (Cd. 3926), which also includes a Treasury minute recording the approval by the Treasury of the recommendations contained in the report of the majority of the committee. The opinion of the 1898 committee, that the work proper for a National Physical Laboratory to undertake should include not only physical research directly or indirectly bearing on industrial problems, and the standardisation and verification of instruments, but also—under proper restrictions—the testing of materials, is in the first place endorsed. The committee then distinguishes "commercial testing" into "contractual" and "investigatory" testing—"contractual" testing being the ordinary testing of materials to ascertain whether their quality and behaviour are in accordance with the requirements of contracts; "investigatory" testing the investigation for commercial purposes of various substances in which no question of contract arises. To place restrictions upon "investigatory" testing would, it is pointed out, hinder the advance of knowledge. The committee thinks that the laboratory should remain entirely free with regard to "investigatory testing," and, as a rule, be debarred from undertaking "contractual testing"—though electrical, thermal, optical, and other physical tests are to be regarded as exceptional, and such as the laboratory may undertake. In the second place, no restriction should apply, the committee reports, to "reference" testing wherever, in cases of dispute, the parties concerned agree to refer their differences to the authoritative decision of the laboratory, or where the laboratory is called in by a Court of law or of arbitration. Lastly, in view of the character of the laboratory as a public institution, the laboratory is to be free to accept any work which any Government department may desire to commit to it. Subject to these observations, the committee does not consider that any alteration is required in the scope of the work of the National Physical Laboratory as defined by the committee of 1898. In a note added to the report Sir Andrew Noble and Sir J. Wolfe-Barry express the opinion that the restriction recommended in respect of "contractual testing" should come to an end after a definite time—say ten years.

IN the report of the Maidstone Museum, Library, and Art Gallery for 1907, attention is directed to the unprecedentedly large number of visitors during the year. It is satisfactory to notice that special attention is being concentrated on the local collection in the Kent county room, for which a special subscription list has been opened.

WE have received from Messrs. Cassell and Co., Ltd., the first part of a revised and enlarged edition of Mr. R. Kearton's "British Birds' Nests." It is to be completed in sixteen fortnightly parts at the price of one shilling each. When the beauty and number of the illustrations—inclusive of coloured plates of eggs—are taken into consideration, the new issue is a marvel of cheapness, and should command a large sale.

IT is announced in the January issue of the *Emu* that active steps are being taken by the Australian Ornithologists' Union to make more effective the laws for the protection of egrets and birds-of-paradise, groups which are specially persecuted for the sake of their plumage. The union is likewise encouraging lighthouse keepers to record observations with regard to the birds that strike against the lighthouses on the Australasian coasts on migration.

ACCORDING to Mr. T. Southwell's notes in the February *Zoologist*, the Arctic whaling voyage of last year, so far as the prime object of pursuit is concerned, was a disastrous failure. The seven vessels which left Dundee captured, in fact, only three right-whales among them, one being little more than a "sucker," which yielded only half a hundredweight of whalebone. This juvenile was taken in Davis Strait, while the two larger whales were captured in Greenland waters. The two latter yielded 32 cwt. of "bone," the price of which is now about 2400*l.* per ton. It is noteworthy that during the last two seasons most of the few whales taken were from Greenland waters, where the species was supposed to be practically exterminated.

THE biting flies of India form the subject of Bulletin No. 7 of the Agricultural Research Institute at Pusa. The account, which is drawn up by Mr. H. M. Lefroy, the Government entomologist, is intended to pave the way for a full investigation into the natural history of these insects, and has been published to a great extent with the view of stimulating the collection of specimens all over the country. If such collection be carried out systematically, there is little doubt that a number of new species will be brought to light, especially among groups like the sand-flies, represented by species of minute size. The Bulletin contains two coloured plates of horse-flies and cattle-flies, with, in some instances, their larvæ and eggs as an aid to the identification of species.

WE have received copies of four papers recently issued by the Entomological Bureau of the U.S. Department of Agriculture. The first of these, by Dr. W. E. Hinds, is devoted to further investigations with regard to the capability of natural agencies for holding in check the ravages of the pernicious cotton-boll weevil. On the whole, a hopeful view of the matter is entertained. The factors in question are conditions of temperature and moisture, predaceous and parasitic foes, and food-supply. While it may be impossible to increase the effectiveness of these agencies, there is reason to believe that others may be caused to lessen materially the weevil's power of mischief. A second paper treats of the ravages of the caterpillars of the catalpa hawk-moth (*Ceratomia catalpae*) on catalpa trees, which are sometimes completely stripped of their foliage. The two remaining papers deal respectively with the lesser apple-worm and wax-moths in connection with bee-keeping. In the case of the latter it is shown that the idea that the larvæ of wax-moths are beneficial to bee-keepers is erroneous.

A REPORT on marking and transplantation experiments with plaice in Danish waters, by Mr. A. C. Johansen, has recently been issued by the Danish Commission for the Study of the Sea (*Medd. Kommiss. for Havundersøgelser, Ser. Fiskeri*, Bd. ii., No. 5). The report contains an account of experiments made by the Danish Government in connection with the international fishery investigations. It is shown that the rate of growth of plaice varies in different districts, a result which confirms the conclusions which have been arrived at by English fishery investigators. Considerable light is also thrown by the experiments on the migration of plaice in Danish waters. Much importance is attached by Johansen to the facts that in the experiments in the Horns Reef area the value of the recovered specimens surpasses the value of all the liberated ones, and that in the Kattegat experiments the size at which the value of all the recovered specimens is equal to the value of all the liberated ones is higher than the present Danish size limit for Kattegat plaice (*ca.* 25·6 cm.) From the latter result it is suggested that a size limit for plaice in the Kattegat somewhat higher than that now enforced by Denmark might be considered by the international authorities with advantage.

MR. S. YAMANOUCHI contributes to the *Botanical Gazette* (January) an account of sporogenesis in the fern genus Nephrodium, dealing with nuclear changes in *Nephrodium molle*. The author comes to the conclusion that in the normal life-history of the genus there is a reduction of chromosomes in sporogenesis, and that the first nucleus which contains the reduced number of sixty-four or sixty-six chromosomes is the spore; further, that the first division of the spore is heterotypic, but the reduction is only completed in the second homotypic division.

THE economic value of the sunflower plant as a source of oil yielded by the seeds not infrequently forms the subject of inquiry. From the account of the plant that is provided by Mr. D. Hooper in the *Agricultural Ledger* (No. 1, 1907), issued by the Government of India, it is evident that as a crop it offers little inducement to planters except in southern Russia—possibly also in China—where there is a local consumption of the kernels roasted or salted, and the oil is in request for culinary or edible purposes. The pamphlet contains information with regard to experimental cultivation in India and the United States of America.

An article communicated by the chief conservator of forests in Burma, Mr. F. B. Bryant, is published in the *Indian Forester* (December, 1907), in which a strong case is made out against continued fire conservancy in certain of the moist teak forests. The policy of fire conservancy continued over a period of years has resulted in excessive development of the bamboos *Bambusa polymorpha* and *Cephalostachyum pergracile*, which smother the young teak and other light-demanding trees. It is also pointed out that, owing to the presence of the latter bamboo, extensive regeneration of teak when the Bambusa flowers gregariously is likely to be frustrated. The sanction of the Government of Burma to the abandonment of fire conservancy in selected areas has already been granted.

An important article on the Douglas fir as a commercial timber tree is contributed to the Transactions of the Royal Scottish Arboricultural Society (vol. xx., part i.) by Mr. J. D. Crozier. Owing to the difference in the rate of growth, it is essential to distinguish between the "green" Oregon variety and the slower growing "glaucous" Colorado variety. The author alludes to the excellent results shown by pure plantations on the Grampians, but expresses the opinion that the Douglas fir is not adapted to mixed plantations unless with the Norway spruce. As a suitable crop for poor and exposed ground, Sir John Stirling-Maxwell recommends the mountain pine, *Pinus montana*. Three varieties are specified, the upright, the intermediate, and the dwarf forms. The first is the more valuable, and grows at high elevations, notably in the Pyrenees. The intermediate is principally useful for afforestation of heaths; the dwarf form has no sylvicultural interest.

The Director-General of Indian Observatories has issued a memorandum (dated December 6, 1907) on the meteorology of October and November, 1907, with a discussion of the conditions affecting the precipitation during the cold weather of 1907–8. These seasonal forecasts, although at present only general opinions based on past experience, are of very great importance both to the Government and to agriculturists. On the mean of the whole country, the rainfall in October was 52 per cent. and in November 31 per cent. in defect. The records of the last thirty years, including some selected from places outside India, show that conditions like those of the past season have been followed by a deficiency of precipitation in January more often than by an excess. The data then available for February throw very little light upon the probable rainfall of that month.

A touch of wintry weather has spread over the whole country during the past week, and somewhat heavy falls of snow have occurred over a large part of Great Britain, whilst the temperature has been lower than for some time past. Strong winds and gales have been experienced in many places, and since March set in our weather has been under the influence of cyclonic disturbances passing down the North Sea. The Summary of the Weather issued by the Meteorological Office shows that for the winter season—December to February—the mean temperature over the United Kingdom was nowhere very different from the average. The heaviest rainfall for the three months occurred in the north of Scotland, where the aggregate measurement was 17·19 inches, whilst the least aggregate fall was 5·21 inches, in the north-east of England. The winter rainfall was generally in excess of the average over the northern portion of the kingdom, but in defect elsewhere. The greatest excess was 1·61 inches, in the north-west of England, whilst the greatest deficiency was 2·65 inches, at the English Channel stations. The number of days with rain ranged from seventy-one in the north of Scotland to forty-seven in the south of England and the Midland counties. The greatest duration of sunshine for the winter was 203 hours, in the Midland counties, which is twenty-nine hours more than the average. The least duration was ninety-five hours, in the north of Scotland.

At the instance of Prof. Ricchieri, of the Accademia Scientifico-Letteraria, Milan, the reader of a paper on the spelling of place names at the sixth International Geographical Congress, held at London in 1895, the organising committee of the ninth International Geographical Congress, which is to meet at Geneva on July 27 to August 6, has placed on the list of agenda of the congress the following question:—What are the principal difficulties in the way of arriving at an international agreement on the transcription and orthography of geographical names, and in what manner can they be surmounted? Prof. Ricchieri, believing that if this problem is to be solved at all it can only be by slow stages and methodical procedure, proposes that all that should be aimed at in the first instance should be a preliminary understanding among a few men of different nationalities interested in this question as to the fundamental points on which it is necessary that a final agreement should, if possible, be reached, and that a statement of those points should be laid before the congress at Geneva, which should then be asked to appoint a small committee to study and procure the discussion of those points, and ultimately to draw up proposals and resolutions thereon. He further suggests that this committee should be expected to publish its proposals at least one year before the meeting of the next International Congress, which, it is hoped, might then be in a position to draw up final resolutions on the subject. This scheme of operations has received the support of Prof. Henri Cordier, of the École spéciale des langues orientales, Paris; Prof. Robert Sieger, of the University of Graz; and of Mr. G. G. Chisholm, Birkbeck College, University of London, who have agreed to cooperate with Prof. Ricchieri in drawing up the preliminary statement of fundamental points requiring solution to be laid before the Geneva congress. Mr. Chisholm will be glad to forward to Prof. Ricchieri any suggestions on this question sent to him at his private address (59 Drakefield Road, Upper Tooting, London, S.W.).

The curious phenomenon of a soft steel disc revolving at a high speed cutting hard steel has attracted the attention of numerous observers, and Mr. F. W. Harbord has endeavoured to throw light on the subject by publishing in the *Engineer* of February 21 the results of a microscopic examination of the revolving disc and of the material subjected to its action. He finds that the material acted upon is heated at the point of contact to a temperature approaching, if not equal to, the melting point of steel, and that this high temperature is confined practically to the surface in contact with the disc.

In the *Engineering Magazine* (vol. xxxiv., No. 5) attention is directed by Mr. Clarence Hall and Mr. W. O. Snelling to the waste of life in American coal-mining. Four recent mine disasters in the United States, with the loss of nearly one thousand lives, emphasise the urgent importance of the theme. Statistics show in regard to deaths per million tons of coal that the United States not only occupies a position worse than that of European countries, but also exhibits a general increase in the rate, whereas every other country has shown a decrease. The situation is still worse when it is considered that the natural conditions in America for raising coal with the minimum amount of danger to the workmen employed are as favourable as in any other country in the world. The natural result of the working of the thinner and less favourably mined seams will be greatly to increase the death-rate unless regulations based on careful investigations are rigidly enforced.

Egypt furnishes a region of great scientific interest which is as yet almost unexplored in many branches of knowledge, and it often happens that observations which seem commonplace to those resident in the country are of great value to workers elsewhere. The success which attended the periodical *Survey Notes* during the fifteen months it has been in existence has suggested that its scope might be extended with advantage, and with that object it has been decided to include communications on all branches of science. The magazine, which will in future be entitled the *Cairo Scientific Journal*, makes, in its January issue, a good start. The principal contents are papers on an expedition to Addis Abbaba, by Mr. J. I. Craig; on the underground waters of Egypt, by Mr. H. W. Beckett; on the use of the slide-rule in surveying, by Dr. J. Ball; on azimuth checks on traverse work, by Mr. M. Villiers Stuart; on upper air research at Helwan, by Mr. B. F. E. Keeling; and on temperature and constructional stability, by Mr. J. I. Craig.

On February 18 Mr. J. J. Prest read before the Institution of Civil Engineers a paper describing a remarkable achievement in mining engineering, the shaft sinking at the Horden colliery, south-east Durham. The work was of exceptional difficulty owing to the large volumes of water encountered in sinking through the magnesian limestone and sands of Permian age. In view of possible legislative interference with the hours of underground labour, it was decided to sink three shafts, two 20 feet and one 17 feet in finished diameter. The north shaft was begun on November 6, 1900, and was finished at a depth of 419 yards on July 23, 1904. The south shaft was begun on February 28, 1901, and was finished at a depth of 302 yards on September 1, 1905. The east shaft, 17 feet in diameter, was begun on September 3, 1900, and was finished at a depth of 406 yards on November 6, 1905. The maximum feeders of water pumped simultaneously at any one period amounted to 9230 gallons per minute, from the east and south shafts, from September 23 to November 26, 1903. The production of coal from this colliery is now averaging a million tons per annum.

The annual report of the council of the Institution of Mechanical Engineers, presented at the annual meeting of members on February 21, summarises the progress and work of the institution during the past year. The council has accepted from Mr. Charles Hawksley an offer of 1000*l*. for the foundation of a scholarship or premium in connection with the institution, to commemorate the centenary of the birth of his father, Mr. Thomas Hawksley, past-president. In connection with the alloys research committee it is noted that sea-water corrosion tests on copper-aluminium alloys are being carried out at Portsmouth Dockyard by the National Physical Laboratory. A systematic investigation of the ternary alloys of copper and aluminium with other metals, in the first place with manganese, zinc, and nickel, has been begun, and the preliminary investigation of the copper-aluminium manganese alloys is approaching completion. The council has made a small grant to Dr. H. C. H. Carpenter to investigate at the Manchester University the conditions which have to be observed if metal castings are to be capable of being gas-tight and steam-tight. Some further experiments on the large gas engine at the University of Birmingham are to be carried out by Prof. F. W. Burstall with a water-brake and with both optical and string indicators. The research committee on the value of the steam-jacket has met twice during the year, and designs are being prepared by Prof. T. Hudson Beare for carrying out jacket experiments with a larger apparatus than that formerly used by the committee. Information on the present state of knowledge on the following subjects is also being collected, previous to the appointment of research committees for prosecuting further inquiries:—(1) the features of refrigerating machinery in which further investigation is needed; (2) the transfer of heat across metallic surfaces in contact with water and with gases; (3) the action of steam passing through nozzles and steam turbines.

The *Physikalische Zeitschrift* for February 15 contains an account of Dr. H. W. Schmidt's experiments on the effect of high temperatures on the disintegration of radium C. The work was undertaken to decide between the conclusion of Messrs. Makower and Russ, that high temperature diminished temporarily the activity of radium, and that of Mr. Bronson, who denied the existence of such an effect. Dr. Schmidt's experiments were made on radium C prepared by von Lerch's method. The preparation was enclosed in a quartz tube which could be heated to 1300° C. in an electric furnace. The activity was measured by the fall of the leaves of a gold-leaf electroscope placed close to the furnace. The author concludes that at 1300° C. the preparation behaves exactly as at ordinary temperatures.

The theory of the radiation of the Auer incandescent gas mantle is discussed by M. M. Foix in the February number of the *Journal de Physique*. It is generally admitted that the mantle owes its brilliance to its selective radiation, which appears, according to the researches of Prof. Rubens, to be brought about by the addition of a little oxide of cerium to oxide of thorium. M. Foix now comes to the conclusion that the luminous efficiency of the mantle can be increased by carrying the dilution of the oxide of cerium in the oxide of thorium a further stage, the result being brought about by the diminution of the infra-red radiation of the mantle and a consequent increase of its temperature. The best proportion of the oxides appears to be 1 of cerium to 100 of thorium.

The attention of those of our readers who practise photography is directed to the catalogue of photographic dry plates, filters, and safelight screens recently issued by Messrs. Wratten and Wainwright, Ltd., of Croydon. The particulars provided are practical in character, and the tables of sizes and prices conveniently arranged.

The March issue of the *National Review* opens a new series, printed in larger type and provided with a different cover. Among its varied contents we notice an appreciation of the late Lord Kelvin by Sir William Ramsay, K.C.B., F.R.S., in which a delightful picture of Kelvin as a teacher is drawn, and a popular account given of some of his contributions to natural knowledge.

MESSRS. JOHN J. GRIFFIN AND SONS, LTD., have issued an illustrated and descriptive catalogue of apparatus suitable for demonstration purposes in the teaching of physiography, physiology, and hygiene. The information included respecting globes and lantern-slides should be particularly useful to teachers of geography who follow modern methods of presenting their subject.

A SECOND edition of Prof. G. S. Boulger's "Wood: a Manual of the Natural History and Industrial Applications of the Timbers of Commerce," has been published by Mr. Edward Arnold. The first edition was reviewed in NATURE of January 15, 1903 (vol. lxvii., p. 245), and it will be sufficient here to say the work has been revised and enlarged, and that its price is now 12*s*. 6*d*. net.

THE National Home-Reading Union, with the cooperation of the Library Association, has arranged to publish a penny monthly magazine for the guidance of readers in public libraries in the choice of books and other reading. The first issue, that for February, is now available, and among its principal contents may be noticed articles by Prof. H. H. Turner, F.R.S., on books about astronomy; books about Australia, by Sir John Cockburn, K.C.M.G.; and the literature of the sea, by Mr. Frank T. Bullen. The *Reader's Review*, as the guide is called, is intended primarily for localisation in the various libraries by means of the insertion of additional pages containing local literary notes, lists of recent additions, and so on. The idea of assisting readers in their choice of books is excellent, and it is to be hoped that the efforts of the editorial board will prove successful. The paper is published by Messrs. Sherratt and Hughes.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH:—

March 5.	1h.	Venus in conjunction with Moon. Venus 5° 49′ N.
,,	8h. 59m.	Minimum of Algol (β Persei).
6.	3h.	Mars in conjunction with Moon. Mars 5° 26′ N.
8.	10h. 10m. to 10h. 32m.	Moon occults δ^2 Tauri (Mag. 4·2).
9.	11h. 42m. to 16h. 31m.	Transit of Jupiter's Satellite IV. (Callisto).
10.		Pallas (Mag. 8·04) in opposition to the Sun.
12.	6h. 12m. to 9h. 54m.	Transit of Jupiter's Satellite III. (Ganymede).
13.	4h.	Jupiter in conjunction with Moon. Jupiter 1° 7′ S.
19.	9h. 47m. to 13h. 28m.	Transit of Jupiter's Satellite III. (Ganymede).
20.	12h.	Sun enters Aries, Spring commences.
21.		Venus. Illuminated portion of disc = 0·677.
26.	22h.	Mercury at maximum elongation West (27° 49′).
28.	7h. 30m.	Minimum of Algol (β Persei).
31.		Ceres (Mag. 7·36) in opposition to the Sun.

MICROMETER OBSERVATIONS OF PHŒBE.—During the period July 24 to October 16, 1906, Prof. Barnard made a number of observations of Phœbe, Saturn's tenth satellite, of which he now publishes the results in No. 4234 of the *Astronomische Nachrichten* (p. 145, February 22). A variation of brightness, amounting to half a magnitude or more, is indicated by the fact that while the object was usually a difficult one, of magnitude 16·0 or 16·5, it was found to be comparatively easy during October, and was perhaps brighter than the sixteenth magnitude. On several occasions the satellite presented a hazy appearance, and Prof. Barnard suggests that, should future observations confirm this nebulous or cometary character, the solution of the question of Phœbe's origin in the Saturnian system will be simplified.

EPHEMERIS FOR DANIEL'S COMET, 1907*d*.—The following is an extract from Herr Kritzinger's ephemeris for comet 1907*d*, published in No. 4234 (p. 159, February 22) of the *Astronomische Nachrichten*:—

Ephemeris 12h. (Berlin M.T.).

1908	α (1908·0) h. m.	δ (1908·0) ° ′	1908	α (1908·0) h. m.	δ (1908·0) ° ′
Mar. 5 ...	15 4·4 ...	−6 44·0	Mar. 21 ...	14 53·6 ...	−5 6·9
,, 13 ...	14 59·7 ...	−5 57·0	,, 29 ...	14 46·5 ...	−4 15·5

The computed magnitude of this object is 10·6, and the comet is now apparently travelling eastwards through the constellation Libra towards Virgo, rising a little south of east at about 10.30 p.m. On March 17 it will be about 2½° north of δ Libræ.

THE SPECTRUM OF THE AURORA BOREALIS.—An exhaustive summary and discussion of the results hitherto obtained from spectroscopic observations of the aurora appears in No. 9, vol. xxxv. (September, 1907), of the *Monthly Weather Review* (U.S. Weather Bureau), from the pen of Dr. W. Marshall Watts. All the recorded visual and photographic observations made since the time of Ångström's observations in 1867 are analysed and compared, and the most probable values for the wave-lengths of the principal lines are tabulated; for the chief green line this value is 5571·6, and for the red line 6303·4. Various observations suggest that the spectrum varies at different times, and Dr. Watts urges that far more numerous and continuous observations should be made. With the apparatus which he describes, such observations could be made at a very small cost by any qualified observer.

SUN-SPOT SPECTRA.—No. 1, vol. xxvii., of the *Astrophysical Journal* (January) contains two papers which should prove of interest to all workers in solar physics. The first of these is by Prof. W. S. Adams, and really consists of a preliminary catalogue of lines affected in sun-spots. The photographs on which these lines were detected were taken with a Littrow spectrograph, used in conjunction with the Snow telescope of the Mount Wilson Solar Observatory, and give a linear dispersion of 1 mm. = 1·5 Å. The present catalogue includes a list of the lines affected in sun-spots in the region λ 4000 to λ 4500, and is to be followed by other lists giving the results obtained in other parts of the spectrum. The lines, their behaviour, and their origins are not discussed now, the discussion being reserved until the catalogue is complete; the present list includes nearly 900 lines, for each of which the probable origin, the intensities in Rowland's table and in the spot, together with remarks on its behaviour in the spot, are given.

In the second paper Mr. Charles M. Olmsted, of the Mount Wilson Observatory, announces that he has succeeded in identifying certain bands in the sun-spot spectrum with similar bands in the spectrum of the calcium arc burning in an atmosphere of hydrogen. There are two main groups of these bands, the stronger one at λ 6385, the weaker running through the B group, and the comparison with the spot spectrum leaves no doubt as to their identity.

ASTRONOMY IN WALES.—The *Cambrian Natural Observer* (January) contains several papers on astronomical subjects read before the Astronomical Society of Wales last year. Among others may be mentioned a paper by Mr. T. E. Heath on star clouds and nebulæ, another dealing with transits past and present, and an abstract of a paper by the Rev. John Griffith on the astronomy of the stones, delivered in November last before a crowded meeting of the Cardiff Archæological Society and the Astronomical Society in Wales. Sir Norman Lockyer's method of investigation of stone monuments was explained, and the audience was urged to aid in the accumulation of the orientation data which is apparently so abundant in Wales.

The periodical is again to be issued as a quarterly.

RECENT ADVANCES IN RADIO-ACTIVITY.[1]

IN 1904 I had the honour of giving an address at the Royal Institution on the subject of radio-activity. In the interval steady and rapid progress has been made in unravelling the tangled skein of radio-active phenomena. In the present lecture I shall endeavour to review very shortly some of the more important advances made in the last few years, but as I cannot hope to mention, even briefly, the whole additions to our knowledge in the various branches of the subject, I shall confine my attention to a few of the more salient facts in the development of which I have taken some small share.

In my previous lecture I based the explanation of radio-active phenomena on the disintegration theory put forward in 1903 by Rutherford and Soddy, which supposes that the atoms of the radio-active bodies are unstable systems which break up with explosive violence. This theory has stood the test of time, and has been invaluable in guiding the experimenter through the maze of radio-active complications. In its simplest form, the theory supposes that every second a certain fraction (usually very small) of the atoms present become unstable and explode with great violence, expelling in many cases a small portion of the disrupted atom at a high speed. The residue of the atom forms a new atomic system of less atomic weight, and possessing physical and chemical properties which markedly distinguish it from the parent atom. The atoms composing the new substance formed by the disintegration of the parent matter are also unstable, and break up in turn. The process of degradation of the atom, once started, proceeds through a number of distinct stages. These new products formed by the successive disintegrations of the parent matter are in most cases present in such extremely minute quantity that they cannot be investigated by ordinary chemical methods. The radiations from these substances, however, afford a very delicate method of qualitative and quantitative analysis, so that we can obtain some idea of the physical and chemical properties of substances existing in an amount which is far below the limit of detection of the balance or spectroscope.

The law that governs the breaking up of atoms is very simple and universal in its application. For any simple substance, the average number of atoms breaking up per second is proportional at any time to the number present. In consequence, the amount of radio-active matter decreases in a geometrical progression with the time. The "period" of any radio-active product, *i.e.* the time for half the matter to be transformed, is a definite and characteristic property of the product which is uninfluenced by any of the laboratory agents at our command. In fact, the period of any radio-active product, for example, the radium emanation, if determined with sufficient accuracy, might well be taken as a definite standard of time, independent of all terrestrial influences.

The law of radio-active transformation can be very simply and aptly illustrated by an hydraulic analogy. Suppose we take a vertical cylinder filled with water, with an opening near the base through which the water escapes through a high resistance.[2] When the discharge is started the amount of water escaping per second is proportional to the height of water above the zero level of the cylinder. The height of water decreases in a geometrical progression with the time in exactly the same way as the amount of radio-active matter decreases. We can consequently take the height of the column of water as representing the amount of radio-active matter A present at any time. The quantity of water escaping per second is a measure of the rate of disintegration of A and also of the amount of the new substance B formed per second by the disintegration of A. The "period" of the substance is controlled by the amount of resistance in the discharge circuit. A high resistance gives a small flow of water and a long period of transformation, and *vice versâ*. By a suitable arrangement we can readily trace out the decay curve for such a case. A cork carrying a light vertical glass rod is floated on the water in the cylinder. A light camel's hair brush is attached at right angles, and moves over the surface of a smoked-glass plate. A vertical line drawn on the glass through the point of contact of the brush gives the axis of ordinates, while a horizontal line drawn through the brush when the water has reached its lowest level gives the axis of abscissæ. If the glass plate is moved with uniform velocity from the moment of starting the discharge a curve is traced on the glass which is identical in shape with the curve of decay of a radio-active product, where the ordinates at any time represent the relative amount of active matter present, and the abscissæ time. With such an apparatus we can illustrate in a simple way the increase with time of radio-active matter B, which is supplied by the transformation of a substance A. This will correspond, for example, to the growth of the radium emanation with time in a quantity of radium initially freed from emanation. Let us for convenience suppose that A has a much longer period than B. In the hydraulic analogy A is represented by a high head of water discharging at its base through a circuit of high resistance into the top of another cylinder representing the matter B. The water from the cylinder B escapes at its base through a lower resistance. Suppose that initially only A is present. In this case the water in the cylinder B stands at zero level. On opening the stop-cock connecting with A, water flows into B. The rise of water with time in the cylinder B is traced out in the same way as before by moving the glass plate at a constant rate across the tracing brush. If the period of A is very long compared with that of B the water is supplied to B at a constant rate, and the water in B reaches a constant maximum height when the rate of supply to B equals the rate of escape from the latter. The curve traced out in that case is identical in shape with the "recovery curve" of a radio-active product supplied at a nearly constant rate. The quantity of matter reaches a maximum when the rate of supply equals its own rate of transformation. The relative height of the columns of water in A and B represents at any time the relative amounts of these substances present.

If the period is comparable with that of B, the height of water in B after reaching a maximum falls again, since as the height of A diminishes the supply to B decreases. Ultimately, the height of B will decrease in a geometrical progression with the time at a rate corresponding to the longer period of the two. This is an exact illustration of the way the amount of a radio-active substance B varies when initially only the parent substance A is present. By using a number of cylinders in series, each with a suitable resistance, we can in a similar way illustrate in a quantitative manner the variation in amount with time of a number of products arising from successive disintegrations of a primary substance. By suitably adjusting the amount of resistance in the discharge circuits of the various cylinders, the curves could be drawn to scale to imitate approximately the variation in amount of the various products with time when the initial conditions are given.

During the last few years a very large amount of work has been done in tracing the remarkable succession of transformations that occur in the various radio-active substances. The known products of radium, thorium, actinium, and uranium are shown graphically below, together with the periods of the products and the character of the radiations they emit. It will be seen that a large list of these unstable bodies are now known. It is probable, however, that not many more remain to be discovered. The main uncertainty lies in the possibility of overlooking a product of rapid transformation following or succeeding one with a very slow period. In tracing out the succession of changes, the emanations or radio-active gases continuously evolved by radium, thorium, and actinium have marked a very definite and important stage, for these emanations can be easily removed from the radio-active body and their further transformations studied quite apart from the parent element. The analysis of the transformation of the radium emanation has yielded results of great importance and interest. After passing through three stages, radium A, B, and C, of short period, a substance, radium D, of long period, makes its appearance. This is transformed through two stages E and F of short period into radium G, of period 140 days. Meyer and Schweidler have conclusively shown that radium D is the primary

[1] A discourse delivered at the Royal Institution on Friday, January 31, by Prof. E. Rutherford, F.R.S.

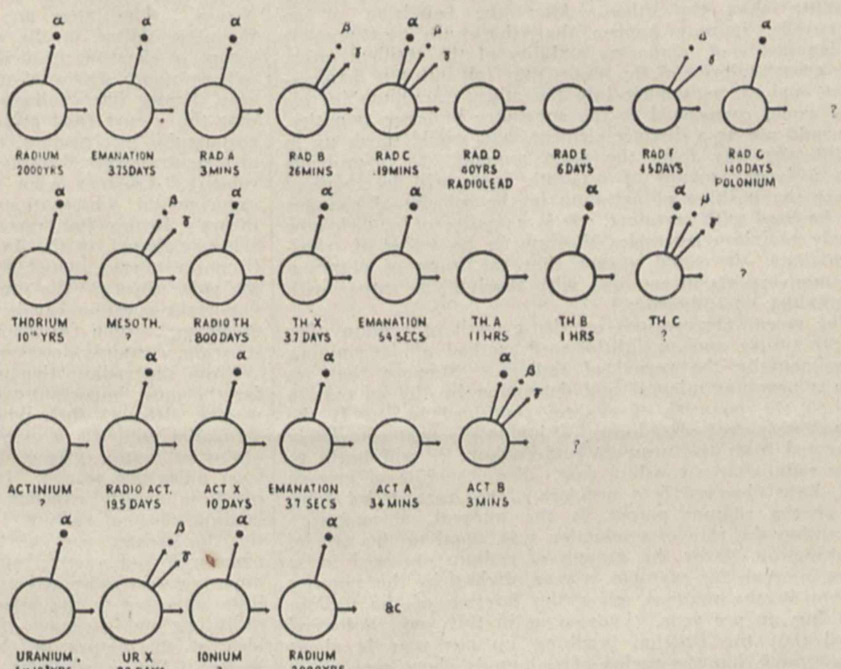
[2] A short glass tube in which is placed a plug of glass wool is very suitable.

constituent of the radio-active substance separated by Hofmann and called by him radio-lead. Radium G is identical with the first radio-active substance separated from pitchblende by Madame Curie, viz. polonium. We are thus sure that these bodies are transformation products of radium. It will be seen that I have added another product of period 4·5 days between radium D and polonium. The presence of such a product has been shown by Meyer and Schweidler.

In the case of thorium, a very long list of products is now known. For several years thorium X was thought to be the first product of thorium, but Hahn has recently shown that at least two other products of slow transformation intervene, which he has called mesothorium and radiothorium. The radiothorium emits α rays, and has a period of more than 800 days. Mesothorium apparently emits β rays, and has a still longer period of transformation, the exact value of which has not yet been accurately determined. Since thorium is used commercially on a large scale, there is every prospect that we shall soon be able to obtain considerable quantities of very active preparations of mesothorium and radiothorium. The separation of these bodies from thorium does not in any way alter its commercial value. It is to be hoped that if these active preparations are separated in quantity, the physicist and chemist may be able to obtain a supply of very active material at a reasonable cost, and that there will not be an attempt to compete with the ridiculously high prices charged for radium.

From the radio-active point of view, the radio-elements are only distinguished from their families of products by their comparatively long period of transformation. Now we have reason to believe that radium itself is transformed according to the laws of other radio-active products with a period of about 2000 years. If this be the case, in order to keep up its supply in a mineral, radium must be produced from another substance of relatively long period of transformation. The search for this elusive parent of radium has been one of almost dramatic interest, and illustrates the great importance of the theory as a guide to the experimenter. The view that radium was a substance in continuous transformation was put forward by Rutherford and Soddy in 1903. The most probable parent of radium appeared to be uranium, which has a period of transformation of the order of 1000 million years. If this were the case, uranium, initially freed from radium, should in the course of time grow radium, *i.e.* radium should again appear in the uranium. This has been tested independently by Soddy and Boltwood, and both have shown that in carefully prepared uranium solutions there is no appreciable growth of radium in the course of several years. The rate of production of radium, if it occurs at all, is certainly less than 1/1000 of the amount to be expected from theory. This would appear at first sight to put out of count the view that uranium is the parent of radium. This, however, is by no means the case, for such a result could be very easily explained if one or more substances of very slow period of transformation appeared between uranium and radium. It is obvious that the necessity of forming such an intermediate product would greatly lengthen the time required before an appreciable amount of radium appeared.

There is, however, another indirect but very simple method of attack to settle the parentage of radium. If radium is derived from the transformation of uranium, however many unknown products intervene, the ratio between the amount of radium and uranium in old minerals should be a definite constant. This is obviously the case, provided sufficient time has elapsed for the amount of radium to have reached its equilibrium value. The constancy of this relation has been completely substantiated by the independent work of Boltwood, Strutt, and McCoy. It has been shown that the quantity of radium corresponding to 1 gram of radium is $3{\cdot}8 \times 10^{-7}$ gram, and is the same for minerals obtained from all parts of the world. Since the radium is always distributed throughout the mass of uranium, we cannot expect to find nuggets of radium like nuggets of gold, unless by some chance the radium has been dissolved out of radio-active minerals and redeposited within the last few thousands of years. To those who had faith in the disintegration theory, this unique constant relation between the amounts of two elements was a satisfactory proof that radium stood in a genetic relation with uranium. A search was then made for the unknown intervening product which, if isolated, must grow radium at a rapid rate. A year or so ago Boltwood observed that a preparation of actinium separated from a uranium mineral did grow radium at a constant but rapid rate. It thus appeared as if actinium were the long-looked-for parent of radium, and that actinium and its long family of products intervened between uranium X and radium. I was, however, able to show that actinium itself was not responsible for the growth of radium, but another unknown substance separated with it. These results were confirmed by Boltwood, who finally succeeded in isolating a new substance from uranium minerals, which was slowly transformed into radium. This substance, which he termed "ionium," has apparently chemical properties similar to those of thorium, and emits α rays of penetrating power less than those of uranium.



Succession of Substances produced by the transformation of radium, thorium, actinium, and uranium. The period of transformation of each substance is added below.

The main previsions of the theory have thus been experimentally verified. Radium is a changing substance the amount of which is kept up by the disintegration of another element, ionium. In order to complete the chain of evidence, we require to show that uranium grows ionium, and it is probable that evidence in this direction will soon be forthcoming. We thus see that we are able to link uranium, ionium, radium, and its long line of descendants, into one family, with uranium as its first parent. As uranium has a period of transformation of more than one thousand million years, it will not be profitable at the moment to try and trace back the family further.

It appears almost certain that, from the radio-active point of view, uranium and thorium must be considered as two independent elements. The case of actinium is different, for Boltwood has shown that the amount of actinium in minerals, like the amount of radium, is proportional to the amount of uranium. This indicates that actinium stands in a genetic relation with uranium. Unless our experimental evidence is at fault, it does not appear probable that actinium belongs to the main line of descent of uranium, for the activity of actinium separated from a mineral compared with radium is only about one-quarter of what we should expect under such conditions. I think that a suggestion which I put forward some time ago may account for the obvious connection of actinium with uranium, and at the same time for the anomaly observed. This supposes that actinium is a branch descent from some member of the uranium family. It does not appear improbable that at one stage of the disintegration two distinct substances may be produced, one in greater quantity than the other. After the expulsion of an α particle, it may happen that there are two possible arrangements of temporary stability of the residual atom. The great majority of the atoms may fall into one arrangement, and the remainder into the other. Actinium in this case would correspond to the substance in lesser quantity. It would act as a distinct element, and would break up in a different way from the main amount. It is probable that a large amount of accurate work will be required before the position of actinium in the scheme of changes can be fixed with certainty. It is a matter of remark how closely actinium resembles thorium in its series of transformations. It would appear that the atom of actinium has many points in common with thorium, or rather with its product, mesothorium.

The recent observations on the growth of radium offer a very simple and straightforward method of determining experimentally the period of radium. Suppose that we take a uranium mineral and determine by the emanation method the quantity of radium contained in it. If the immediate parent of radium (*i.e.* ionium) is next completely separated from the uranium and radium, it will begin to grow radium at a constant rate. Now the rate of growth of radium observed is a measure of the rate of breaking up of the radium parent in the mineral, since before separation the rate of production was equal to the rate of breaking up. Now the growth of radium observed for a short interval, for example, a year, divided by the quantity present in the mineral, gives the fraction of the radium breaking up per year. Proceeding in this way, Boltwood found that the fraction breaking up per year is about 1/3000, and that the period of radium is about 2000 years—a value which lies between the most probable values deduced from quite distinct data.

From an inspection of the radio-active families, it will be seen that out of twenty-six radio-active substances that have been identified, seventeen give out α rays or α and β rays, four give out only β rays, and five emit no rays at all. The rayless and β-ray products are transformed according to the same law as the α-ray products, and there is the same sudden change of physical and chemical properties as the result of the transformation. In the case of the substances which throw off atoms of matter in the form of α particles, there are obvious reasons for anticipating a change in properties of the substance, but this is not the case for the rayless or β-ray products. We must either suppose that the mass of the atom is not appreciably changed by the transformation, which consists in an internal rearrangement of the parts of the atom, or that the atom expels a particle at too low a velocity to be appreciated by the electrical methods. Unfortunately, it is very difficult to study the rayless products with care, as in practically every case they are succeeded by a ray product of comparatively rapid transformation. The rayless products are of great interest as indicating the possibility of transformations which can occur without any detectable radiation.

In the course of the analysis of radio-active changes, special methods have been developed for the separation of the various products from each other. It is only in a few cases, however, that we can hope to obtain a sufficient quantity of the substance to examine by means of the balance. It should be possible to obtain workable quantities of actinium, radium D (radio-lead), and radium G (polonium), but the isolation of these substances in any quantity has not yet been effected. Sir William Ramsay and Mr. Cameron have made a number of important investigations of the properties and volume of the radium emanation, freed so far as possible from any traces of known gases. The remarkable initial contraction of the volume due to the emanation shows that there is still much to be done to obtain a clear understanding of the behaviour of this intensely radio-active gas when obtained in a pure state.

Simultaneously with the work on the analysis of radio-active changes, a large number of investigations have been made on the laws of absorption by matter of the three primary types of radiation from active matter, viz. the α, β, and γ rays, and the secondary radiations to which they give rise. It has generally been accepted for some years that the γ rays are a type of penetrating X-rays. The latter are supposed to consist of electromagnetic pulses in the ether, set up by the impact or escape of electrons from matter, and akin in many respects to very short waves of ultra-violet light. Recently, however, Bragg has challenged this view, and has suggested that the γ rays (and probably also the X-rays) are mainly corpuscular in character, and consist of uncharged particles or "neutral pairs," as he terms them, projected at a high velocity. Such a view serves to explain most of the experimental observations equally well as the pulse theory; Bragg has recently brought forward additional evidence, based on the direction of the secondary radiation from the γ rays, which he considers to be inexplicable by the pulse theory. We must await further data before this important question can be settled definitely, but the theory of Bragg, which carries many important consequences in its train, certainly deserves very careful examination.

From the radio-active point of view, the α rays are by far the most important type of radiation emitted by active matter, although their power of penetration is insignificant compared with the β or γ rays. They consist of veritable atoms of matter projected at a speed, on an average, of 6000 miles per second. It is the great energy of motion of these swiftly expelled masses that gives rise to the heating effect of radium. In addition, they are responsible for the greater part of the ionisation observed near an uncovered radio-active substance. On account of their importance in radio-active phenomena, I shall devote some little attention to the behaviour of these rays. The work of Bragg and Kleeman, of Adelaide, first gave us a clear idea of the nature of the absorption of these rays by matter. The α particles from a very thin film of any simple kind of radio-active matter are all projected at an identical speed, and lose their power of ionising the gas or of producing phosphorescence or photographic action after they have traversed exactly the same distance, which may conveniently be called the "range" of the α particle. Now every product emits α particles at an identical speed among themselves, but different from every other product. For example, the swiftest α particles from the radium family, viz. that from radium C, travels 7 cm. in air under ordinary conditions before it is stopped, while that from radium itself is projected at a slower speed, travelling only 3·5 cm. We may regard the α particle as a projectile travelling so swiftly that it plunges through every molecule in its path, producing positively and negatively charged ions in the process. On an average, an α particle before its career of violence is stopped breaks up about 100,000 molecules. So great is the kinetic energy of the α projectile that its collisions with matter do not sensibly deflect it, and in this respect it differs markedly from the β particle, which is apparently easily deflected by its passage through matter. At the same time, there is undoubted evidence that the direction of motion of some of the α particles is slightly changed by their passage through matter.

The sudden cessation of the ionising power produced by the α particle after traversing a definite distance of air has been shown by Bragg to be a powerful method of analysis of the number of α-ray products present in a substance. For example, suppose the amount of ionisation in the gas produced by a narrow pencil of α rays is examined at varying distances from the radium. At a distance of 7 cm. there is a sudden increase in the amount of ionisation, for at this distance the α particles from radium C enter the testing vessel. There are again sudden changes in the ionisation at distances of 4·8 cm., 4·3 cm., and 3·5 cm. These are due to the rays from the radium A, the emanation and radium itself respectively entering the testing vessel. The α-ray analysis thus discloses four types of α rays present in radium in equilibrium—a result in conformity with the more direct analysis. This method allows us to settle at once whether more than one α-ray product is present in a given radio-active material. For example, an analysis by Hahn by this method of the radiation from the active deposit of thorium has disclosed the existence of two α-ray products instead of one as previously supposed. We can consequently gain information on the complexity of radio-active material, even though no chemical methods have been found to separate the products concerned. The range of the α particle from each product is a definite constant which is characteristic of each product.

The α particle decreases in velocity as it passes through matter. This result is clearly brought out by photographs showing the deflection of a homogeneous pencil of α rays in a magnetic field before and after passing through an absorbing screen. The greater divergence of the trace of the α rays on the plate, after passing through the screen, shows that their velocity is reduced, while the sharpness of the band shows that the α particles still move at an identical speed.

In order to make an accurate determination of the constants of the α particles, it is necessary to work with homogeneous rays, and we consequently require to use a thin layer of matter of one kind. For experiments of this character, a wire coated with a thin film of radium C by exposure to the radium emanation is very suitable. The velocity of the α particle and the value e/m, the ratio of the charge carried by the α particle to its mass, can be deduced by observing the deflections of a pencil of α rays exposed in a magnetic and in an electric field of known strengths. The deflection of a pencil of α rays in an electric field is small under normal conditions, and special care is needed to determine it with accuracy.

In this way I have calculated the velocity and value of e/m for a number of α-ray products. The velocity of expulsion varies for different products, but is connected by a simple relation with the range of the α particle in air. The value of e/m has been determined for selected products of radium, thorium, and actinium, and in each case the same value has been found. This shows that the α particles expelled from radio-active substances in general are identical in constitution. They have all the same mass, but differ from one another in the initial velocity of their projection. Although we are sure that the α particles, from whatever source, are identical atoms of matter, we are still unable to settle definitely the true nature of the α particle. The value of e/m found by experiment is nearly 5×10^3. Now the value of e/m for the hydrogen atom in the electrolysis of water is 10^4. If the charge carried by the α particle and the hydrogen atom is the same, the mass of the α particle is twice that of the hydrogen atom, *i.e.* a mass equal to the hydrogen molecule. But we are not certain that they do carry the same charge. Here we are, unfortunately, confronted by a number of possibilities, for the magnitude of m for the α particle is conditioned by the value assumed for e. If the charge of the α particle is assumed to be twice the value of the hydrogen atom, the mass comes out four times the hydrogen atom—the value found for the helium atom. The weight of evidence still supports the view that the α particle is in some way connected with the helium atom. If the α particle is a helium atom with twice the ionic charge, we must regard the helium produced by radio-active bodies as actually the collected α particles the charges of which have been neutralised. This at once offers a reasonable explanation of the production of helium by actinium as well as by radium. In addition, Strutt has recently contributed strong evidence that helium is a product of thorium. Such results are only to be expected on the above view, since the α particle is the only common product of these elements.

The determination of the true character of the α particle is one of the most pressing unsolved problems in radio-activity, for a number of important consequences follow from its solution. Unfortunately, a direct experimental proof of its true character appears to be very difficult unless a new method of attack is found. We have seen that if the charge carried by the α particle could be experimentally determined, the actual value of m could be determined in terms of the hydrogen atom, since the value of the charge carried by the latter is known. This could be done if we could devise a method of detecting the emission of a single α particle, and thus counting the number of particles expelled from a known quantity of a radio-active substance, for example, from radium. In considering a possible method of attack of this question, the remarkable property of the α particles of producing scintillations in zinc sulphide at once suggests itself. Apart from the difficulty of counting the scintillations, it is very doubtful whether more than a small fraction of the α particles which strike the screen produce the scintillations. Viewed from the electrical side, a simple calculation from the data at our disposal shows that the ionisation produced in a gas by a single α particle should be detectable. The electrometer or electroscope used for measurement would, however, require to be extremely sensitive, and under such conditions it is known that small electrical disturbances are very difficult to avoid.

In order to obtain a reasonably large effect, we require some method of magnifying the ionisation produced by the α particle. In conjunction with Dr. Hans Geiger, I have recently developed a method whereby the electrical effect produced by the α particle can be magnified several thousand times. From the work of Townsend it is known that if a strong electric field acts on gas at low pressure, any ions generated in the gas by an external agency are set in motion by the electric field, and under the proper conditions produce fresh ions by collision with the gas molecules. The negative ion is the most effective ioniser in weak fields, but when the voltage is increased near the point at which a discharge passes, the positive ion also produces fresh ions by collision. In the experimental arrangement the α particle from the active matter is fired through a small opening about 2 mm. in diameter, covered with a thin layer of mica, into a cylinder 60 cm. long and 2·5 cm. in diameter, in which the gas pressure is about 3 cm. of mercury. A thin insulated wire connected to the electrometer is fixed centrally in the cylinder. If the outside cylinder is charged negatively, for a difference of potential of about 1000 volts any ionisation produced in the cylinder is increased about 2000 times by collision. This can be simply illustrated by using the γ rays of radium as a source of ionisation. When a difference of potential is applied to the cylinder, the ionisation produced by the γ rays only causes a slight movement of the electrometer needle. By applying, however, a voltage nearly equal to that required for a discharge through the gas there is a very rapid movement of the needle. On removing the radium there is no appreciable current through the gas. On placing a source of α rays near the small opening in the cylinder so that some of the α particles can be fired along the axis of the cylinder, the electrometer needle does not move uniformly, but with a succession of rapid throws with a considerable interval in between. Each of these throws is due to the discharge produced by a single α particle entering the cylinder, increased several thousand times by the intermediary of the strong electric field. If a sheet of paper which stops the α rays is placed before the opening, the electrometer needle at once comes to rest. The interval of time between the throws is not uniform. This is exactly what we should expect if the number of α particles entering such a small opening is governed by the law of probability. On the average, a certain number of α particles are fired through the opening per minute, but in some cases the interval is less than the average, in others much greater. In fact, by observing the intervals between the entrance of a large number of α particles, we should be able to determine accurately the "probability" curve of distribution of the α particles with time. For purposes of measurements, the active material, in the form of a thin film covering a small area, is placed in an exhausted tube connected in series with the ionisation cylinder, and at a considerable distance from the hole. The number of α particles entering the opening per minute is counted, and from this the total number expelled can be calculated. Preliminary measurements show that the number of α particles expelled from a known weight of radium is of the same order as the calculated value. When the measurements are completed it should be possible to determine the charge carried by each α particle, since the total charge carried by the α particles from 1 gram of radium is known. In this way it may be possible to settle whether the α particle is a helium atom or not. In any case, it is a matter of some interest to be able to detect by its electrical effect a single atom of matter, and so to determine directly with a minimum of assumption the magnitude of some of the most important quantities in radio-active phenomena.

MEDICAL INSPECTION OF SCHOOL CHILDREN.[1]

THE memorandum issued by the English Board of Education on the medical inspection of children in public elementary schools is a statesmanlike document. It propounds a policy; it indicates a method, and the method, no less than the policy, takes full account of conditions, difficulties, and obstacles. The memorandum gives body to the provisions of section 3 of the Education (Administrative Provisions) Act, 1907. This section confers three broad powers on education authorities, first, to provide special environments for special children, *e.g.* vacation schools, vacation classes, play centres, &c.; second, to establish a medical inspection of the individual children; thirdly, "to make such arrangements as may be sanctioned by the Board of Education for attending to the health and physical condition of the children educated in public elementary schools." These three powers may be exercised in cooperation with voluntary agencies, of which, it is needless to say, there are many. But the point of importance is that the powers may now be exercised by the education authorities, and practically, since grants may be made to depend on their exercise, the education authorities are now placed under obligation to carry them into full effect. The memorandum proceeds on this assumption; but it aims rather at sketching a process of natural administrative growth than at imposing an imperative system to be immediately realised. Accordingly, it starts from what is already being done in several localities to supervise the hygiene of schools and scholars. The sanitary authorities are in possession. This Act does not supersede, it expands and supplements, their work. Here emerges the cardinal principle of the memorandum, namely, the extension of the conception of public health to include, not merely the environmental sanitation considered apart, but the individual child's health as it is affected by his environment in the widest sense—physical, educational, &c.

The purpose of individual inspection, no less than of the general inspection of the hygienic conditions, is "to secure ultimately for every child, normal or defective, conditions of life compatible with that full and effective development of its organic functions, its special senses and its mental powers which constitute a true education." Unfortunately, owing to accidents of administrative convenience or development, there has arisen within the medical profession an acute difference of opinion as to the relative advantages of a special school medical service and an expanded public health service. Dr. Newman's appointment implied that the Board of Education favoured the idea of an expanded public health service, and this memorandum sketches in firm outline what this view implies. Incidentally, it shows that there is no opposition between the two views. On the one hand, it puts upon the medical officer of health the organising of the system of medical inspection, but on the other, it provides that "its actual execution" shall be "deputed wholly or partly to suitable colleagues or assistants (men or women)." The two factions are thus reconciled in the one administrative organisation.

The memorandum in more than one place emphasises in a way that it is impossible to controvert the primary importance of the home and its hygiene in the school-life of the child, and the absolute necessity for maintaining continuity of inspectorial interest between the home and the school. Medical inspection will thus work backwards to the home and forwards to the after-school life of the child, so covering the entire period between birth and the entry on industrial life. When this conception of continuity is fully grasped, there will be no further theoretical dispute between the medical factions concerned.

The British Medical Association has issued a memorandum dealing in a thoroughly practical spirit with the proposals and suggestions of the Board of Education. It is of immense importance that the medical profession should thus declare itself at the beginning. The differences between the association and the Board are essentially differences of detail. The association is quite frank in its acceptance of the general positions. The association's memorandum states that "these duties could not, having regard to the nature and extent of the duties already required of Medical Officers of Health, be efficiently discharged by them personally." This is not inconsistent with the Board's suggestions on the same point. The association also states that "part-time" medical officers, paid as for work done, could appropriately undertake medical inspection. This comes naturally from the profession, and there is much to say for it; but again there is nothing here inconsistent with the Board's views. But just as in the earlier, so in these later expansions of preventive medicine, the tendency will be towards "whole-time" specialists. In England many of the counties have not yet appointed whole-time or even part-time medical officers—so differing from Scotland, where every county is obliged to appoint a medical officer, and all except five have appointed whole-time men.

The association's memorandum is emphatic on another point, namely, that treatment of disease and visitation of the homes of the children shall be excluded from the scope of the medical inspector's duties. The full bearing of this suggestion will require very careful consideration. The Education Board's memorandum contains a very judicious discussion of the implications of the Act as to treatment, and it is difficult to reconcile the Act with the letter of the association's decision. The schedule proposed by the association is very well drawn, but it makes no provision for any record as to home conditions or occupation of parents, &c., which are insisted on in the Board's memorandum.

The Board of Education has followed up its memorandum by a detailed schedule, with full directions for the medical inspection. In most respects, this schedule meets all the proposals of the British Medical Association. From the tenor of the memorandum on the clear necessity for recording the home conditions and the occupational condition of the parents, we naturally expected that these points would be explicitly provided for in the schedule. In this we are somewhat disappointed; for all that we find is a heading for "Directions to Parent or Teacher." It would have been much simpler to have specified what details are wanted for every child—number of rooms in house, number of persons, occupation of father or mother, pre- and post-school labour of the child. These are all primary factors in the mental state of the child at any one time, and practically all these data are already in possession of the school authority. In other respects, the schedule is very comprehensive. Indeed, this is the one real criticism offered by medical critics. But when it is closely scrutinised, it will be found to contain only the bare essentials of a real inspection. The order of the schedule is simple, and the directive notes are models of lucidity. The anthropologist may regret that his special point of view is not as such provided for, but there is nothing

1 (1) Memorandum on Medical Inspection of Children in Public Elementary Schools, under Section 13 of the Education (Administrative Provisions) Act, 1907 (Board of Education; Circular, 576).
(2) Memorandum by British Medical Association on the Circular of the Board of Education (*British Medical Journal*, Supplement, December 21, 1907.)
(3) Schedule of Medical Inspection (accompanying Circular 582).

antagonistic to this either in the memorandum or in the schedule. Though not aiming directly at scientific facts, the medical inspection will certainly accumulate a vast number of facts that will form material of the first value for the anthropologist's methods.

We congratulate both the Board of Education and the British Medical Association on the practical sense displayed in these documents, and the general regard paid in each to the claims of science as well as to the claims of medicine. The great movement is now effectively inaugurated. Many points will emerge for adjustment, but these only experience can reveal. The main thing is that the work should now proceed on approximately uniform lines, and the Board of Education has given an effective lead.

FORTHCOMING BOOKS OF SCIENCE.

FOLLOWING our usual custom, we give the titles and names of authors of works relating to science which are to be found in the spring announcement lists of various publishers :—

Mr. S. Appleton :—" Minerals," by L. J. Spencer, illustrated; and " The Life and Habits of the Ants," by Dr. L. I. Dublin, illustrated.

Mr. Edward Arnold :—" Power Gas Producers, their Design and Application," by P. W. Robson.

Messrs. A. and C. Black :—" A Treatise on Zoology," edited by Sir E. Ray Lankester, K.C.B., F.R.S., part i., first fascicle, " Introduction and Protozoa," by Prof. S. J. Hickson, F.R.S., Dr. F. W. Gamble, F.R.S., J. J. Lister, F.R.S., Dr. H. M. Woodcock, and the late Prof. Weldon, F.R.S., illustrated; part vii., " Crustacea," by W. T. Calman, illustrated; part ix., " Vertebrata Craniata," by E. S. Goodrich, F.R.S., illustrated; " The Science and Philosophy of the Organism," the Gifford Lectures delivered before the University of Aberdeen in the Year 1907, by Dr. H. Driesch; " Cancer : Relief of Pain and Possible Cure," by S. and G. E. Keith; "Analytical Geometry of the Conic Sections," by the Rev. Dr. E. H. Askwith; " A Plant Book for Schools, being an Easy Introduction to the Study of Plant Life," by O. V. Darbishire, illustrated; " Descriptive Geography of the British Isles," by F. D. Herbertson, illustrated; " Man : his Manners and Customs," by Prof. L. W. Lyde, illustrated; " School Text-book of Geography," by Prof. L. W. Lyde; and new editions of " Studies in Fossil Botany," by Dr. D. H. Scott, F.R.S., illustrated; " An Introduction to Structural Botany," by Dr. D. H. Scott, F.R.S., part ii., " Flowerless Plants," illustrated; and " Totemism," by Prof. J. G. Frazer.

Messrs. W. Blackwood and Sons :—" Stephen's Book of the Farm," by J. Macdonald; " Forest Entomology," by A. T. Gillanders; " Significant Etymology," by J. Mitchell; and " Through the Depths of Space : a Primer of Astronomy," by H. Macpherson.

Messrs. Cassell and Co., Ltd. :—" The Complete Farmer —Soils : their Nature and Management," by P. McConnell; " Cassell's ABC of Gardening : an Illustrated Encyclopædia of Practical Horticulture," by W. P. Wright, illustrated; " The Townsman's Farm," by " Home Counties "; " Familiar Swiss Flowers," by F. E. Hulme, illustrated; " Gardening for Women," by the Hon. F. Wolseley; " Structural Engineering," by Prof. A. W. Brightmore, illustrated; and " Tinplate Work," edited by P. N. Hasluck, illustrated.

Messrs. Chatto and Windus :—" A History of Babylonia and Assyria from the Earliest Times until the Persian Conquest," by L. W. King, illustrated; vol. i., " A History of Sumer and Akkad, being an Account of the Primitive Inhabitants of Babylonia from the Earliest Times to about B.C. 2000 "; vol. ii., " A History of Babylon from the Period of the First Dynasty, about B.C. 2000, until the Conquest of Babylon by Cyrus, B.C. 539 "; vol. iii., " A History of Assyria from the Earliest Period until the Fall of Nineveh before the Medes, B.C. 606 "; " The Open Air," by R. Jefferies, illustrated; and " Nature near London," by R. Jefferies, illustrated.

Messrs. Archibald Constable and Co., Ltd. :—" The North-West Passage : being the Record of a Voyage of Exploration of the Ship *Gjöa*, 1903–1907," by R. Amundsen, with a supplement by First Lieut. G. Hansen, 2 vols., illustrated; " Ice-bound Heights of the Mustagh : being an Account of Two Seasons of Pioneer Exploration and High Climbing in the Baltistan Himalaya," by F. B. and W. H. Workman, illustrated; " Electrical Measuring Instruments, Recorders and Meters," by K. Edgcumbe; " Heavy Electrical Engineering," by H. M. Hobart, illustrated; " Steam Electric Power Plants and their Construction," by F. Korster, illustrated; " Text-book of the Steam Engine," by J. Richardson, illustrated; " Boiler Construction," by F. B. Kleinhans, illustrated; " Hydraulics and its Application," by A. H. Gibson, illustrated; " Cranes," by A. Böttcher, translated from the German, enlarged, and edited with a complete description of English and American practice by A. Tolhausen, illustrated; " Sewage Disposal Works," by H. P. Raikes, illustrated; " Economics of American Railway Operation," by M. L. Byers, illustrated; " Railway Shop Up-to-date : a Reference Book of American Railway Shop Practice," compiled by the editorial staff of the *Railway Master Mechanic*; " Patents, Trade Marks and Designs," by K. R. Swan, illustrated; " The Manufacture of Paper," by R. W. Sindall, illustrated; " Wood Pulp and its Applications," by C. F. Cross, E. J. Bevan, and R. W. Sindall, illustrated; " Steam Engines," by J. T. Rossiter, illustrated; " Electric Lamps," by M. Solomon, illustrated; " Steam Locomotives," by V. Pendred, illustrated; " Gold and Precious Metals," by Dr. T. K. Rose; " Photography," by A. Watkins, illustrated; " Commercial Paints and Painting," by A. S. Jennings, illustrated; " Brewing and Distilling," by J. Grant, illustrated; " Specifications and Contracts," by Dr. J. A. L. Waddell and J. C. Wait; and a new edition of " Railway Tracks and Track Work," by E. E. R. Tratman, illustrated.

Mr. H. Frowde and Messrs. Hodder and Stoughton :— " A System of Medicine," edited by Prof. W. Osler, F.R.S., and Dr. T. McCrae, 7 vols., illustrated, vols. iv. and v.; " The Collected Papers of Lord Lister," with an introduction by W. W. Cheyne, F.R.S., 2 vols.; " A System of Diet and Dietetics," under the editorship of Dr. G. A. Sutherland, introduction by Sir Lauder Brunton, F.R.S.; and " Diseases of the Eye," by S. Mayou, illustrated.

Messrs. Gauthier-Villars (Paris) :—" Leçons sur les Fonctions définies par les Équations différentielles du premier Ordre," by P. Boutroux; " Œuvres complètes," by A. Cauchy, Ière. Série, Tome II., Mémoires extraits des Mémoires de l'Académie des Sciences; " Leçons élémentaires sur le Calcul des Probabilités," by de Montessus, illustrated; " La Terre et la Lune : Forme extérieure et Structure interne," by P. Puiseux, illustrated; " Précis d'Arithmétique des Calculs d'emprunts à Longterme et de Valeur mobilière," by H. Sarrette; and a new edition of Villard's " Rayons cathodiques," illustrated.

Messrs. Harper and Brothers :—" Hypnotic Therapeutics," by Dr. J. D. Quackenbos; " Worlds in the Making : the Evolution of the Universe," by Prof. S. Arrhenius, translated by Dr. H. Borns, illustrated; and a new edition of " The History of Science," by Dr. H. S. Williams, 5 vols., illustrated.

Messrs. G. G. Harrap and Co. :—" Manual of Clinical Chemistry," by Prof. A. E. Austin, illustrated; " A Text-book of Topographical Drawing," by F. T. Daniels, illustrated; " Feathered Game of New England," by W. H. Rich, illustrated; and " The Teaching of Practical Arithmetic to Junior Classes," by J. L. Martin, illustrated.

Mr. W. Heinemann :—" The Natural History of Cancer," by W. R. Williams.

Messrs. Hutchinson and Co. :—" The Naturalist in West Cornwall," by W. H. Hudson, illustrated; " The World's Peoples," by Dr. A. H. Keane, illustrated; and " The World's Birds, a Simple and Popular Classification of the Birds of the World," by F. Finn, illustrated.

Messrs. Longmans and Co. :—" Refrigeration : an Elementary Text-book," by J. W. Anderson, illustrated; " The Life and Work of George W. Stow, South African Geologist and Ethnologist," by Prof. R. B. Young; and " A Practical Guide to School, Cottage, and Allotment Gardening," by J. Weathers, illustrated.

Messrs. Sampson Low and Co., Ltd.:—"Mosses and Liverworts," by T. H. Russell, illustrated.

Messrs. Macmillan and Co., Ltd.:—"African Nature Notes and Reminiscences," by F. C. Selous, with a foreword by President Roosevelt, illustrated; "A Text-book of Botany," by Drs. E. Strasburger, F. Noll, H. Schenck, and A. F. W. Schimper, revised with the eighth German edition by Dr. W. H. Lang, illustrated; "Origin and Development of the Moral Ideas," by Dr. E. Westermarck, vol. ii.; "Cotton Fibre," by F. H. Bowman, illustrated; "General History of Western Nations from 5000 B.C. to 1900 A.D.," by Dr. E. Reich, vols. i. and ii.; and "Atlas Antiquus: Forty-eight Maps in Colours, on a New Graphic Plan, with Explanatory Text in English; the Names of Places, Countries, &c., on the Maps themselves being in Latin; with a full Alphabetical Index," by Dr. E. Reich.

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Sir Isaac Pitman and Sons, Ltd.:—"Notes of Lessons on Science"; "'The Teacher' Certificate Science"; "Notes of Lessons on Hygiene and Temperance," 2 vols.; "Notes of Lessons on Arithmetic," 2 vols.; and "Notes of Lessons on Geography," 2 vols.

Messrs. G. P. Putnam's Sons:—"Elements of Plane and Spherical Trigonometry," by Prof. J. H. Gore; "Alpine Flora of the Canadian Rocky Mountains," by S. Brown, illustrated; "Mosquitoes: the Habits and Life Cycles of the known Mosquitoes of the United States; Methods for their Control; and Keys for easy Identification of the Species in their Various Stages," an accoun based on the investigations of the late James Willia Dupree, Surgeon-General of Louisiana, and upon origin observations by the writer, by E. G. Mitchell, illustrated "The Muscles of the Eye," by Dr. L. Howe, 2 vols illustrated; and a new edition of "Thinking, Feeling Doing: an Introduction to Mental Science," by Dr. E. W Scripture, illustrated.

Messrs. Alston Rivers, Ltd.:—"Water: its Origin an Use," by C. C. Finch.

Messrs. Smith, Elder and Co.:—"Animal Life," by D F. W. Gamble, F.R.S., illustrated; and a new edition c "Hardy Ornamental Flowering Trees and Shrubs," b A. D. Webster.

Messrs. Swan Sonnenschein and Co., Ltd.:—"Th History and Ethnography of Africa South of the Zambe from the Settlement of the Portuguese at Sofala i September, 1505, to the Conquest of the Cape Colony b Great Britain in September, 1795," by Dr. G. M. Theal vols. ii. and iii.; "The History of Philosophy, based o the Work of Dr. J. E. Erdmann," by W. S. Hough "Introduction to the Study of Philosophy," by Prof. C Kulpe, translated by Prof. E. B. Titchener; "Outlines c Psychology," by Prof. O. Kulpe, translated under tl supervision of Prof. E. B. Titchener; "Physiologic Psychology," by Prof. W. Wundt, a translation of t fifth and wholly re-written German edition by Prof. E. F Titchener, vol. ii., illustrated; "The Student's Text-bo of Zoology," by Prof. A. Sedgwick, F.R.S., vol. iii., cor pleting the work, illustrated; "Electricity: What is It?" by W. D. Verschoyle, illustrated; "Plant Life: a Manu of Botany for Schools," by Prof. E. Warming, translat by M. Rehling and E. M. Thomas, illustrated; and r editions of "A Text-book of Petrology," by Dr. F. Hatch, illustrated; "Elementary Text-book of Prac Botany for the Botanical Laboratory and Private Stud by Prof. E. Strasburger, translated by Prof. W. Hillhou and "An Elementary Text-book of Botany," by Pro S. H. Vines, F.R.S., illustrated.

Messrs. E. and F. N. Spon, Ltd.:—"Facts, Figures and Formulæ for Irrigation Engineers: being a Series c Notes on Miscellaneous Subjects connected with Irrig tion," compiled by R. B. Buckley; and a new edition o "Leather Industries Laboratory Book of Analytical an Experimental Methods," by Prof. H. R. Procter.

The University Tutorial Press, Ltd.:—"Geometry Theoretical and Practical," part ii., by W. P. Workma and A. G. Cracknell; Elementary Science for th Certificate Examinations (Certificate and Prelimina Certificate):—"Section A: Chemistry," by H. W. Bausor "Section B: Physics," by J. Satterley; "Section C Botany," by Prof. F. Cavers; and "Junior Chemistry," by R. H. Adie.

Mr. T. Fisher Unwin:—"Nature Studies by Night an Day," by F. C. Snell; and "Health at its Best v. Cance and other Diseases," by R. Bell.

Messrs. Watts and Co.:—A sixpenny edition of Prof Huxley's "Man's Place in Nature."

Messrs. Williams and Norgate:—"The Surgica Anatomy of the Horse," by J. T. S. Jones, part iii., illus trated; and a new edition of "Principles and Practice Agricultural Analysis: a Manual for the Study of Soil Fertilisers, and Agricultural Products," by H. W. Wiley vol. ii.

Messrs. Witherby and Co.:—"Three Voyages of Naturalist: being an Account of many Little-known Island in Three Oceans visited by the *Valhalla*, R.Y.S.," b M. J. Nicoll, with an introduction by the Right Hon. th Earl of Crawford, K.T., F.R.S., illustrated.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Cambridge.—There is a desire on the part of th biologists of Cambridge to celebrate in 1909 the centenar of Darwin's birth and the jubilee of the publication of th "Origin of Species" by endeavouring to found a chai of biology, the occupant of which shall devote himself t those subjects which were the chief concern of Darwin' life-work. It is probable that this will be accomplished for the council of the Senate has had under consideratio a generous offer of support made by a member of the University who wishes to remain anonymous.

Convinced of the great importance of the subjects with which such a professorship would be concerned, the benefactor offers to pay to the University 300*l*. a year for five years, provided that the University establishes for that period, and before June 30, 1908, a professorship of biology of the minimum annual value of 500*l*.

The donor also offers to increase the 300*l*. to 400*l*. for any portion of the five years during which the professor may be holding a professorial fellowship. The further condition is made that it shall be the duty of the professor or professors elected during the period of five years above mentioned to teach and make researches in that branch of biology now entitled genetics (heredity and variation).

The author of this offer further suggests, though he does not make it a condition, that the proposed temporary professorship, if established, should be entitled the "Darwin Professorship of Biology." The council of the Senate, while giving full weight to this suggestion, inclines to the view that it would be more expedient to reserve such a title until it shall have become clear that the professorship can, from whatever source, be placed on a permanent footing.

The council is of opinion that the generous offer anonymously made should be accepted, and that a professorship of biology of the value of 700*l*. per annum should be established, which will terminate at the end of the Easter term, 1913, unless the University shall previously have otherwise determined. The electors to the professorship shall, so long as the professorship is only temporary, be the council of the Senate, but if the professorship shall be made permanent a board of electors shall be constituted.

It is proposed to make a grant of 30*l*. from the Worts fund to Mr. A. R. Hinks, of Trinity College, towards defraying his expenses in travelling on the continent of Europe with the view of investigating the methods used in the study of astronomy and geodesy in certain observatories and institutions.

It is proposed to continue for a further period of five years, from Michaelmas, 1908, the Caley and Stokes lectureships in mathematics, the annual stipend of 200*l*. being attached to each lectureship. The general board is of opinion that, should the endowments for these two lectureships prove to be insufficient to provide these stipends, the University should undertake to make up for the five years any deficiency which may result from this insufficiency. This may involve a contribution from the University of 80*l*. a year.

Mr. C. A. Barber and Mr. A. W. Rogers have been approved by the general board of studies for the degree of Doctor in Science.

The syndicate appointed to obtain plans and estimates for the extension of the chemical laboratory has issued a second report, in which it is stated that last August a contract was signed by the builder for erecting the building, which is now rising in Pembroke Street, at a cost of 13,750*l*. The syndicate now asks leave of the Senate to expend a sum of 485*l*. for extras in the building, 2455*l*. for benches, lecture tables, and other fittings, and 700*l*. for instruments and apparatus.

LONDON.—The degree of D.Sc. in chemistry has been granted to Mr. R. J. Caldwell, an internal student of the Central Technical College. Mr. Caldwell presented a thesis entitled "A.—Studies of the Processes Operative in Solutions, part i., the Sucroclastic Action of Acids as influenced by Salts and Non-electrolytes; B.—The Hydrolysis of Sugars," and other papers.

The degree of D.Sc. in zoology has been granted to Mr. D. H. de Souza, an internal student of University College. Mr. de Souza presented a thesis entitled "The Activation of Pancreatic Juice."

THE death is announced of Prof. Laurent, professor of mathematical analysis in the Paris École polytechnique and Institut national agronomique.

MISS E. N. THOMAS, assistant in the department of botany, University College, has been appointed lecturer and head of the department of botany, Bedford College for Women.

M. CAMILLE MATIGNON has been appointed professor of mineral chemistry at the Collège de France in succession to M. H. Le Châtelier, who recently accepted the chair of general chemistry at the Sorbonne.

THE governing body of the Imperial College of Science and Technology has appointed as secretary Mr. Alexander Gow, formerly scholar of Gonville and Caius College, Cambridge, who for the last four years has occupied the position of director of education and principal of the Technical School, Blackburn.

IN the House of Commons on Monday Mr. Ramsay Macdonald asked the President of the Board of Education whether he proposed to appoint a Royal Commission to inquire into the constitution of the University of London, with a view to the University taking over the Imperial School of Science and Technology, or whether, in the event of no such commission being appointed and the school being in consequence maintained as a separate foundation, he would reconsider the constitution of the governing body of the school so as to strengthen it on its industrial side with the view of establishing a connection between it and technological institutions of lower grades. In reply, Mr. McKenna said that no representations had reached him from the bodies principally concerned leading him to suppose that the consideration of this question is urgently desired, and that no commission would be appointed unless these representations were made.

THE thirtieth annual meeting of the Institute of Chemistry was held on Monday, March 2, Prof. P. F. Frankland, F.R.S., president of the institute, being in the chair. In the course of his address the president dealt with the difficulties of students in deciding the most advisable method of preparing for admission to the profession of chemistry. He is convinced that the usual three years' curriculum is wholly inadequate, for whilst the ground to be covered in the study of chemistry has attained colossal dimensions compared with what it was twenty-five years ago, and is continually being extended, the student's time is no more protracted than before. The limited time at the disposal of the student gives him little opportunity to take proper advantage of the excellent equipment now to be found in the universities and colleges, and teachers are aware of the urgent necessity of increasing the minimum length of the curriculum prior to graduation, but no university appears to have the courage to initiate this reform. In the matter of students, it is quality, not quantity, that universities require, for every science student is a net loss financially, and the work of the classes is too often hampered by a large proportion of undesirables.

THE Board of Education has published (Cd. 3885) the reports from those universities and university colleges in Great Britain which participated during the year ended March 31, 1907, in the annual Parliamentary grant, now amounting to 100,000*l*. The reports deal with the work of the colleges during the year 1905–6, and appear to be reprinted just as they were received by the Board of Education. The information is arranged, it is true, under headings prescribed by the Board, such as land and buildings, staff and educational work, students, fees, finance, and so on, and it is possible with much labour to institute comparisons between the various institutions. The usefulness of the Blue-book would be increased greatly if, following the practice adopted in many other of the Board's publications and the custom which is fairly general in American volumes of a similar kind, the statistics relating to the various colleges were summarised and the totals obtained for the different institutions classified and compared. It would then be possible to coordinate the facts, and to say, for instance, how the interest in higher education in the north of England compares with that in the Midlands or in Wales. If some such plan were adopted much greater use would be made of what would then be an interesting and serviceable volume.

THE interim report for the period January 1 to September 30, 1907, submitted on February 25 last to the trustees by the executive committee of the Carnegie trust for the universities of Scotland, gives information concerning the allocation of grants during that period. The publication of this interim report, dealing only with nine months, was necessitated by an alteration of the financial year of the trust to bring it into line with the academic year of the universities. Sums amounting to 22,000*l.* have been handed over to the four Scottish universities during the nine months, bringing the total expenditure in this direction, since the inauguration of the first quinquennial scheme of grants in January, 1903, to 156,489*l.* The conditions which will regulate the second quinquennial distribution are under the consideration of a special subcommittee, and will, it is hoped, be published shortly. The total expenditure for 1906–7 under the scheme of endowment of post-graduate study and research was 7004*l.*, and the estimated expenditure for the current academic year is 7615*l.* The expenditure upon fees for the summer session, 1907, amounted to 11,685*l.* The proposed scheme of inclusive fees, that is, that in each faculty a beneficiary of the trust should be granted all such instruction as it is desirable for him to receive in his course for a degree on the payment of one fee for each academic year, is still under discussion. Numerous appendices to the report provide detailed information as to the different items of expenditure.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 12, 1907.—"Further Consideration of the Stability of the Pear-shaped Figure of a Rotating Mass of Liquid." By Sir G. H. **Darwin**, K.C.B., F.R.S.

In vol. xvii., No. 3 (1905), of the Memoirs of the Imperial Academy of St. Petersburg, M. Liapounoff has published an abstract of his work on figures of equilibrium of rotating liquid. In this paper he explains how he has obtained a rigorous solution for the figure and stability of the pear-shaped figure, and he pronounces it to be unstable. In a paper in the Philosophical Transactions (vol. cc., A, pp. 251–314) the present author arrived at an opposite conclusion.

The stability or instability depends on whether the sign of a certain function is negative or positive.

M. Liapounoff attributes the disagreement to the fact that the author only computed a portion of an infinite series, and only used approximate forms for the elliptic integrals involved in the several terms. He believes that the inclusion of the neglected residue of the infinite series would lead to an opposite conclusion.

In the author's computation the critical function is decisively negative, whilst M. Liapounoff is equally clear that it is positive. The inclusion of the neglected residue of the series, which forms part of the function, undoubtedly tends to make the whole function positive, but after making the revision it remained incredible, at least to the author, that the neglected residue should amount to the total needed to invert the sign.

The analysis of his former investigation was re-examined throughout, and the computations were repeated by improved methods. The same method was also applied to the investigation of Maclaurin's spheroid, where the solution could be verified by the known exact result.[1]

Dissent from so distinguished a mathematician as M. Liapounoff is not to be undertaken lightly, and therefore especial pains were taken to ensure correctness. The author states his conviction that the source of the disagreement is to be found in some matter of principle, and not in the neglected residue of this series.

Entomological Society, February 5.—Mr. C. O. Waterhouse, president, in the chair.—*Exhibits.*—Dr. T. A. **Chapman**: A collection of butterflies made last summer at Gavarnie, in the Pyrenees, including a number of specimens of *Erebia lefebvrei*, with *E. melas* from south-east Hungary, for comparison.—H. St. John **Donisthorpe**: Eleven species of ants taken in the hot-houses in Kew Gardens in December, 1907, and January, 1908, eight being new to the published Kew list, and six species not before recorded as introduced in Britain.—J. E. **Collin**: Microscopically mounted specimens of the gnat *Epidapus scabiei*, Hopk., a potato pest in the United States recently discovered in England attacking narcissus bulbs.—A. H. **Hamm**: Very young larvæ of *Bitaris muralis*, hatched in captivity, the natural place of deposit of these eggs being at the entrance to the burrow of the bee, *Anthophora pilipes*, in stone walls near Oxford.—Commander **Walker**: Two specimens of the rare *Pyralis lienigialis*, Zell, ♀, taken at light in his house at Summertown, August, 1906, and 1907.—R. E. **Turner**: A box of Thynnidæ from South America, mostly from Chile, with several new species from Mendoza and the Peruvian Andes.—Prof. T. Hudson **Beare**: A specimen of *Trachyphlaeus scabriculus* taken at St. Margaret's Bay in August, 1907, with the two deciduous mandibles still in place.—Lieut.-Colonel **Manders**: The ♀ of *Papilio phorbanta* from Bourbon, an aberrant member of the Nireus group of Papilios, compared with the other members of the same group from the African mainland, Madagascar, and Mauritius. It was pointed out that whereas in all the other species the ♀♀s were some shade of green similar to the ♂♂s, the Bourbon insect was more or less uniformly brown. It was suggested that this was due to mimicry, *Euplaea goudoti*, a species strictly confined to Bourbon, being the model.—Hon. Walter **Rothschild**: Interesting papilionids; (1) *Troides alexandrae*, Rothsch., remarkable for the beauty of the ♂ and the gigantic size of the ♀, a new discovery by A. S. Meek, who found this fine insect in the north-eastern portion of British New Guinea at some distance inland from the coast; (2) a gynandromorphic specimen of Troides, the only one known of this genus, obtained by Dr. L. Martin in South Celebes. It belongs to *T. haliphron*, the left side being ♀ and the right side ♂.—R. **Adkin**: Bred specimens of *Tortrix pronubana*, Hb., to demonstrate that the species is continuously brooded.—L. W. **Newman**: Long series of *Melitaea aurinia* and *Notodonta chaonia* from various localities in the United Kingdom to illustrate the wide superficial variation of the respective species.—Dr. F. A. **Dixey**: Specimens of *Nychitona medusa*, Cram., and *Pseudopontia paradoxa*, Feld.—*Papers.*—(1) Two dipterous Hymenoptera from Queensland; (2) notes on Thynnidæ, with remarks on some aberrant genera of the Scotiidæ: R. E. **Turner**.—Diaposematism, with reference to some limitations of the Müllerian hypothesis of mimicry: G. A. K. **Marshall**.

Zoological Society, February 18.—Dr. Henry Woodward, F.R.S., vice-president, in the chair.—A series of specimens of internal parasites obtained from animals recently living in the society's gardens: Dr. L. W. **Sambon**. Stress was laid on the important additions to knowledge to be derived from an adequate investigation of such material, and on the practical results to the health of the animals in the gardens that might be expected.—The inheritance of colour in domestic pigeons, with special reference to reversion: R. **Staples-Browne**. A series of skins was exhibited illustrating some experiments upon which the communication was based. Crosses had been made between black barbs and white fantails. The F1 generation was black with some white feathers. In the F2 generation, among other forms, blacks and whites were obtained, and also some blues. Blues were found to be dominant to whites, but blacks were dominant, or rather "epistatic," to the blues, which accounts for the fact that the reversionary form does not appear until the F2 generation. When two blues of the F2 or later generations were mated together blacks were never obtained again. A white in F2 mated to a fantail gave whites only. A second series of skins illustrated a cross between a white tumbler and a white fantail. Some white birds splashed with red had figured in the ancestry of the tumbler, although the bird itself showed no trace of colour. In the F1 generation such splashed kinds occurred, which, when mated together, gave in F2 birds which were red and white with some distinct blue feathers. Possibly the white tumbler was a dominant white.—Mammals collected by Mr. M. P. Anderson during a trip to the Mongolian Plateau, N.W. of Kalgan: O. **Thomas**. Nine species were mentioned, of which two were described as new. The paper formed the

[1] Amer. Math. Soc. Trans., 1903, vol. iv., p. 113, on "The Approximate Determination of the Form of Maclaurin's Spheroid," and a further note on the same subject, recently sent to the same society.

eighth of the series on the results obtained by the Duke of Bedford's zoological exploration in eastern Asia. No properly collected material from the Mongolian plateau had been previously available to students, and these specimens, representatives of its comparatively poor fauna, were therefore of much interest.—Butterflies of the division Rhopalocera from Africa and from New Guinea: G. T. **Bethune-Baker.**

Chemical Society, February 20.—Sir William Ramsay, K.C.B., F.R.S., president, in the chair.—Organic derivatives of silicon, part vi., the optically active sulphobenzylethylpropylsilicyl oxides: F. S. **Kipping.** The sulphonic acids obtained by resolving *dl*-sulphobenzylethylpropylsilicyl oxide have been further studied, and the two acids are shown to be optically active, enantiomorphously related compounds having the constitution

$$(SO_3H.CH_2.C_6H_4.SiEtPr)_2O.$$

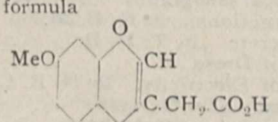
—The preparation of conductivity water: H. **Hartley,** N. P. **Campbell,** and R. H. **Poole.** A still has been constructed which in one operation gives a fair yield of water with a conductivity 0·75 gemmho at 18°, starting from ordinary distilled water with a conductivity of 5 gemmhos.—Derivatives of *para*-diazoiminobenzene: G. T. **Morgan** and Miss F. M. G. **Micklethwait.**—The affinity constants of bases as determined by the aid of methyl-orange: V. H. **Veley.** Results were given for the hydrochlorides of (1) bases not containing an alkyl grouping; (2) aliphatic amines; (3) amino-acetic acids; and (4) uric acid derivatives.—The action of thionyl chloride and of phosphorus pentachloride on the methylene ethers of catechol derivatives: G. **Barger.**—A study of the diazo-reaction in the diphenyl series: G. T. **Morgan** and Miss F. M. G. **Micklethwait.** The arylsulphonylbenzidines, $RSO_2.NH.C_6H_4.C_6H_4.NH_2$, furnish yellow crystalline diazonium salts giving rise on treatment with aqueous sodium acetate to dark brown crystalline compounds, which are either monohydrated nitrosoamines,

$$R.SO_2.NH.C_6H_4.C_6H_4.NH.NO,H_2O,$$

or dihydrated diazoimides, $\begin{array}{l} C_6H_4.N_2 \\ | \quad\quad | \\ C_6H_4.N.SO_2R,2H_2O \end{array}$. The diazonium salts of the arylsulphonylalkylbenzidines,

$$RSO_2.N(C_2H_5).C_6H_4.C_6H_4.NH_2,$$

although distinctly less coloured than those of the unalkylated bases, have nevertheless not been obtained in a colourless condition. There is accordingly no reason for supposing that the diazonium salts of the alkylated bases are differently constituted from those which still contain the labile acidic hydrogen atom (*).—A simple manometer for vacuum distillation: N. L. **Gebhard.**—Researches on the anthraquinones: W. H. **Bentley** and C. **Weizmann.** The condensation products of phthalic and hemipinic anhydrides with veratrole and pyrogallol trimethyl ether are described. —The formation of 4-pyrone compounds from acetylenic acids, part i.: S. **Ruhemann.**—The action of mustard oils on the ethyl esters of malonic and cyanoacetic acids: S. **Ruhemann.**—The triazo-group, part ii., azoimides of propionic ester and of methyl ethyl ketone: M. O. **Forster** and H. E. **Fierz.** On comparing the behaviour of the α- and β-triazo-derivatives of ethyl propionate towards alkali, it was found that, whilst the first-named resembles triazoacetic ester, ethyl β-triazopropionate rapidly parts with hydrazoic acid.—Brazilin and hæmatoxylin, part viii., synthesis of brazilinic acid, the lactones of dihydrobrazilinic and dihydrohæmatoxylinic acids, anhydrobrazilic acid, &c. The constitution of brazilin, hæmatoxylin, and their derivatives: W. H. **Perkin,** jun., and R. **Robinson.** Further confirmation of the constitution (Proc., 1907, xxiii., 291) of the members of this group is afforded by the synthesis of anhydrobrazilic acid, which has been proved to possess the formula



EDINBURGH.

Royal Society, February 17.—Dr. John Horne, F.R.S., vice-president, in the chair.—The systematic motion of the stars: Prof. **Dyson.** A careful study of 1500 stars having large proper motions corroborated Kapteyn's hypothesis that the stars moved in two well-defined streams crossing each other in space.—Preliminary note on *Lepidophloios Scotti*, a new species from the Calciferous Sandstone series at Pettycur, Burntisland: W. T. **Gordon.** Some of the diagnostic features of this new species named after Dr. D. H. Scott are:—(1) the short straight ligular canal the opening of which is protected by the overlying leaf base, and which opens far back from the leaf scar; (2) a marked concavity of the leaf base from half-way between the opening of the ligular canal and the leaf scar to the leaf scar itself; (3) the comparatively long course of the parichnos before it forks.—The middle cells of the grey matter of the spinal cord: Dr. J. H. Harvey **Pirie.** The description of the anatomical arrangement of these small cells showed that Argutinski was wrong in ascribing a segmented character to the group, and that the cells extended throughout the whole length of the cord, being specially numerous in the two enlargements.—*q*-Functions and a certain difference operator: Rev. F. H. **Jackson.**

PARIS.

Academy of Sciences, February 24.—M. H. Becquerel in the chair.—M. B. Baillaud was elected a member of the section of astronomy in the place of the late M. Lœwy. —Results of the measurements of the diameters of Mercury during its transit of November 14, 1907: Robert **Jonckheere.** The mean diameter is 9″·10, higher than the figure usually accepted, 8″·68. A table of results is given.—Observations of the sun made at the Observatory of Lyons during the fourth quarter of 1907: J. **Guillaume.** The results are summarised in three tables showing the number of spots, the distribution of the spots in latitude, and the distribution of the faculæ in latitude. —Researches on the dispersion of light in celestial space: Charles **Nordmann.** From measurements on two fixed stars by the photometric method previously described by the author, the conclusion is drawn that light undergoes a dispersion in space. These results can be applied to give new indications of the parallax of variable stars.— The congruences of plane curves: C. **Popovici.**—Remarks on a communication of M. E. E. Levi: E. **Holmgren.** A question of priority.—The singularities of differential equations of the first order: Georges **Rémoundos.**— Images the appearance of which changes with a projection screen ruled as a grating: E. **Estanave.**—The influence of sunlight on the disengagement and on the orientation of the gaseous molecules in solution in sea-water: Raphael **Dubois.** If test-tubes containing various coloured solutions are plunged into sea-water and the whole exposed to the sun, it is noticed that bubbles of gas are deposited on the outside wall of the tube. If the solution in the tube is green, the evolution of gas, which is rich in oxygen, is much greater than with the other colours. That this is not due to the selective absorption of calorific radiations was shown by substituting water charged with carbon dioxide for the aërated sea-water; the increased effect with the green tube was not observed.—The curves of induced radio-activity obtained by MM. Sarasin and Tommasina: J. **Danne.** An explanation of the results of these authors, by considering the distribution of the field in the different parts of the measuring apparatus.—The method of working of the electrolytic detector: the influence of temperature: Henri **Abraham.** The change in capacity and resistance of the electrolytic detector caused by raising the temperature to 120° C. gives several advantages in practical working.—The atomic weights of nitrogen, oxygen, and carbon: A. **Leduc.** The International Committee on Atomic Weights has now lowered the atomic weight of nitrogen from 14·044 to 14·01. Using this figure and the ratio of the densities of carbon monoxide and nitrogen, as determined experimentally by Lord Rayleigh and by the author, it is shown that the atomic weight of carbon must lie between 12·011 and 12·016.— Phosphorus oxybromide: E. **Berger.** Phosphorus pentabromide heated with phosphorus pentoxide gives a good yield (85 per cent.) of phosphoryl bromide.—This forms crystals, melting at 56° C. and boiling at 189°·5 C. under 774 mm. Its vapour density is normal. The heat of formation has also been determined.—The essentially chemical causes of the allotropic transformation of white phosphorus dissolved in essence of turpentine: Albert **Colson.**—An isomeric modification of hydrated hypovanadic acid: Gustave **Gain.** The acid $V_2O_4,2H_2O$ exists in two forms, one green and the other rose colour. The change from one of these isomers to the other is accompanied by a thermal change, and this has been measured in the calorimeter.—Lutecium and neoytterbium: G. **Urbain.** The fact that Marignac's ytterbium can be separated into two elements differing in atomic weight by more than three units was briefly described by the author three months ago. The present communication contains fuller details of the methods and results. These results have been confirmed by Auer von Welsbach, who has described the two elements thus separated under the names of aldebaranium and cassiopeium. The former of these is identical with lutecium, and the latter with neoytterbium.—The action of sulphosalicylic acid upon borax: L. **Barthe.**—The action of nascent hypoiodous acid (iodine and sodium carbonate) upon some acids of the general formula

$$R—CH=CH—CH_2—CO_2H,$$

R being the phenyl group more or less substituted: J. **Bougault.** The product of this action is an acid of the general formula $R—CO—CH=CH—CO_2H$.—Antiamylasic serum: C. **Gessard** and J. **Wolff.** Quantitative studies on an enzyme preventing the action of malt extract upon starch.—The action of amylase of the pancreatic juice and its stimulation by the gastric juice: H. **Bierry.**—Note on the existence of products of cellular degenerescence recalling Negri's bodies: Y. **Manouélian.**—The measurement of the ventricular wave in man: Gabriel **Arthaud.**—The fixation, multiplication, and mode of attack of pathogenic trypanosomes in the proboscis of the tsetse-fly: E. **Roubaud.**—The genus Doliocystis: L. **Brasil.**—Stratigraphical researches in eastern Morocco: Louis **Gentil.**—Primary strata of Morvan and the Loire: Albert **Michel-Lévy.**—The extension of the Oligocene depressions in a part of the central *massif*, and their *rôle* from the hydrological point of view: Ph. **Glangeaud.**—New researches on the rare gases of thermal springs. Yields of gas in certain cases: Charles **Moureu** and Robert **Biquard.** The gases from nine springs have been examined. The proportions of the rare gases, taken together, vary from 1·24 per cent. to 6·39 per cent., the helium from 0·097 per cent. to 5·34 per cent. The total quantity of helium thus obtainable is very large, a spring at Bourbon-Nancy giving 10,000 litres per annum. The helium was separated by means of charcoal at the temperature of liquid air boiling under reduced pressure, and contained only a trace of neon as impurity.

DIARY OF SOCIETIES.

THURSDAY, MARCH 5.

ROYAL SOCIETY, at 4.30.—On the Atomic Weight of Radium: Dr. T. E. Thorpe, C.B., F.R.S.—On the Electrical Resistance of Moving Matter: Prof. F. T. Trouton, F.R.S., and A. O. Rankine.—On the Nature of the Streamers in the Electric Spark: Dr S. R. Milner.—The Relation between Wind Velocity at 1000 Metres Altitude and the Surface Pressure Distribution: E. Gold.

ROYAL INSTITUTION, at 3.—Early British History and Epigraphy: Sir John Rhys.

CHEMICAL SOCIETY, at 8.30.—The Solubility of Iodine in Water: H. Hartley and N. P. Campbell.—Traces of a New Tin-group Element in Thorianite: Miss C. de B. Evans.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Fuse Phenomena: Prof. A. Schwartz and W. H. N. James.

LINNEAN SOCIETY, at 8.—On the Morphology of Stigmaria in Comparison with Recent Lycopodiaceæ: Prof. F. E. Weiss.—On *Trichoniscoides albidus* and *T. sarsi*: Alexander Patience.—*Exhibits*: Fruit Destroying Flies: W W. Froggatt.—Mimicry in the Common Sole: Dr. A. T. Masterman.

FRIDAY, MARCH 6.

ROYAL INSTITUTION, at 9.—The Figure and Constitution of the Earth: Prof. Love.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Surveying on Thunder Bay Branch of the Grand Trunk Pacific Railway, Canada: R. V. Morris.—British Practice in Railway Surveying W. Graham.—Railway Surveying in Great Britain: W. C. Crawford.

GEOLOGISTS' ASSOCIATION, at 8.—The After-history of the West Indian Eruptions of 1902: Dr. Tempest Anderson.

SATURDAY MARCH 7.

ROYAL INSTITUTION, at 3.—Electric Discharges through Gases: Prof. J. J. Thomson, F R.S.

MONDAY, MARCH 9

ROYAL SOCIETY OF ARTS, at 8.—Fuel and its Future: Prof. Vivian B. Lewes.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in Southern Nigeria: Lieut. E. A. Steel.

TUESDAY, MARCH 10.

ROYAL INSTITUTION, at 3.—Membranes: Their Structure, Uses and Products: Prof. W. Stirling.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—The Origin of the Crescent as a Muhammadan Badge: Prof. W. Ridgeway.—Some Prehistoric Antiquities in Central France: A. L. Lewis.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Further discussion*: The New York Rapid-transit Subway: W. B. Parsons.

WEDNESDAY, MARCH 11.

ROYAL SOCIETY OF ARTS, at 8.—The Use of Reinforced Concrete in Engineering and Architectural Construction in America: Ernest R. Matthews.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Lecture on the Dawn of Meteorology: Dr. G. Hellmann.

THURSDAY, MARCH 12.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—Description of the Brain of Mr. Charles Babbage, F.R S.: Sir Victor Horsley, F.R.S.—The Origin and Destiny of Cholesterol in the Animal Organism. Part II., The Excretion of Cholesterol by the Dog: C. Dorée and J. A. Gardner.—On Reciprocal Innervation in Vasomotor Reflexes and the Action of Strychnine and of Chloroform thereon: Dr. W. M. Bayliss, F.R.S.—Bacteria as Agents in the Oxidation of Amorphous Carbon: Prof. M. C. Potter.

ROYAL INSTITUTION, at 3.—Early British History and Epigraphy: Sir John Rhys.

ROYAL SOCIETY OF ARTS, at 4.30.—Progress in the Native States of India during the past Forty Years: Sir David W. K. Barr, K.C.S.I.

MATHEMATICAL SOCIETY, at 5.30.—On the Projective Geometry of some Covariants of a Binary Quintic: Prof. E. B. Elliott.—On the Inequalities connecting the Double and Repeated Upper and Lower Integrals of a Function of Two Variables: Dr. W. H. Young.—On the Operational Expression of Taylor's Theorem: W. F. Sheppard.—A Proof of a Theorem of Fermat's: Dr. H. A. P. de S. Pittard.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—America Re-visited, 1907: Sir W. H. Preece, K.C.B., F.R.S.

CONTENTS.

SUPPLEMENT TO "NATURE."

PHYSIOLOGICAL STIMULUS AND RESPONSE.

Comparative Electro-physiology. A Physico-physiological Study. By Prof. J. C. Bose. Pp. xliii + 760. (London: Longmans, Green and Co., 1907.) Price 15*s*. net.

IN sequence to his books on response in the living and non-living (1902) and plant response (1906), Prof. Chunder Bose has published a third volume on comparative electro-physiology. Prof. Bose has great ingenuity in device of experimental apparatus, fertility in initiating new lines of observation, and a clear style of setting forth his experimental results and theoretical deductions; nevertheless, we feel far from satisfied with his performance. He strives constantly to group every result he obtains under "some property of matter common and persistent in the living and non-living substance," and to explain by this assumed common underlying property the diverse phenomena of response which occur in metal wires, plant and animal tissues, on mechanical, thermal, or electrical excitation.

Prof. Bose says he started his investigations seven years ago in order to demonstrate this underlying unity, and we cannot help feeling that he has prejudged his phenomena, and, biassed by his philosophical conceptions, may select his experimental results and set before his reader those which confirm the main line of his argument. Using the photographic method of recording, and the galvanometer as the indicator of electrical response, he has published a series of figures, each one of which illustrates some argument in the text. No tables are given showing the number of experiments done or the failures and contrary results which occur in all lines of fresh investigation, and thus, while we feel grateful to Prof. Bose for suggesting fresh and fruitful lines of research, we must wait for confirmation by others of his many new and somewhat startling conclusions.

To instance some of these, Prof. Bose maintains that nerve, which is universally regarded as non-contractile, "is not only indisputably motile, but also that the investigation of its response by the mechanical method is capable of greater delicacy, and freedom from error, than that by the electrical." He demonstrates the contractility of nerve by means of the deflection of a spot of light reflected from a mirror attached to a light lever, thus obtaining magnification up to 100,000 times, but at the same time states that it can be demonstrated even by a light aluminium lever magnifying 50 times. This is contrary to the result of an English physiologist, who has, to our knowledge, tried a similar experiment. Here we have a definite assertion supported by many photographic curves and details of experiment, and one which, when tested by others, can enable us to arrive at a definite valuation of Prof. Bose's work. Such an independent valuation is required, as Prof. Bose and the English authorities on electrical physiology have been greatly at variance.

Prof. Bose claims that the fibro-vascular bundles of plants, which can be isolated in long lengths from the frond of a fern or petiole of cauliflower, act as vegetable nerves, the response being in every respect similar to animal nerve, and being affected similarly by ether, alcohol, ammonia, carbon dioxide, tetanus, &c. He regards the fibro-vascular system which forms the venation of leaves as a "vast catchment basin" for the reception of light stimuli and their transmission to the parts of the plant which are in the dark. By this nervous system, he says, the tone of the whole plant is maintained. In regard to Pflüger's law of the polar effects of currents, Prof. Bose demonstrates photographs showing the like effects on plant and animal structures, but finds that "above and below a certain range of electromotive intensity the polar effects of currents are precisely opposite to those enunciated by Pflüger." He endeavours to prove that the response of nerve to excitation consists of a positive and a negative variation, and that the tones of sensation, pleasure and pain depend on the ascendancy of one or other variation. He seems to recognise no deficiencies in the galvanometric method, and is unaware or neglectful of the work done with the capillary electrometer and of the diphasic variations obtained with this instrument by Prof. Gotch. The galvanometer is far too inert an instrument to demonstrate the true electrical response of nerve. Prof. Bose says that

> "all the diverse phenomena of response may be summarised in the two following formulæ:—(1) Excitatory response takes place by contraction and galvanometric negativity. (2) Increase of internal energy induces the opposite effect of expansion and galvanometric positivity."
>
> "The first of these effects is simply demonstrated by direct excitation of an excitable tissue. In order to demonstrate the second, stimulus is applied at a distance from the responding point. In consequence of sudden local contraction at the receptive area, a wave of increased hydrostatic tension is transmitted with great rapidity. Energy is thus conveyed hydraulically, and at the distant point the transmitted effect induces expansion and galvanometric positivity. This is followed by the more slowly transmitted wave of true excitation, which on its arrival gives rise to the normal response of contraction and galvanometric negativity."

All we can say in criticism of this statement is that while it may be true for plant tissue, there is not a shadow of fact in favour of it holding good for muscle, and we must remain unconvinced by the evidence adduced by the author in favour of its holding good for nerve, until his experiments on the expansion and contraction of nerve have obtained confirmation.

Prof. Bose finds that a metallic wire, the stem of a plant, and a nerve when suddenly submitted to torsion give the same electrical response, and in consequence is led to make the following statement:—

> "By the conception of matter itself, on the other hand, as possessed of sensibility—that is to say of molecular responsiveness, we attain an immediate accession of insight into those physical interactions

which must furnish the terms of ultimate analysis . . . and are led to the discovery of the impressive continuity as existent between the responses of the most complex living and the simplest inorganic matter."

Sensibility is the power to feel, and is the function of the cerebral cortex of man, and also, we may assume justly from the similarity of the neuromuscular reactions, the function of the brain of the higher animals. That it is a function of the fish or frog brain we cannot affirm with any certainty. To ascribe it to a plant or wire is altogether unwarrantable.

A similar condition of molecular strain may be present in a wire, a plant stem, and a nerve fibre, and give the same electrical response, but this is not sensibility, and we even cannot conclude justly from the similarity of electrical response that the same mechanism is present.

Suppose we see a cloud of steam rising over the wall of a field. It may be from a traction engine, from a dung heap, or from a team of horses heated with ploughing. Observations on the direction of the current of steam, and on the effect of modifying agents upon it, will tell us nothing as to the nature of the chemical process which results in the manifestation of heat and the evaporation of water. Prof. Bose's philosophy seems almost capable of asserting that the similarity in direction of the steam current proves the sensibility, not only of the horses, but of all three structures.

Apart from these criticisms, there are in Prof. Bose's book a great many very interesting observations and ingenious methods of experimentation which will repay the reader's attention. In particular, his experiments on root pressure and the rise of sap; those by which he seeks to demonstrate that not only sensitive plants but all plants respond to excitation by variations in turgescence and electrical state; his comparison of the glandular structures of sundew and pitcher plants with animal glands; his demonstration of Dr. Waller's "blaze current" in a brominated lead plate and assertion that it cannot be regarded as a sign of life; his demonstration on the motile leaflets of Biophytum of the anodic and kathodic effects of the constant current, and the velocity of transmission of excitatory waves; his comparison of retentiveness of molecular change in metals with memory. In fact, the whole book abounds in interesting matter skilfully woven together, and would be recommended as of great value if it did not continually arouse our incredulity.

L. H.

THE STEREOSCOPE AND STEREOSCOPIC INSTRUMENTS.

Die binokularen Instrumente. By Moritz von Rohr. Pp. viii+223. (Berlin: Julius Springer, 1907.) Price 6 marks.

THE scientific staff of the Zeiss firm have of late years devoted much attention to the theory of binocular instruments, and to the development of methods of measurement depending on stereoscopic vision. The impetus given by the successful realisation of the prism field-glass has carried them on to a more exact examination of the conditions under which binocular vision can be employed for the accurate determination of relative position, which has led to the design of a series of new instruments for surveying and other purposes, of which the stereo-comparator is the most widely known.

The thoroughness with which the problem has been considered is sufficiently illustrated by the present work of von Rohr, who has already in his previous writings dealt very completely with the theory of vision by means of binocular instruments. This previous work he has now supplemented with an examination into the historical evolution of stereoscopic instruments, systematically planned with the view of clearing the ground and avoiding loss of labour from the re-development of ideas already investigated by previous workers. The book is divided into three parts; the first gives in a few pages a concise statement of the theory; then follows the history, to which part i. is merely an introduction; and the volume concludes with a most useful systematic summary of the matter contained in part ii., assisted by what may be described as a logical guide arranged in the form of a genealogical table, showing the subdivisions of the subject and referring to the place of treatment. This third part, of course, includes a bibliography.

The history begins seriously with the work of Ch. Wheatstone, who is even better known as an electrician. Reference is indeed made to some previous writers and instruments, from the early binocular of Lipperhey, and the suggestive experiments of R. Smith. One notices some omissions here, but the book makes no pretence to be exhaustive; the object is only to trace out the development of correct principles of construction, and to indicate the most important workers and the advances due to them. From this aspect the book is almost too thorough and complete.

Much space is devoted to the famous controversy between Sir David Brewster and Wheatstone, again because of its value for the development of the theory. It is now generally recognised that Wheatstone had the much more correct grasp of the principles, and that the popularity of the Brewster type of prism stereoscope as against the Wheatstone mirror instrument was due to its superior handiness, which outweighed its optical deficiencies. It is interesting to note that Brewster records the sale of prism stereoscopes from the time of the Great Exhibition to 1856 as amounting to more than half a million; these for the most part on the improved mechanical design of Duboscq. One can still remember the wide interest aroused by this method of obtaining pictures in relief.

The interest, however, soon died down, only to be revived in comparatively recent years. The simple stereoscope was gradually improved, as well as the binocular microscope, and more especially the binocular field-glass. The advances of photography were accompanied by the invention of various methods of obtaining "stereograms." But public interest only revived with Abbe's introduction of the prism binocular. Since then Jena has been the centre for the spread of renewed enthusiasm for the subject, while in this country few developments have been made. More attention has been given probably in England to the binocular microscope than to any other form of stereoscopic instrument. Quite recently Theodore Brown has experimented with a method of monocular bio-stereoscopic projection, which will doubtless one day be perfected and become widely known. But only his earlier work is mentioned by von Rohr, who does not carry his account beyond 1900. For the same reason, perhaps, we find no mention of the Forbes stereoscopic range-finder, or of the Aitchison prism binocular.

To those interested in the history of optics, and more especially to workers in stereoscopy, von Rohr's compilation will be of great value. For the general reader it is to be feared the technical manner in which the subject is presented throughout will prove somewhat of a stumbling block. This is, we think, a matter for regret.

AMERICAN PHYSICAL GEOGRAPHY.

Physiography. By Prof. R. D. Salisbury. Pp. xx+770; xxvi plates, 707 figures. (London: J. Murray, 1907.) Price 21*s.* net.

THE large three-volume text-book of geology by Profs. Chamberlin and Salisbury has gained a firm place in this country owing to its full treatment of many questions, inadequately discussed in previous available English text-books. This companion volume on physical geography by Prof. Salisbury will accordingly be welcomed by British teachers of geology and geography. It is of great educational value owing to its wealth of lucid illustration and its clearness of exposition, while it will be indispensable as a reference work in geographical libraries owing to its detailed information regarding the physical geography of the United States.

The book is entitled "Physiography," but the term is used, as the author remarks in his introduction, as a synonym for physical geography, for it excludes many subjects which are included in physiography as that science was defined by Huxley and is accepted in the British Isles. The book consists in the main of a description of the structure of the earth's crust, of the working of the various agencies that attack it, and an account of the atmosphere and the oceans in so far as they affect the surface of the earth. Perhaps the most striking feature of the book is its illustrations, which are very numerous, well selected, and excellently reproduced. They are so clear that the author has been able to abridge his text, leaving his series of photographs to tell their own story. The excellence of the illustrations is probably in part secured by the use of heavy paper, so that the volume is of such weight as to hamper its use as a student's text-book.

As a book of reference its especial value is in its descriptions of the phenomena of physical geography taken from a country where the illustrations are unusually clear and suggestive; and it gives most useful summaries of such well-known geographical incidents as the San Francisco earthquake and of the fault which caused it; of the storm which destroyed Galveston in 1900, and the tornado which devastated Louisville in 1896.

In the chapter on the "weather-maps," the author summarises various reasons for the failure of weather predictions, and he remarks that occasional mistakes are inevitable, and that one mistake is remembered longer than many correct forecasts. He claims that in many cases the American forecasts have been of immense economic value; for example, fifteen million dollars' worth of property were saved in 1897 by warnings of impending floods; on one occasion half a million dollars' worth of fruit about Jacksonville, in Florida, and during 1901, 3,400,000 dollars' worth of produce were saved by warnings of approaching cold; the forecasts also render it possible to avoid unnecessary risks, as when, in September, 1903, vessels valued at 585,000 dollars were detained in ports on the coast of Florida, and thus avoided a heavy storm.

In a work of so wide a scope there are naturally many points on which there is room for difference of opinion, but the author is cautious and fair in his treatment of all controverted questions. We are glad to find that he is emphatic in his statement that the term "Gulf Stream" is of doubtful propriety for anything beyond Newfoundland, and that the climate of north-western Europe would be much more temperate than that of corresponding latitudes of North America even if there were no Gulf Stream (pp. 544–5).

He holds that the only explanation of glacial periods which has not been discredited is that based on variations in the composition of the atmosphere. In his discussion of the question there is no criticism of Schloesing's view as to the control of the amount of atmospheric carbonic acid by the sea. The author is a firm adherent of the view of the ice erosion of fiords.

Each chapter is followed by a table of useful exercises, and by a list of references to literature. They are mainly from American sources, which is natural in a book designed for American students, but an English edition might have included more references to work easily available to British students; for instance, among the excellent illustrations and account of the eruption of Mt. Pelée and St. Vincent, there is no reference to the reports of Anderson and Flett. It may also be remarked that the Aconcagua ascent no longer holds the record, and that while it did, Zurbriggen was not the only man who had made it.

J. W. G.

POLYPERIODIC FUNCTIONS.

An Introduction to the Theory of Multiply-Periodic Functions. By Dr. H. F. Baker. Pp. xvi+336. (Cambridge: University Press, 1907.) Price 12*s.* 6*d.* net.

THE saying that *Il n'y a que le premier pas qui coûte* certainly does not hold good of mathematics; and, oddly enough, it conspicuously fails in cases where it might be expected to justify itself. It is but a step from elliptic to hyperelliptic, from single to double Theta-functions; yet whereas Jacobi reduced all the essential theory of elliptic functions to a most elegant, and for some purposes a final, shape, it is only now becoming possible to construct a corresponding theory for the hyperelliptic functions.

Towards this Dr. Baker, in the first part of his treatise, has made a really valuable contribution. The first chapter contains an extremely clear account of the hyperelliptic integrals, and in particular gives the standard ones in their explicit algebraic form. The corresponding Theta-functions are defined, and their properties investigated; the solution of Jacobi's inversion problem is given in an unusually clear form, and art. 10 contains an instructive discussion of the vanishing of a double Theta-function—perhaps one of the most troublesome points in the whole theory.

Chapter ii. contains the differential equations for the Sigma-functions which are afterwards used to find their expansions. By means of Aronhold's symbolical notation they are expressed in a compact invariantive form; and the way in which they are obtained is an elementary one. At the same time, as the author would probably admit, the process is that of leading up to a known result, and not a heuristic one; this is not said by way of disparagement, because it often happens that tedious methods of discovery are properly replaced by others of a more artificial kind. Dr. Baker, in a note at the end, directs attention to the desirability of re-casting the demonstration so as to make it more strictly analogous to the method used for the elliptic Sigma-function.

Chapter iii. deals with the properties of Kummer's surface and Weddle's surface in connection with the properties of the hyperelliptic functions. Here the author's powers of dealing with algebraical analysis appear to great advantage. He has expressed the principal results in a form that is both explicit and elegant; and the English reader who has this book and Hudson's "Kummer's Surface" will be able to attack, if he likes, a very interesting and unusually definite field of research. Chapter v. is of a similar character, and contains, among other things, Mr. Bateman's proof of the differential equation of the asymptotic lines on Weddle's surface, and a geometrical interpretation of the addition theorem. Chapter iv. deals with the expansions of the Sigma-functions, and gives a great number of explicit terms; the invariantive character of the coefficients should be specially noticed.

The second part of the book, "on the reduction of the theory of multiply-periodic functions to the theory of algebraic functions," is of a much more recondite and difficult character. One of its main objects is to prove the theorem that the most general single-valued multiply-periodic meromorphic function is expressible by Theta-functions. The proof given partly depends upon Kronecker's theory of the definition of algebraic constructs (*Gebilde*) by means of systems of equations, partly upon the consideration of a set of "defective" integrals. Dr. Baker is admirably honest, and on p. 207 makes the remark:—"It seems certain that the values of k_{rs} can be taken so that the determinant $|c_{rs}|$ is not zero"; the temptation to make this a positive statement instead of a conjecture would have been considerable to many writers. Whether or not Dr. Baker's proof will stand minute examination in all its parts remains to be seen; it is at any rate an original and very interesting discussion of an extremely difficult and important problem. It is not easy at the present time to foresee what will be the ultimate shape assumed by the general theory of Abelian functions. So far as mathematical rigour is concerned, as well as in its definiteness and attention to detail, the work of Weierstrass is preeminent, and its influence may be continually noted, and is frequently acknowledged in the present treatise. On the other hand, the more intuitive methods of Riemann and his followers are extremely illuminating and fruitful in suggestions and results; while as regards algebraic functions, the method of Dedekind and Weber is very hard to improve upon. One main difficulty, of course, is the increase in the number of independent variables in the associated Theta-functions; to get a "geometrical" field for the variables we must either plunge into unknown spaces or take new elements (*e.g.* straight lines) in our own.

Much light on the general theory and its difficulties is afforded by some special examples which Dr. Baker gives here and there, for instance, on pp. 255–72. In fact, an accumulation of such examples would greatly help beginners to grasp the arguments of the general theory.

In conclusion, attention may be directed to the great economy of space which the author obtains by abbreviated notation for matrices. The only drawback is that matrices are continually denoted by letters of the same type as those indicating quantities. Moreover, double Theta-functions are expressed in the form $\theta(u)$, which stands for $\theta(u_1, u_2)$; consequently, the beginner must be careful to realise the full meaning of the symbols, and he must at once make himself familiar with the elementary theory of matrices. Perhaps, in another edition, matrices might be indicated by letters of a special type.

G. B. M.

REINFORCED CONCRETE.

Principles of Reinforced Concrete Construction. By F. E. Turneaure and E. R. Maurer. Pp. viii+317. (New York: John Wiley and Sons, 1907.)

THIS is the latest text-book on a branch of engineering construction which during the past ten years has developed from its first small beginnings to such an important position that not only is it essential for civil engineers and architects to be familiar with its various applications, but they should also have a sound knowledge of the principles which underlie the design of reinforced concrete structures. The authors have therefore practically divided the book into two sections, the first part dealing with the theory of the subject, the results of tests, and such questions as working stresses and economical proportions, while the second part is devoted to the application of reinforced concrete to building construction, arches, retaining walls, &c.

After discussing fully the properties of the two materials, concrete and steel, both when used independently and when used in combination, the authors proceed to obtain working formulæ for the stresses in reinforced concrete beams and columns; in the case of beams of rectangular and T section, flexure formulæ are deduced, based on the assumption of linear variation of the compression of the concrete for working loads; and for rectanglar beams on the assumption of a parabolic variation of this compression for ultimate loads, in both cases neglecting the tension in the concrete; examples are fully worked out to illustrate the use of these formulæ. A considerable amount of lengthy arithmetical work is necessary in using these formulæ, and a series of diagrams has been prepared, published on pp. 213—223, by means of which problems may be solved with rapidity and with a degree of accuracy quite sufficient for all practical purposes. These diagrams are at the end of chapter vi., in which the authors have collected together into a convenient form for reference all formulæ deduced in the earlier chapters of the book. Any engineer or architect who did not wish to check the accuracy of these formulæ or to become familiar with the principles upon which they are based, but merely desired to apply the results directly to some problem of design, would find everything he wanted in a compact form in the forty pages of this chapter.

Since T beams are often continuous over their supports, and since at such points there is a negative bending moment throwing the flange into tension and the lower part of the web into compression, a system of double reinforcement must be adopted in such cases, and this problem is fully worked out, as is also the problem of computing the stresses when the resultant of the external forces acting on the one side of the section of a beam is not parallel to that section. The remainder of chapter iii. is devoted to a discussion on the shearing stresses in reinforced beams, and to the strength of reinforced columns; as the authors point out, in ordinary construction the ratio of length to least width seldom exceeds 15, hence they have dealt with the problem simply as one of short columns.

In chapter iv., the results of a large number of tests of reinforced beams and columns are given, including many tests carried out by the authors themselves; not only are the actual numerical results of these tests of importance, as they afford the only safe test of the accuracy of the formulæ used in their design, but also much valuable information in regard to the design of such reinforced members may be gained from a study of the way in which the final collapse takes place; several plates are given, reproductions of photographs of the fractured beams, which show clearly how the disposition of the reinforcing bars in the beam influences the manner in which it gives way when the destructive load is reached.

In the next chapter the working stresses which can be permitted with this material are fully treated, and such constructive details as the use of steel of high elastic limit, the durability of the material, and its power of resisting the effect of fire. In the last three chapters a number of practical details in reinforced concrete work is given, and the problem of the determination of stresses in arches is dealt with in a very neat and compact fashion. T. H. B.

THE EVOLUTION OF DRESS.

The Heritage of Dress, being Notes on the History and Evolution of Clothes. By W. M. Webb. Pp. xxvi+393. (London: E. Grant Richards, 1907.) Price 15s. net.

THERE was certainly room for a scientific account of the evolution of dress. The present book, however, which professes to be "a popular contribution to the natural history of man," is hardly more than a collection of curious survivals in modern fashions, uniforms, the dress of the Court, the Church, the Bar, and other learned and official personages. The bibliography consists largely of articles in magazines and newspapers, and the author seems to have little acquaintance with the scientific literature of the subject, such as the frescoes of the Minoan Age unearthed by Mr. A. J. Evans; the contributions of Mr H. Balfour, Mr. Skeat, Dr. Westermarck, and Dr. Haddon on the evolution of ornament; Prof. Ridgeway on the penannular brooch; Dr. J. G. Frazer's classical paper on mourning as a disguise to baffle the ghost. He appears not to have read even such popular works as those of the late Mr. Elworthy on the "Evil Eye" and "Horns of Honour."

But if Mr. Webb has not written a scientific treatise on the "Heritage of Dress," he has given us, within its limits, an interesting and suggestive book, provided with excellent drawings which really illustrate the many topics with which he attempts to deal, and with an index which, if not quite accurate, is still sufficiently comprehensive. His aim is to furnish a record of survivals, and perhaps in no department of modern life are these more numerous than in that of dress. It is a fact of much scientific importance in connection with the history of social development that so many details in modern costume which we are inclined to believe capricious or accidental, due to the inventive genius of the tailor or the milliner, are really traceable to primitive forms, and that the perpetual changes of fashions are the result of a process of evolution, advancing on conservative lines, in which the influence of early ideas is apparent.

This can be readily illustrated from the wealth of material supplied by Mr. Webb. Thus perhaps the earliest form of dress is the shawl or wrapper, the fringes of which in the modern examples date back to the most early kind of loom. From this are derived the jacket of the woman as well as the trousers of the man. It is more hazardous to trace the shape of the hat to that of the primitive hut; but the band on our silk hats and "bowlers," now purely ornamental, is almost certainly a relic of the fastening of the original cloth headdress.

The origin of liveries, which represent the costume of the wearers' masters in earlier times, is equally curious. When we come to uniforms, almost all their distinguishing features have a history as survivals. The red coat took its colour from that of the best coat in the days of Charles II., and it has thus naturally descended to the fox-hunter and golfer; the baton of the field-marshal is the box in which he used to carry the orders of his sovereign; the epaulettes of the Imperial Yeoman take us back to chain-mail; the "prickers" of the hussar to the old flint-lock musket. Putties, which Mr. Webb traces back to Anglo-Saxon times, are proved by recent discoveries to be as old as the Mycenæan culture.

Much, of course, still remains mysterious. Why has a man's coat its buttons on the right, that of a woman on the left? Is the cockade descended from the chaperon headdress of the time of Richard II.? Whence come the buttons on the jacket of the page and on the trousers of the costermonger? Can it be, as Mr. Webb suggests, that grooms weave straw in the manes of horses because the horse was once thought to be a corn-spirit? Such matters require for their solution a wider range of induction and a more scientific study of the evidence than is provided by the present book, which raises, if it fails to solve, many other curious problems of the same kind.

MODERN VIEWS OF ELECTRICITY.

Modern Views of Electricity. By Sir Oliver Lodge, F.R.S. Third edition, revised. Pp. xvi+518. (London: Macmillan and Co., Ltd., 1907.) Price 6*s*.

WHEN Sir Oliver Lodge decided to issue a new edition of his well-known treatise, he set himself a very difficult task. The first edition was published in 1888, the second in 1892; he might well have thought that the development of the science during the past fifteen years had been so rapid that nothing short of complete re-writing could render the book deserving of its title. However, he has concluded that, since recent progress has amplified our views of electricity rather than altered them, the treatise has not lost its value; that it is still an expression of the truth, though it may be only a partial expression. Accordingly the general plan of the third edition is the same as that of the first; the changes that have been made consist of a few minor alterations and omissions, together with the addition of six appended lectures.

The earlier editions are so familiar that no detailed comment is necessary. Electrostatic, conductive, and magnetic processes are described and illustrated by a series of mechanical analogies, leading up to the representation of the electromagnetic ether as a medium made up of elastically connected gear wheels, separated in some regions by surfaces of slip. In the elaboration of these analogies the author is seen at his best; everything that he writes is extremely suggestive, though some students may be puzzled by the inconsistency between the different illustrations that are used in different parts of the book to represent the same action. We would direct special attention to the admirable treatment of the magnetic effect of materials with a permeability greater than unity.

However, we think that the author has underrated somewhat the change in even the simpler parts of the work, which has been necessitated by recent discoveries. It is true that these discoveries have affected our views of the electric properties of matter rather than the properties of electricity itself, but all electrical experiments involve the use of material bodies. Thus the discovery of the great difference between positive and negative electricity invalidates Sir Oliver Lodge's representation of the magnetic field. He can no longer account for the negative result of Maxwell's attempt to find a finite angular momentum in a closed current circuit by the existence of two oppositely directed streams of positive and negative electricity; there must be a gyrostatic effect, though it is too small to be detected by any arrangement devised at present.

Again, our view of the effect of a material dielectric on electrostatic phenomena has changed completely. It is not believed now that the presence of sulphur alters the properties of the lines of force issuing from a neighbouring charged body; the effect of the sulphur on electrostatic actions should be represented in the same way as the effect of iron on magnetic actions. The view that all electric actions take place in the medium surrounding a charged body and not in the body itself has been modified; attention has been concentrated once more on the importance of the conception of a charge. It is misleading to speak of the dispersion of light as obscure and to suggest that it has no causal connection with selected absorption. The old view that a dielectric resists the passage of a current but may be "broken down" by a force sufficiently great suggests that a perfect vacuum devoid of all resisting matter should be a perfect conductor, and is utterly discordant with modern views. If the author did not see his way to re-write the book completely, we think that at least he should have added copious notes on these and many similar points to warn the student that the older statements must be revised in the light of later knowledge. As it stands, the book is of immense interest to those to whom modern conceptions are familiar, for it enables them to grasp at once the bearing of those conceptions on fundamental problems, but it would be dangerous in the early stages of reading.

We have detected one misprint on p. 224, l. 24: for "infinite" read "finite." We must also protest strongly against the use on p. 255 of the expression "centre of gravity of the ether" in place of "centre of mass." There is no evidence whatever that ether has a centre of gravity. N. R. C.

ENGLAND AN EXAMPLE FOR GERMANY.

Der naturwissenschaftliche Unterricht auf praktisch-heuristischer Grundlage. By Dr. F. Dannemann. Pp. xii+366. (Hanover and Leipzig: Hahnsche Buchhandlung, 1907.) Price 6 marks.

WE are accustomed in matters relating to school teaching to have German methods and results eulogised by contrast with our own, so that it is especially gratifying for once to find the tables turned. The author is a leading exponent of science teaching in his country, a schoolmaster of high repute in secondary schoolwork, and he has written this elaborate work frankly on the model of teaching that he witnessed at Harrow and other English secondary schools; and he has produced an account which in some respects is more thorough and comprehensive than anything we have in England. The only work to compare with it is the American book by Smith and Hall which appeared two years ago, and that deals only with chemistry and physics, while Dr. Dannemann covers biology as well. One half of the work is taken up with detailed recommendations for class teaching in branches of natural science, viz. physics, chemistry, mineralogy, geology, astronomy, and biology, then chapters are added on the equipment of laboratories, the preparation and use of text-books, the training of science teachers, the treatment of scientific ideas in the order of their historical development; then some half-dozen appendices give documents taken partly from the regulations of the Kultus Ministerium in Prussia and in other German States, side by side with resolutions adopted by associations of science teachers, in which no doubt Dr. Dannemann is a leading personality.

The adoption of the term "praktisch-heuristisch" is sufficiently significant of the author's position. He does not give the history of the name "heuristic," and only incidentally refers to Prof. Armstrong, but in all his work he is definitely on the side of those who insist that the centre of a course of science teaching shall be at the bench in the laboratory, and that demonstration and discussion in the class-room must be associated with and take their cue from this centre of activity. He has nothing but scorn for the "Kreidephysik" which is still too commonly found in German schools, where the teacher with his chalk and blackboard demonstrates the truths of natural philosophy. It is very interesting to witness, from the pages of this work, how very reluctant German authorities are to adopt these reforms, and no doubt a strenuous advocate of English methods has not always a happy time among his countrymen. Indeed, the case is curiously paralleled by what is happening in England as regards modern language teaching. The "reformers" here look chiefly to Vietor and others in Germany for inspiration, and turn to many examples in German schools to show how a foreign language can be acquired. Dr. Dannemann tells his countrymen to look to the practical English teacher and to abandon their reliance on the parrot-like learning of scientific text-books.

Although much of the ground covered by these chapters will be familiar to the English teacher of science, there are portions which are novel, especially in the plans by which the author hopes to give a secondary schoolboy some grasp of the entire field of natural science before leaving school; and the sketch of science teaching from the genetic standpoint is also well worthy of careful perusal.

The chapter on the training of science teachers seems to us the weakest part of the book. It is difficult to see how university men can be kept for a year doing the very elementary work which Dr. Dannemann proposes for them; a man ought to have learned, during his university career in laboratories, to be able to secure himself and his scholars against accidents. But it is a little difficult to realise fully the conditions of German schools in these respects. We are sure from the quality of this and other writings by the author that any "Kandidat" who was sent to learn the business of a science teacher from him would gain a thorough understanding both of principles and practice.

WIRELESS TELEGRAPHY AND TELEPHONY.

Jahrbuch der drahtlosen Telegraphie und Telephonie. Band i., Heft i. Edited by Dr. G. Eichorn. (Leipzig: S. Hirzel, 1907.) Preis fur den Band, 20 marks.

Wireless Telephony in Theory and Practice. By E. Ruhmer. Translated by J. Erskine-Murray. Pp. xv+224. (London: Crosby Lockwood and Son, 1908.) Price 10*s.* 6*d.* net.

THE publication of the first number of a German year-book of wireless telegraphy and telephony affords an indication of the growing importance of this branch of electrotechnics. The volume before us is more of the character of an ordinary scientific magazine than of a year-book, since there is not really much attempt to summarise the progress during the past year, which, we take it, is peculiarly the function of a year-book. This objection apart, the publication deserves praise on account of the merit of the articles which it contains. Of these the most important are one by Prof. F. Braun on directed wireless telegraphy, one by Dr. Simon on the production of undamped waves, and one by Prof. Fleming on some of the most recent developments.

Dr. Simon's article will be read with special interest at the present time on account of the experimental work which is being carried on in all countries for the development of wireless telephony. In addition to these and some minor papers, there is a valuable bibliography.

The development of wireless telegraphy during the twenty years which have passed since the discoveries of Hertz has presented some peculiar features. Grown out of a discovery which, theoretically regarded, was of a sensational nature, wireless telegraphy has always seemed to have a tendency to sensational rather than solid progress. Except in so far as its military and naval value is concerned, the world at large cannot be said to have derived as yet any very great advantage from its development, and we doubt whether financial success, the touchstone of utility, has as yet rewarded any of the companies which have been pioneering the various systems. On the other hand, sensational performances, in which the hearts of all wireless workers appear to rejoice, have been frequent. The Marconi Company's first attempts to establish Transatlantic communication, the signal failure of their first commercial system of Transatlantic wireless telegraphy, and the apparent failure, so far, of their more recent attempt, will be fresh in the minds of all. As we have before pointed out in these columns, it would appear that the enormous efforts and expenditure which have been lavished on the development of long-distance signalling might have been much more usefully spent on the development of less ambitious but more solidly useful schemes.

More recently the attention to the production of undamped oscillations on the principle of the Duddell musical arc (as in the Poulsen system) has stimulated research on the wireless transmission of speech, and considerable success has attended the experiments. In Germany successful transmission across ten miles of land (right across Berlin) has been attained, and in America, in addition to the equipment of the torpedo-boats of the Pacific fleet with wireless telephone apparatus on the De Forest system, one may note that stations have been working successfully on the Fessenden system over a distance of 200 miles (more than half over land).

A very full descriptive account of the experimental work which has been carried out on wireless telephony is to be found in Prof. Ruhmer's book. The volume is not confined to telephony by means of Hertzian waves, the particular branch which now occupies the most important and the most promising position. In fact, nearly one-third of the volume is devoted to wireless telephony by means of light, in which a speaking arc is utilised as transmitter and a sensitive selenium cell as receiver. This method, which owes much of its development to Prof. Ruhmer, has attained considerable success, fair distances having been bridged over both water and land. The volume is profusely illustrated by both photographs and drawings, and should prove a useful reference work for those directly or indirectly interested in the subject.

There can be no question that the successful solution of the problem of wireless telephony will mark a very considerable advance in the art of wireless communication. It is true that the difficulties of interference and lack of secrecy have to be met with telephony as with telegraphy, but there are, at any rate, the same compensating advantages which are to be found in ordinary telephony over telegraphy. It is to be remarked also that efforts to establish long-distance wireless telephony, across the Atlantic, for example, are not open to the same objection as applies to the attempts to establish Transatlantic wireless telegraphy, since in this case the field is not already occupied by cables performing the same service more efficiently.

M. S.

THE TABERNACLE AND THE TEMPLE.

The Tabernacle: its History and Structure. By the Rev. W. Shaw Caldecott. Pp. xxii + 236. Second Edition. (London: Religious Tract Society, 1906.) Price 5*s*.

Solomon's Temple: its History and Structure. By the Rev. W. Shaw Caldecott. Pp. xiii + 358. (London: Religious Tract Society, 1907.) Price 6*s*.

THE interest which Anglo-American Protestantism has always taken in the præ-Christian Biblical books, and in the land of Canaan, in which the events of ancient Israelitish history, traditionally described in them, took place, has again been exemplified in yet another addition to the long list of pious speculations as to the appearance of the Israelitish Tabernacle and of the Temple of Yahweh at Jerusalem. Mr. Caldecott is an enthusiast, like his forerunners, for none but an enthusiast would be bold enough to explain the meaning of doubtful cuneiform signs to cuneiform scholars, or to invite prefaces from a master of cuneiform science, Prof. Sayce, in which the ingenuous author of the book is publicly told that, however nice and interesting his discussion of the Tabernacle and the Temple may be, his cuneiform cannot be accepted.

Mr. Caldecott's *naïveté* in thus rushing in where those who know the root of the matter fear to tread, necessarily vitiates the credibility of the remainder of his speculations in the mind of the scientific reader.

Nevertheless, Mr. Caldecott is more critical than most of his predecessors, which is an encouraging symptom. His sketch of the history of the Jewish Kingdom is very readable, and, though conservative, contains little at which a moderate "higher critic" might cavil, though no doubt a Jerahmeelite might consider it a sufficiently benighted performance. The views of the Jerahmeelites do not, however, any longer count among scientific archæologists in England, although the Germans, swayed by their quaint national delusion that no really valuable work in archæology or Biblical criticism can possibly be done by anybody but Germans (or non-Germans taught to perform the scientific *Parademarsch* by German drill-instructors), no doubt still believe in the wild "North-Arabian" theories of Winckler in which Cheyne found support for the Jerahmeel-cryptogram.

We are glad that Mr. Caldecott has not adopted the legend of the "second Musri," and that for him Esarhaddon's "Sib'e, the *Tartannu* of Pir'u King of Muṣri," is, as he is to every sane critic, "So (Seve) the general of Pharaoh King of Egypt," *i.e.* the King Shabak understood as an officer of the Ethiopian king, probably Kashta, who ruled in Upper Egypt. But we think that Mr. Caldecott, in his note on Sib'e ("Temple," p. 139), should have referred to Winckler's Muṣri-theory, and given his reasons for not accepting it. This would have been the scientific way of doing things. As it is, he lays himself open to the suspicion of not having known anything about an important theory, very germane to his subject, which archæologists and "higher critics" have been debating for years. And this possibility again makes one doubt the real value of this sort of work, despite the kind words of encouragement bestowed by Prof. Sayce upon the present author in respect of everything but his cuneiform. Whether, as he thinks, Mr. Caldecott's speculations will excite new interest in excavations in Palestine is doubtful; unluckily, these excavations have not always produced such "pat" results as seem generally to be expected from them. Those of the Austrians at Taanach seem to be the most interesting hitherto.

The identification of the modern Rāmet el-Khalīl with the ancient Ramah near Jerusalem, where the Tabernacle was set up, is, as Mr. Caldecott points out, due to the late Edward Robinson, who proposed it in 1838. The latter calls it quite correctly "er-Rameh"; Mr. Caldecott should be careful not to go on calling it, as he continually does, "Ramet" when he does not add the suffix "el-Khalil"; the name of the place is Rāmeh or Rāma (usually with the definite article prefixed), which becomes "Rāmet" in the *construct state*, as "Rāmet el-Khalīl."

In conclusion, we would advise our author, before he publishes new editions of his books, to consult the articles "Tabernacle" and "Temple," by Dr. Benzinger, in the "Encyclopædia Biblica"; they may give him some novel information on certain points.