THURSDAY, DECEMBER 4, 1902.

DR. NANSEN'S OCEANOGRAPHY OF THE NORTH POLAR BASIN.

The Norwegian North Polar Expedition, 1893-1896, *Scientific Results*. Edited by Fridtjof Nansen. Vol. iii. Published by the Fridtjof Nansen Fund for the Advancement of Science. Pp. xii + 428; 88 Plates. (London: Longmans, Green and Co., 1902.)

THIS volume discusses at great length the not very numerous observations on the physical conditions of the water in the Arctic Sea which were made on board the *Fram* during her memorable drift. The matter is dealt with in two memoirs, both by Dr. Nansen, the first on the oceanography of the North Polar Basin, the second on hydrometers and the surface tension of liquids.

The second memoir may be considered as an appendix to the first, a great part of which also deals with methods and discusses experiments carried out after the return of the expedition.

We must, in the first place, express gratitude to Dr. Nansen for his choice of the English language as the medium by which the official account of his expedition is made public; a choice which brings at least this reward, that his volumes will find their natural place beside the magnificent record of the *Challenger* expedition.

It is natural to look at the contents of this volume from the separate points of view of methods and results. As to methods, it must be confessed that the key-note is one of regret mingled with hope. "What might have been" if the experience gained during the voyage had been available before it started is insisted upon almost too much; and we are sometimes tempted to forget, in dealing with the results, that the high degree of possible precision lay latent in the methods and was not actually attained. Dr. Nansen, indeed, loses no opportunity of disclaiming higher accuracy than his instruments as they were handled could give, and we have rarely seen a scientific man more candid in blaming himself for neglecting precautions which, after all, few specialists in his subject, if any, thought necessary at the time of his departure.

The methods most fully dealt with are those of determining the temperature and density of sea-water at various depths. Two methods of observing the temperature were usually used, one involving the use of the Pettersson insulating water-bottle and the other the reversing thermometer on Negretti and Zambra's principle. The insulating water-bottle is an apparatus which encloses at a given depth a large sample of water, partly in a central tube, partly between the members of a series of concentric outer tubes having no communication between them. It is thus apparent that before the temperature in the inner tube can change, the temperature of each of the concentric water-jackets must be changed to a greater degree. The important question is how long a time may be allowed to elapse before the temperature in the inner tube changes by an amount appreciable on the thermometer. The actual water-bottle used on the voyage was lost, and its constants could not be tested. Two other water-bottles of apparently identical construction gave on examination distinctly different results, and differences were also found when the external temperature was changed in various ways. It seems probable, however, that with one of the improved water-bottles on this principle, the constants of which have been elaborately determined before use, it may be possible to arrive at temperature readings to something approaching the hundredth of a centigrade degree; but this will be the result of applying many corrections, some of considerable magnitude. The question is not definitely settled, but it is clear at least that no error exceeding one-tenth of a centigrade degree should occur with a water-bottle of this description when skilfully handled. The peculiar virtues and failings of the Negretti and Zambra reversing thermometer are familiar to all who have had occasion to use that beautiful but capricious instrument for deep-sea work. Dr. Nansen discusses the various corrections which have to be applied, and in their case also he suggests improvements which should lead to increased precision and certainty. For the *Fram* expedition, the reversing thermometers gave readings the error of which in almost all cases could be guaranteed not to exceed $\pm 0^{\circ}\cdot1$C.

The determination of density received a great deal of attention, for just as Dr. Nansen believes that observations of sea-temperature should be correct to one-hundredth of a centigrade degree, so he believes that the density of sea-water should be obtained with a degree of precision sufficient to indicate a difference as small as one unit in the fifth place of decimals, when the density of distilled water is taken as unity. But in the case of density, as in that of temperature, the results of the *Fram* did not realise the desired ideal. The investigation as to why this was so occupied much time and led to the interesting study in hydrometry which forms the second paper. We cannot follow the experiments in detail, and it must suffice to say that the villain of the piece was finally exposed and found to be grease. Variations in surface tension due to observing with unwashed hands or wiping the hydrometer with a towel not above reproach led to the most distressing irregularities. It was shown that an ordinary stem-reading hydrometer could give good results if the glass was perfectly clean and the surface of the water swept free from impurities by careful brushing with a piece of clean paper. But better results can be obtained by using hydrometers of total immersion, which act in the heart of the liquid untroubled by surface tension or capillarity. Dr. Nansen finds the best results when using a jar with vacuum jacket on the principle employed by Prof. Dewar for handling liquid air, thus preventing change of temperature by radiation. The stemless hydrometer is weighted so as just to float in the sample of sea-water, the temperature of which is read by means of a very sensitive thermometer. The temperature is then raised by stirring with a tube containing warm water, and the exact temperature at which the hydrometer begins to sink is noted; a tube of cold water is then used as a stirring rod until the hydrometer begins to rise again, and thus by one or two operations the temperature at which the sample has the precise density of the weighted hydrometer can be ascertained with high precision. Other methods of determining salinity were tried on board, the

refractometer and an apparatus for measuring electrical resistance having been experimented with. Both gave fair results, but were troublesome and consequently not much used. The electrical method required the use of a standard solution of potassium chloride the resistance of which was balanced against that of the sample by means of a slide-wire Wheatstone's bridge, a telephone being used instead of a galvanometer. In the long run, the indications of the stem-reading hydrometers had to be relied on for the tables of specific gravity and salinity published in the memoir.

Samples of sea-water were brought back for chemical analysis, but they were not numerous enough to enable any definite conclusions to be drawn. So far as they went, they showed great similarity between the chemical composition of the salts in Arctic Sea water and in average ocean water, the freezing of the surface appearing to exercise very little selective action on the dissolved salts.

The observations of temperature and density are printed in full with critical remarks, and the data are utilised to throw light on the circulation of the water in the North Polar Basin, the results of other expeditions being considered simultaneously, so far as they affect the region under discussion. Dr. Nansen endeavours to arrive at the circulation of water in the sea by calculating the density *in situ* and representing this on maps and sections by isopyknals, which bear the same relation to the circulation of the sea that isobars do to the circulation of the air, and by isosteres or lines of equal specific volume. The flow of water is deviated from the direction of the density gradient, both for horizontal and vertical movement, by the rotation of the earth, and the amount of this deviation being calculated, it is possible to estimate the circulatory force of the sea due to differences of density alone, supposing that there was no wind. But the wind, acting on the surface water or even on the ice, probably has a greater influence on the movement of the water than the isopyknal gradient; hence a large part of the discussion is occupied by the consideration of the wind-drift and its rotational deviation. It is quite impossible in the limited space of a review to enter critically into the methods by which Dr. Nansen arrives at his conclusions; indeed, the only criticism we are prepared to make is that he has perhaps given too much detail, erring towards diffuseness rather than towards conciseness. However, we can give no more concise statement of the general conclusion as to the Arctic Sea than in Dr. Nansen's own words:—

"We have thus, in our discussion of the distribution of salinity and temperature in the North Polar Basin, arrived at the conclusion that there are at least four systems of currents in a vertical section from the surface to the bottom, along the route of the *Fram*, viz.,

"(1) A surface current of water with low salinity (from about 29 per mille to 32 per mille), perhaps 20m. or 30m. deep, running towards the north-west and west;

"(2) An underlying, slow current of water with a lighter salinity and a very low temperature, running in a different direction, and consisting of surface water from other parts of the Polar Sea. The absolute minimum of temperature is situated in this current, at about 50m. or 60m.;

"(3) A current of relatively warm water with salinities of from 35·1 per mille to 35·3 per mille, coming from the Gulf Stream west of Spitzbergen, and running towards the east at depths below 250m., the maximum of temperature being situated in the water of this current at depths of from 350m. to 450m.; and

"(4) An extremely slow current of colder water, filling the deepest part of the basin between 900m. or 1000m. and the bottom. This water is the heaviest water of the preceding current, which has been cooled down and has sunk towards the bottom; it has a salinity of about 35·29 per mille. It is possible that this water forms to some extent a spiral current under the preceding current, running in a similar direction."

The relation between the water of the North Polar Basin and that of the Norwegian Sea requires additional observations before it can be fully explained, and at every step of the discussion new questions are raised which future investigations must settle.

The fresh surface layer of water in the Arctic Sea is attributed by Dr. Nansen mainly to the inflow from the great rivers of Siberia. In the mass of very slightly warmer water filling the vast hollow of the central Arctic Sea below the zone of maximum temperature, there is undoubtedly a small but distinct rise of temperature towards the bottom, and this is attributed to the influence of the internal heat of the earth.

We feel that it has been possible to give only an inadequate idea of the value and originality of this great contribution to oceanography, and we have laid stress rather on the methods than the results, because it is by the experience gained in arriving at these methods that Dr. Nansen, as Director of the International Marine Laboratory, will be able to make the physical work of the International Council for the Study of the Sea fuller and more accurate than any similar oceanographical investigation that has gone before it.

H. R. M.

ANIMAL HISTOLOGY.

Lehrbuch der vergleichenden Histologie der Tiere. By Dr. Karl Camillo Schneider. Pp. xiv+988. (Jena: Gustav Fischer, 1902.) Price 24 marks.

WE have only one serious fault to find with this book and it reflects no discredit on the author. That any book should be issued to the public in such a form that the mere operation of cutting the leaves—to say nothing of perusing the pages—involves its falling to pieces can only be characterised as a grave fault, although it is common in scientific books which are "made in Germany." Another fault usual in books hailing from the same quarter, and against which we have frequently protested, is absent in this one, for it contains an index, although not a very complete or well-arranged index. For example, we find "mehrreihiges Epithel," "mehrschichtiges Epithel," indexed, not with "Epithel" the substantive, but in the alphabetical situation of the adjective, where no one would think of looking for them. The art and science of index making has not, it must be confessed, up to the present made much progress in Germany, a fact the more remarkable since it is the country which beyond all others is a producer of books imperatively demanding efficient indices.

For the work itself as a text-book of comparative histology we have nothing but praise. The letterpress

is well written and well printed, and the illustrations are numerous and accurate, and are also beautifully reproduced. By far the majority are original, although the author has, not unwisely, availed himself of good figures by other workers, especially in the domain of vertebrate histology, which has hitherto been more completely exploited than that of Invertebrata. Such a book as this fills an important hiatus in our series of text-books, and it is to be hoped that before long we shall see an English translation. It is certainly strange, considering the importance of the subject and the necessity that so many workers must have felt to be informed regarding what is known as to the minute structure of the tissues and organs in this or that class of animals, that no effort has been made, since the work of Leydig, which was published as long ago as the middle of the last century, to furnish, on modern lines, such an account of minute structure as is ably given by Dr. Schneider in this volume. Oppel's "Vergleichende Histologie" deals, it is true, with a part of the subject, but in a different manner, giving an account, more or less historical and bibliographical, of researches which have been made into the structure of particular organs and groups of organs in Vertebrata, with occasional original observations interspersed; while in the book before us we find a description of structure founded mainly on the author's own observations on certain types in each class of the animal kingdom, and merely supplemented by occasional references to the work of other authors. Both methods have their value. That of Oppel tends to produce a book which is a veritable storehouse of information on the more limited subject with which it deals, but it suffers from the disadvantage that such a work must necessarily be enormously bulky and proportionately slow in coming to completion, and as a matter of fact Oppel's book, two or three volumes of which have already been noticed in NATURE, is not only very far from that stage, but it would almost appear—from the present rate of progress—that the end would never be reached at all; whereas in the work before us we have an account of the minute structure of all classes of animals which is, so far as it goes, complete, and is not unduly large considering the vast extent of the subject.

As a matter of fact, Dr. Schneider's work is compounded of three distinct parts, each of which might very well have been published as a separate book. The first of these—under the terms "Cytology" and "Organology"—comprehends an account of the structure of the tissues and organs of animals in general, the resemblances and differences being duly noted; it is, in fact, a general minute anatomy of the animal kingdom. The third or special part, which occupies by far the largest bulk, is also purely histological, but the minute structure is dealt with class by class, beginning with Porifera and ending with Vertebrata. There is in this some unavoidable repetition of the matter contained in the first part. On the other hand, the second part—which is termed "Architektonik"—is not histological at all, but morphological. It deals with the forms of Metazoa and their mode of production, and also includes the consideration of their classification, and such questions as the formation of species and the causes of variation. All this might very well have been omitted in a work dealing with histology—that is to say, a knowledge of the subject might very well have been assumed—in which case the bulk of the volume would have been reduced to more manageable proportions. Moreover, it could have been further reduced by a great diminution of the bibliography, which, although extensive, merely amounts to a collection of titles, for the papers given in it are not specifically referred to in the text. The value of such a list is not apparent, since at best it is sure to be incomplete and could, in fact, be readily compiled more efficiently from well-known publications accessible to everyone. It will appeal to authors who do not take the trouble to search out their own references or to verify them for themselves, but adds no real scientific value to a work of this sort unless the papers quoted have a direct bearing on points treated in the book itself. There are always to be found in the compilation of such lists sins both of omission and of commission—papers of a trivial and unimportant character included, and others of considerable importance omitted altogether. A bibliography, to be of actual value to the readers of a book, must not only have a general relationship to the subject-matter of the work, but a direct specific relationship to the detailed statements and conclusions of the author. As examples of what bibliographies in works on morphology should be like, those given in Balfour's "Comparative Embryology" and in Minot's "Human Embryology" may be instanced. With such as these, which add a definite value to the works which they complete, a bibliography like that in the work under review, even although it contains 36 pages of titles, contrasts unfavourably. In most other respects, Dr. Schneider's book is to be commended as a creditable attempt to supply a want which has been long felt, but which, no doubt, the magnitude of the task has hitherto deterred others from embarking upon.

It should, however, be stated that the author's method is dogmatic rather than critical, and that in disputed and controversial questions he gives the views of the Vienna school of histologists, to which he himself belongs, without, as a rule, so much as hinting that other views are held. If this is a fault, it is one which can be easily forgiven to the author of a text-book, for at least it tends to prevent a confusion of ideas on the part of the learner, to diminish the bulk of the work, and generally to present its contents in a more readable form, and one more useful to the average student.

PHILOSOPHY AND SCIENCE.

The World and the Individual. First Series: The Four Historical Conceptions of Being. By Josiah Royce, Ph.D. Pp. xvi + 588. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1900.) Price 12*s.* 6*d.* net.

The World and the Individual. Second Series: Nature, Man, and the Moral Order. By Josiah Royce, Ph.D. Pp. xvii + 480. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1901.) Price 12*s.* 6*d.* net.

IN the first series of these remarkable Gifford lectures, Prof. Royce gives us the broad outlines of an ontology which serves as the philosophical basis for the special discussion of cosmological and ethical problems contained

in his second volume. As a contribution to the investigation of ultimate metaphysical issues, Prof. Royce's first volume, like previous works by the same writer, deserves high commendation for the frequent grace of its style and the freshness and freedom from unnecessary technicalities with which the problems are presented to the reader. Metaphysics has a bad name with the cultivated public in general on the score of aridity and unintelligibility, but there is nothing in Prof. Royce's lectures that a thoughtful man of ordinary education should find unduly difficult or repellent, and there is much that every such man must find of the highest importance. Writing from a standpoint which may roughly be described as that of Hegelian idealism, but in entire freedom from mechanical adhesion to a master, and often with marked individual originality, Prof. Royce gives us a most instructive discussion of the different senses which have, in the history of human thought, been put upon the concept of Being. We are led by consideration of the complementary errors of realism and mysticism to the definition of real existence in Kantian terms as the valid, that which accords with the conditions of a "possible experience." But validity or genuine possibility must, again, rest on a basis of actual existence as part of a real experience; hence Prof. Royce conducts us from the third, or Kantian, to his own, the fourth, definition of real existence as the completed purpose or meaning of an idea. Space forbids detailed examination of his line of argument, but there are perhaps two main positions of the writer which seem hardly satisfactory as stated. It is not made sufficiently clear how it can be an "idea," in any recognised sense of the word, which ultimately sets all selective attention to work, and generally the relation between thought and will is left in some obscurity. Thus, both in the first and second series of lectures, Prof. Royce often seems to imply the very doubtful view that voluntary attention is the same thing as a volition to attend, but he nowhere explicitly states his position on the question. A minor peculiarity in the first series, which is perhaps open to attack, is the use made of certain logical theories in criticising the Kantian conception of reality. Prof. Royce might reconsider, in the light of objections with which he is no doubt familiar, but which he nowhere meets, the view, adopted by him from the writers on symbolic logic, of the universal proposition as a negative existential judgment.

To the professed metaphysician the most important thing in the two volumes will be the supplementary essay to vol. i., in which ingenious use is made of the modern theory of infinite series, as expounded by Dedekind and others, as the basis of a defence of the conception of the Absolute as a Self against the negative dialectic of Mr. F. H. Bradley. The argument cannot be dealt with here, but one difficulty may be noted. Prof. Royce, if I understand him rightly, assumes a very direct relation between validity and actuality. He appears to take it for granted that if you can reason about an infinite series in mathematics, it must be possible for that series to be actually summed; or again, that every proposition of an infinite series of propositions which would be true if made must actually be thought by some mind. As the infinite series of such minds, according to Prof. Royce's view, in its entirety makes up the mind of God, it would seem to follow that the *infinitus intellectus Dei*, which we are assured knows all that we know, just as we know it, is like nothing so much as an infinitely extended Bradshaw's Guide without an index. Before we can adopt this view, we need, I think, a more searching investigation into the relation of mathematical truth to actual fact than Prof. Royce has supplied. Is it, after all, allowable to assume without criticism that mathematical conceptions must be the exact counterpart of actual existence?

In the second series of his lectures, Prof. Royce uses the metaphysical standpoint secured in the first volume as the basis for a striking theory of the real character of the processes which appear to our senses as the physical order. His general thesis is one which seems inevitable if we accept the premisses of idealism, that what we perceive as physical nature is a vast society of purposive and intelligent beings, which appears to us to be a dead mechanism simply because we have no direct insight into the special nature of the purposive life which animates it. In connection with this general thesis, Prof. Royce supplies an invaluable criticism of the notion of uniformity or "natural law" and a most suggestive attempt at a philosophical interpretation of the empirical facts of evolution.

The concluding essays of the series contain a striking vindication of the doctrine of moral freedom and an ingenious argument for human immortality, in a sense rather different from that commonly put on the term. I hope it is not ungracious, in the presence of such a wealth of suggestive discussion of topics of vital interest, to suggest that Prof. Royce's psychology is sometimes of a doubtful kind. More than once he seems to make the contrast between my self as it is in time and my "self in eternity," with its complete insight into the solution of the problems my temporal self finds insoluble, so sharp as to amount to a positive ascription of two distinct types of existence to the same individual. His eternal self becomes, especially in the last lecture, so much a sort of lesser god, and so remote from the struggling, perplexed creature I know as my temporal self, that it is not quite easy to see how the two can ultimately be one. His doctrine of sin, deeply true as many of his statements are felt to be, again, seems to me to involve the already mentioned confusion between attending voluntarily and willing to attend. Lastly, the argument for the temporal immortality of every self might perhaps be found hardly consistent with the admission of the temporal origination of new selves by evolution. Does not evolution involve the disappearance of selves in precisely the same sense in which it involves their origination? Prof. Royce's argument, if pressed, ought to prove immortality *ex parte ante* as well as *ex parte post*. And, in view of his general acceptance of a clarified Christianity, it is not improper to ask whether Prof. Royce agrees with all serious forms of Christian doctrine in recognising the possibility that some selves may be finally "lost," and, if so, how he interprets such ultimate loss. Misgivings of this kind, however, need in no way detract from our admiration of the courage with which Prof. Royce has essayed the task of bringing idealistic philosophy into line with the positive results of empirical science, and of the vast originality and ability with which that task has been, on the whole, executed. The Gifford trustees are indeed

to be congratulated on having been the immediate causes of the publication of three such works as the Gifford lectures of Profs. Ward, Royce and James. There have been few equally important additions to English philosophical speculation in recent years. A. E. TAYLOR.

THE PARALLEL RUNNING OF ALTERNATORS.

Der Parallelbetrieb von Wechselstrommaschinen. By Dr. Gustav Benischke. Pp. 55. (Brunswick: Friedrich Vieweg und Sohn, 1902.) Price M. 1.20.

THE second volume of "Elektrotechnik in Einzel-Darstellungen," of which the first was mentioned in these columns some time ago, appears in the above form and fully sustains, if it does not surpass, the excellent character of the first volume. Besides the general normal parallel running of alternators, including, of course, polyphase machines, the disturbing influences which make parallel running difficult or impossible are discussed. To the mathematically inclined, the theoretical explanation of the phenomena met with in the parallel running of alternating-current machinery offers exceptional opportunity for a fine display of mathematical calculations and formulæ. Fortunately, Dr. Benischke is not so inclined, and in his preface declares that the physical explanation of the phenomena appeals more directly to one's intelligence than the mathematical, and that, in the cases under consideration, the swinging and falling out of step of alternators, the mathematical method is not much good, as it is not possible thereby to prophesy whether two machines will run in parallel or not. This is, of course, what has been found in practice, and it is now usual in the construction of alternators to so design them that means for the prevention of swinging (Le Blanc's damping rings) can be placed in position should it prove necessary. The author is to be particularly congratulated on chapters x. and xi., in which these matters are discussed, for the very clear and logical manner in which he has put them.

As an introduction, the first three chapters of the book deal with the parallel running of continuous-current machinery, and the question of motor current and division of the load between the parallel sets. With continuous-current generators, the division of the load between the machines is a question for the switchboard attendant, who simply has to regulate the exciting currents, the steam-engine governors doing the rest. With alternators, the task becomes more difficult, for not only have we the additional necessity of the machines being in synchronism one with the other, but also the proper division of the load between the generators can only be attained by concurrent adjustment of both the exciting current and the steam admission. This is due to the fact that increase of the excitation of the unloaded machine is not followed by a diminution in speed due to current flowing, followed by a greater admission of steam, as in a direct-current machine, as the alternator is kept at the same speed always, being in synchronism. The proper division of the load between the alternators becomes, therefore, largely the work of the engine-driver, acting under the instructions received from the switchboard attendant, while the latter has to see that the wattless current given by the machines is kept at a minimum by the proper regulation of the exciting currents. In accordance with German practice, the author recommends the use of an indicating wattmeter or power-factor indicator on each machine to control the power factor. This has not been the usual practice in England, as the matter can just as well be done by regulating to minimum current on the machine ammeters. To-day, recording power-factor indicators are being demanded in England; this is presumably to enable the engineer to have a check on his assistants. They are also, so far as we are aware, only for use on circuits off which synchronous substation machinery is running, where the question of power factor is of greater importance than in the case now considered.

We can now only refer to the other chapters in the book, which treat of the influence of the shape of the current and electromotive-force curves, the electrical connections for parallel running with diagrams, synchronisers, under which we did not find a description of the Lincoln synchroniser, which we think is an omission, parallel running of machines situated on the same axil, and of alternators driven by gas engines. We can warmly recommend the book to all who seek trustworthy and detailed information on this important engineering subject. C. C. G.

OUR BOOK SHELF.

Hand- und Hülfsbuch zur Ausführung physiko-chemischer Messungen. By W. Ostwald und R. Luther. Zweite Auflage. Pp. xii + 492. (Leipzig: W. Engelmann.) Price 15*s.* net.

THE second edition of this well-known work will undoubtedly be welcomed by a large circle of students and teachers, the more so since for some time the first edition has been out of print. The cooperation of the original author with Dr. Luther in the production of the second edition has resulted in a considerable number of changes being made in the book; a new work is, in fact, the result. Dr. Luther's long experience as demonstrator and later as subdirector of the Physico-chemical Institute at Leipzig has made him specially fitted for this collaboration, and the value of the book is greatly enhanced by the results of his daily contact with the practical difficulties of students engaged in physico-chemical work.

In the new edition, the headings of the first fifteen chapters agree with those of the first issue. Considerable changes have, however, been made in detail by the introduction of new matter. The sixteenth chapter of the original edition is represented by five chapters in the present one, the headings of which are respectively electrical measurements, electromotive force, conductivity of electrolytes (dielectric constant), quantity of electricity and transport number and finally electrical measuremen of temperature. In this portion of the book, the chief work of reconstruction has been performed. The twentieth chapter deals with chemical dynamics, and a new chapter has been added on the application of physico-chemical methods to chemical questions.

Noteworthy alterations in detail are the introduction of a number of new tables of useful data, the use of the new unit for the expression of conductivity values and the inclusion of copious references to original papers dealing with the subject-matter in hand. Special forms of apparatus and details of manipulation which cannot be included in a practical text-book of anything like modest

dimensions are thus placed within easy reach of the student.

Although so rich in material, one or two omissions might with advantage be remedied in a future edition. In the chapter on measurement of pressure, no apparatus such as the differential manometer suitable for the measurement of very small pressures is described. The methods and apparatus so frequently employed in the investigation of transition phenomena of different kinds should also find a place. Such are the use of the Bremer-Frowein tensimeter, the dilatometer, the electric transition cell, &c. Apart from these omissions, the book is undoubtedly excellent. It will be found invaluable to teacher and student alike, and should find a place in every chemical and physical laboratory. H. M. D.

London Birds and Other Sketches. By T. Digby Pigott. New and enlarged edition. Pp. xiii + 256; illustrated. (London: E. Arnold, 1902.) Price 7*s.* 6*d.*

MR. PIGOTT is of opinion that every man, especially as he grows older, ought to have a "hobby," his own being the observation of birds in their native haunts. That he has recorded the results of these observations in a manner acceptable to the public taste may be taken for granted from the fact of his book having reached a third edition. Whether, indeed, he is treating of the wood-pigeons in Kensington Gardens, of the gulls and cormorants on the ornamental water in St. James's Park, of London insects, of the bearded tit in the Norfolk fens or of the sea-birds of the Shetlands and Farne Islands, the author is equally interesting; while the exquisite frontispiece by Mr. Thorburn and the other illustrations confer an additional attraction on a very charming little volume. In several instances, as in the case of gulls essaying to perch on the trees in St. James's Park, Mr. Pigott has new facts regarding bird life to place before his readers. The statement that rooks are not likely again to build in Kensington Gardens will be read with regret by all. On the other hand, bird-lovers will learn with pleasure that the bearded tit is on the increase in the Norfolk reed-brakes. Among the most interesting chapters in the volume are those on birds nesting in the Shetlands and bird life in St. Kilda.

It is, perhaps, a pity that the author did not get some professional ornithologist to look through his proofs. Had this been done, we should not have found the kingfisher, the swift and the nightjar classed as "Passeres" (p. 253) or "Regulus" given as the name of the wren (p. 22), while the statement (p. 5) that the shrikes form a link between other passerines and the birds of prey would perhaps have been modified. R. L.

How to Buy a Camera. By H. C. Shelley. Pp. xii + 144. The "How to Buy" Series. (London: George Newnes, Ltd., 1902.) Price 1*s.* 6*d.* net.

THERE are no doubt many people who would have continued to practise photography if they had had the advice contained in this handy little volume. The amateur has been, and is now, too often led to invest his money in a camera the size and bulk of which renders it impossible for him to carry it about and use except with great inconvenience. The utility, and therefore the value, of a camera to the average photographer is gauged by its facility of erection, lightness and portability, and when these qualities are combined with good workmanship in every respect, photography becomes a pleasure. In the present book, the author gives some very sound advice to the would-be photographer, and he has not forgotten to bear in mind the different sizes of pockets which have to be considered. Chapters are devoted to each of the principal items that the photographer requires, and the author seems to have shown a very fair and impartial judgment in his suggestions as to the best or most serviceable articles to be purchased. A thorough perusal of this book will effectively help anyone who wishes to take up this delightful subject, either as a hobby or as an aid to some portion of his daily work.

Recent Advances in Science. By A. E. Ikin, B.Sc. Pp. 83. (London: Normal Correspondence College Press.) Price 1*s.* net.

ACCORDING to the preface, this book has been written mainly with the object of giving pupil teachers an opportunity of obtaining some general information on the advances made in the past ten or twelve years. Unfortunately, the author shows only a superficial knowledge of his subject, and much of the information is in consequence incorrect. A good deal of it is also out of date, some of the inventions described having long since passed out of use. It may also be objected that technical terms are used much too freely in a book intended for those having no technical knowledge. Mr. Ikin's object in providing the pupil teacher with a sort of general guide to modern scientific progress is a very laudable one, but we fear it will not be realised by the book he has written. A correct description, in non-technical language, of present-day practice in the various branches of applied science would be far more valuable than a book such as this, which is likely, we fear, to do more harm than good to its readers. M. S.

Agricultural Industry and Education in Hungary. Compiled by T. S. Dymond. Pp. 177; with 98 illustrations. (Chelmsford: John Dutton, 1902.) Price 2*s.* 6*d.* net.

THIS is an account of a visit, arranged under the auspices of the Essex Technical Instruction Committee, made by the Essex farmers' party to Hungary in May and June of this year. The tour was conducted by Mr. Dymond, the lecturer in agricultural chemistry in the Essex County Technical Laboratories at Chelmsford. It would appear from these pages that excellent results are likely to follow the opportunities then given to Essex farmers to acquaint themselves with agricultural methods in Hungary. The visitors were impressed by the good farming, the abundant grain and forage crops, the breeding of excellent horses and cattle, the organisation of agricultural industries and the complete measures taken by the State to foster agricultural improvements of every kind. One of the pleasantest pieces of reading in the volume is that describing the hearty welcome extended to the party by the Hungarian authorities and people generally. A guide book, edited by the Minister of Agriculture, containing an itinerary of the journey planned under his direction, and descriptions in English of Hungarian agriculture, was, at Vienna, presented to each visitor. The party was accompanied throughout the fortnight's journey by Mr. György, Dr. Goger and Mr. Szilassy, who, as Hungarian experts in agriculture, gave invaluable assistance.

Le Ciment Armé et ses Applications. By Marie-Auguste Morel. Pp. 158. (Paris: Masson et Cie., 1902.)

THIS book, belonging to the well-known "Aide-mémoire" series, deals briefly with structures produced by the association of cement with iron or steel, distributed in such a manner as to utilise to the fullest extent the special characteristics of each. The volume opens with a description of results obtained in this field of work by numerous French engineers. Among other matters dealt with are the principal systems of applying this plan of construction to floors, girders, arches and pillars, and the materials employed. The book concludes with a set of mathematical expressions for the forms of structure approved by engineers. The text is simplified by the hundred illustrations, which, with a few exceptions, are very clear, and the book is provided with a bibliography.

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.*]

Becquerel Rays and Radio-activity.

IN your report of the meeting of the Physical Society of October 31, I find the following sentence given as having been said by me in the course of some remarks on Mr. Ridout's paper on the size of atoms, with the four words which I underline accidentally omitted.

"If the electrions, or atoms of electricity, succeeded in getting out of the atoms of matter, they proceeded with *velocities which might exceed* the velocity of light, and the body was radio-active."

The omission of those four words made it appear that I had considered the velocity of the escaping electrions to be essentially the velocity of light. In reality, the electrions may escape with velocities possibly less or possibly more than the velocity of light, but certainly not all with one definite velocity.

It is probable that the electrification of air produced by the breaking up of liquids into drops,[1] by a jet of water falling through air,[2] by water-falls,[3] by the bubbling of air through water and other liquids, and by the shaking up of liquids and gases in a bottle,[4] are all to be explained by the splashing out of electrions in consequence of violent vibrations of molecules of the liquid at surfaces of separation between liquid and gas in rapid relative motion, and at places of disruption between two portions of liquid. KELVIN.

Netherhall, Largs, Ayrshire, November 27.

[The official report of Lord Kelvin's remarks was printed as received.—EDITOR.]

The Conservation of Mass.

WITH reference to the letter from Mr. Sommerville in your present issue, may I state that, in the discussion at the Belfast Meeting of the British Association, I pointed out that the height in the scale pan at which a thing is weighed affects its apparent weight and that the change from this cause is quite within the capacity of the best balances? I also referred to the last report from Sèvres by Dr. Guillaume, who made the interesting statement that it would be certainly possible now to observe that one pair of kilogram weights side by side weighed more than they would do when resting one on the other.[5]

These small differences due to distance from the centre of the earth are, however, considerably smaller than the discrepancies obtained by Dr. Landolt, but I mentioned them as representing the kind of unexpected disturbance that might come in without discovery. C. V. BOYS.

Germs in Space.

I HAVE received the enclosed letter from Mexico with a request to forward it to you; and accordingly I do so, since I suppose it not impossible that the dust of space might contain life germs of some kind. I do not think the suggested bombardment by electric corpuscles sufficient cause, though electric repulsion might sometimes act, and it has been suspected that the earth may have a faint cometary tail; but no such action is needed to account for the existence of cosmic dust of any kind.

Whether the advent of new diseases could be thus accounted for is a possible matter for debate; and incidentally it has struck me to ask whether there can possibly be any physiological discrimination between the, so to speak, windward and leeward sides of the earth on its journey through the ether, giving the morning hours a different "feel" from the afternoon hours. The idea, I admit, is extremely improbable. OLIVER LODGE.

The University, Birmingham, November 19.

[1] Holmgren, *Swedish Academy of Sciences*, 1873.
[2] Maclean and Goto, *Phil. Mag.*, August, 1890.
[3] Lenard, *Ann. der Phys. und Chem.*, 1892.
[4] Kelvin, Maclean and Galt, *R.S. Proc.* and *Trans.*, 1895.
[5] "La Convention du Mètre et le Bureau International des Poids et Mesures," p. 145 (1902).

IT is commonly assumed (*cf. e.g.* NATURE of October 16, p. 602) that if life did not originate upon the earth, it must have come upon a meteorite. How it got on the meteorite is not explained.

It occurs to me that there is no reason why small living bodies (*e.g.* spores of bacteria) should not be floating about by themselves in space. We know from recent experiments that the cold of space would not in the least destroy their germinating power, but, on the contrary, would (I presume) preserve them in a dormant state indefinitely.

Now, why should not such bodies gradually settle down upon the earth, without any destructive friction? If this can be, the meteor hypothesis becomes wholly unnecessary. [It is the *same* hypothesis: only the meteors assumed are extra small.—O. L.]

We still have to account for the living bodies in space. Is there any way in which minute particles (as bacterial spores) could leave the earth (or any other planet)? They could be carried far up in atmospheric currents, and my friend Mr. Weinzirl has found bacteria in the mountain air of the arid parts of this country. Is it possible that electric currents (such as produce the aurora) could in some cases carry them far enough to permit them to escape into space? I do not know enough about electricity to judge of this possibility.

THEO. D. A. COCKERELL.

East Las Vegas, New Mexico, U.S.A., November 2.

The Leonid and Bielid Meteor-showers of November, 1902.

IN a letter just now received from Mr. W. H. Milligan, in Belfast, some interesting details are given of observations made in his watch for Leonids at and near the November date of the shower's recently looked for reappearance. As a cloudy state of the sky prevailed generally in England on the nights in question, the result obtained in a prolonged clear view of the sky on at least one of the two most probably predicted mornings of November 15 and 16 for the shower's reappearance, that but one true Leonid, and no sign whatever of any great abundance of the shower, was visible in a watch of 4 hours on the first of those two mornings, possesses considerable interest from the fresh support which it affords to the lately calculated conclusions of very eminent astronomers, that the meteor-stream's celestial route, instead of just crossing the earth's orbit-track, as it did in the shower's three last previous returns and in many bygone centuries, now probably falls, by the effects of planetary perturbations on its course, sufficiently far inside the earth's orbit to no longer give us the magnificent spectacle of a great star-shower.

On the mornings of November 15 and 17, only (on the last of which the sky was overcast in Belfast), could short and tolerably clear views be here obtained of the brightly moonlit sky; and that the shower was indeed feebly active on the former morning was shown by one small true Leonid's appearance at 15h. 52m., of second magnitude, shooting overhead from 134° +47½° to 126½° +54°, about 8° in ⅜ths of a second, as from a radiant point at 151° +21°, the only meteor seen in a brief half-hour of cloudless sky well watched for the Leonids from 3h. 45m. to 4h. 15m. a.m. On the night of November 16–17, no meteor at all was visible in a full hour's watch in clear sky from 11h. 45m. to 12h. 45m. From Mr. A. King, at Leicester, I have just now heard that he observed one meteor only—a Leonid—in a 25m. watch on the latter night, and that in 1½ hours on the early morning of November 13 (the only other cloudless time at Leicester in that November period), he observed 7 meteors, not one of which was a Leonid.

The watch, this year, for Bielid meteors on November 23–24 was about equally unproductive of both periodical and ordinary meteors; for in a watch of 4 hours' duration, from 7h. to 11h. on the first of those two nights (the next night being cloudy), Mr. Milligan reports from Belfast that no Andromede at all was there observed, and in 2½ hours of clear sky, until midnight, here, only two shooting-stars (both in the first hour, and none in the last 1½ hour of the watch) were seen, neither of which were Andromede or Bielid meteors. In 1½ hour on the second night, until moonrise and cloud and rain interfered at 15h., only one true Bielid meteor and two other shooting-stars were here recorded.

Regarding his long watches at Belfast for the Leonids, in their recent period, Mr. Milligan writes thus:—

"Below I give a record of the watches kept. Although the results are few, yet from the fact of having seen three meteors—

two true Leonids and one slow, "stray," spent-looking shooting-star—in the strong moonlight, I should say that had the shower been in any force I should have seen more, and that therefore it must be taken to have been weak and to have gone past us inside the earth's orbit, as it did, presumably, in the past year or two. The radiant point was not determined, but it seemed to be in the usual position."

Date, 1902.	Duration of watch (Local Time*) ; a.m. From h. m.	To h. m.	Number of Leonids	Other meteors.	Remarks. (* Local Times about 25m. slow on Greenwich Time.)
November 13 ...	12 0	1 0	0	0	Clear horizon-belt in E. and S. ; cloudy afterwards.
November 14 ...	...	...	...	...	Cloudy throughout.
November 15 ...	12 0	2 0	0	1	Clear ; moonlight (2nd magnitude meteor ; very slow.
,, 15 ...	3 0	4 0	0	0	,, ,,
,, 15 ..	6 0	7 0	1	0	,, ,,
November 16 ...	12 0	5 30	...	...	Cloudy.
,, 16 ...	5 45	6 15	0	0	Clear space around Leo.
November 17 ...	...	...	...	...	Cloudy throughout.
November 18 ...	12 0	4 0	0	0	Clear.
,, 18 ...	4 0	5 0	1	0	,,
,, 18 ...	5 0	6 0	...	..	No watch kept.
November 19 ...	5 0	6 0	0	0	Clear.
	Totals		2	1	

To complete the partial record which these notes supply of the shower's apparent strength this year, at somewhat near its time of greatest brightness, it may be hoped that more favourably observed particulars of the appearance of the Leonids may reach us yet from foreign places, and it might earnestly be wished, as well, that notes of the number of shooting-stars observed may have been kept at any distant station on the globe where possibly some sensible ramification and dense clustering of cometary dust along the wake of the departing meteor-stream may have happened to produce a fairly bright and numerous display of what it now appears probable may have to be known for some time to come, if not perhaps for all coming time, as the traditionally splendid celestial spectacle of the November Leonids. A. S. HERSCHEL.

Observatory House, Slough, November 26.

Vitality and Low Temperatures.

THE remarkable results of the experiments of Prof. Macfadyen and others, on the effects of low temperatures on organic life, render it highly desirable to ascertain how long vitality can be retained under such conditions, and with liquid air now available it becomes possible to extend the inquiry for an indefinite number of years—a generation if necessary.

The fact that organisms, after having been maintained for six months at temperatures far below those at which vital activities are possible, have retained their vitality practically unimpaired, profoundly modifies the conception hitherto attached to the word "life," and if it can be shown that vitality can survive for a protracted period in these circumstances, the conclusion that it is a molecular function seems inevitable.

If such an experimental result were obtained, it would strengthen the possibility of Lord Kelvin's speculation that the origin of life on the earth may have been ultra-terrestrial, and this implies that the ultimate source would probably have to be looked for under conditions not common to, possibly transcending, our experience. W. J. CALDER.

Stellenbosch, South Africa.

THE BRITISH ACADEMY.

AT a general meeting of the Fellows of the British Academy, held on November 19, the Right Hon. Lord Reay, G.C.S.I., president of the Institute of International Law and president of the Royal Asiatic Society, was elected first president of the Academy.

At the same meeting, the *Times* announces, the following Fellows were elected the first members of the council of the Academy:—Sir W. R. Anson, the Right Hon. James Bryce, Prof. I. Bywater, Prof. T. W. Rhys Davids, the Rev. Prof. S. R. Driver, the Rev. Principal Fairbairn, Sir C. P. Ilbert, K.C.S.I., Sir R. C. Jebb, the Rev. Prof. J. E. B. Mayor, Dr. J. A. H. Murray, Prof. H. F. Pelham, the Rev. Prof. W. W. Skeat, Sir E. Maunde Thompson, K.C.B., Dr. A. W. Ward, Prof. James Ward.

At a meeting of the council, held on November 26, Mr. I. Gollancz, Fellow of the Academy, University lecturer in English at Cambridge, was appointed secretary of the Academy.

In the report of the anniversary meeting of the Royal Society, printed elsewhere in this issue, the position taken by the Royal Society in connection with the constitution of the British Academy is described. By its action, the Society limits its sphere of activity to that of the experimental sciences, and dissociates itself from the scientific study of archæology, philology, philosophy, political economy and similar branches of knowledge. Its scope is thus to be that of the Paris Académie des Sciences—one of the five academies which constitute the Institute of France—and the British Academy will correspond very nearly to the Académie des Inscriptions et Belles-Lettres and the Académie des Sciences morales et politiques. Many men of science regret that the Royal Society has thus ceased to represent the totality of British scientific work, as it formerly did, and has limited its scope to certain branches.

ANOTHER HODGKINS GOLD MEDAL AWARDED.

IN March last, Dr. S. P. Langley, secretary of the Smithsonian Institution, appointed a committee to consider whether any discovery had been made since the award of the first Hodgkins gold medal in 1899, under the general terms of the gift, "the increase and diffusion of more exact knowledge in regard to the nature and properties of atmospheric air in connection with the welfare of man," which would render it proper that such a medal should be again awarded. This committee consisted of the following distinguished men of science:—Mr. Richard Rathbun, assistant secretary of the Smithsonian Institution, chairman ; Dr. A. Graham Bell, for electricity ; Dr. Ira Remsen, for chemistry ; Dr. Charles D. Walcott, for geology ; Prof. E. C. Pickering, for astronomy ; Dr. Theodore N. Gill, for biology ; Prof.

Cleveland Abbe, for meteorology; Mr. William H. Holmes, for anthropology; and Mr. S. W. Stratton, for physics.

Owing to the absence of Mr. Rathbun, Dr. Remsen served as chairman at a meeting of the committee held at the Smithsonian Institution in Washington, April 15. At this meeting, the following resolution was unanimously adopted:—

"That the committee recommend to the secretary of the Smithsonian Institution that it is desirable that one of the Hodgkins gold medals be struck, and that it be

awarded to J. J. Thomson, of Cambridge, England, for his investigations on the conductivity of gases, especially on the gases that compose the atmospheric air."

The finding of the committee being approved by the secretary, steps were at once taken to have the second Hodgkins gold medal struck, under the personal supervision of its designer, M. J. C. Chaplain, of Paris. The medal (one side of which is shown in the accompanying photographic illustration) has recently been received by the Institution, and has been dispatched to Prof. Thomson through the Department of State.

SIR WILLIAM ROBERTS-AUSTEN, K.C.B., F.R.S.

BY the death of Sir William Roberts-Austen, which occurred at his official residence in the Mint on Saturday, November 22, metallurgical science has to deplore the loss of one of its most distinguished representatives. He had been in failing health for some months past, and had suffered from one or two sharp attacks of illness during the last few years, but even his most intimate friends, until a few days before his death, were quite unprepared for the suddenness of his end.

William Chandler Roberts, as he was formerly called, was born in 1843. His father, George Roberts, was of Welsh descent, whilst his mother, Maria Louisa, belonged to the Kentish family of Chandler which intermarried with the Austens. In 1885, at the request of his uncle, the late Major Austen, J.P., of Haffenden and Camborne, in Kent, he obtained Royal license to take the name of Austen.

At the age of eighteen, he entered the Royal School of Mines with the intention of being a mining engineer, but after obtaining the associateship of the school he became, in 1865, a private assistant to the late Prof. Graham, then Master of the Mint, and was employed, at the outset, mainly on the researches in inorganic chemistry and on physical chemistry which continued to occupy Graham until the end of his days. Graham died in 1869, when the Department was reorganised in accordance with the provisions of the Coinage Act of the following year. Under that Act, the Chancellor of the Exchequer became "Master, Worker and Warden" of the Royal Mint. No salary was attached to the office, but it was provided that its duties should "be performed and exercised by his sufficient deputy." In order to provide for the efficient discharge of the scientific work devolving on the Mint, a new post—that of "chemist of the Mint"—was created, and Roberts was selected to fill it, being appointed by Treasury minute of January 7, 1870.

On the death of Mr. Horace Seymour, the late Deputy Master, in June last, Sir William Roberts-Austen was appointed to fill the office *ad interim*, or until his own official connection with the Mint should be severed by resignation. This he had intended should take effect in the spring of the coming year. It may be said, therefore, that Sir William Roberts-Austen had, at one time or other, filled every office in the Mint which a man of his order could aspire to. No more convincing testimony to the manner in which he discharged his official duties, and no more eloquent proof of how he acquitted himself under the great responsibilities of his position, could be adduced than this single fact.

Roberts-Austen was one of the most many-sided men of his time. His intellectual activity found scope for itself in many ways. He had an insatiable capacity for work and he never spared himself. Those who knew him intimately frequently remonstrated with him on the manner in which he incessantly made large drafts on his store of mental and nervous power, with no thought of repose or recuperation. It was rarely that he could be induced to pay much heed to the warnings of his friends, declaring that he found in the very variety of his avocations the relaxation and rest which they desired him at times to take. This was strikingly exemplified by the manner in which he clung, with an interest amounting to affection, to his position as professor of metallurgy in the Royal School of Mines. Roberts-Austen always cherished, as one of the most treasured memories of his life, the recollection of his early association with the Royal School of Mines. Although the Royal School of Mines is to-day incorporated with the Royal College of Science, a fusion of which Roberts-Austen entirely approved and which he loyally supported, his colleagues on the council of the school were more or less dimly conscious that deep down in his mind, "at the back of his head," as the saying goes, he was still apt to regard the school as a corporate entity with a separate existence, with all the powers, privileges and prestige which it enjoyed as a separate entity in his old Jermyn Street days. There was probably no one position he coveted more than its chair of metallurgy, and no incident in his career which gave him a greater sense of pleasure and satisfaction than his appointment, in 1880, to that chair in succession to the late Dr. Percy. The feeling with which he regarded the school is intelligible enough, for it is very human and sprang from his very affection for it. It is akin to that which leads the fond father or doting brother in his secret soul to resent the removal of the daughter or the sister to a new home. No amount of talk about "a larger potentiality for good," "enlarged sphere of activity," "greater measure of advantages," &c., however willingly and sincerely assented to, will entirely subdue and efface the feeling which in the younger and more militant masculine members of a family has been known to degenerate into a secret wish

to punch the head of him who has presumed to impose his own name on his partner.

How loyal he was to the school, how affectionately he guarded its interests and how he studied to enhance its usefulness, I, who was his colleague on the council of the Royal College of Science for upwards of nine years, desire now to bear testimony. It was the wish of his heart, had he been spared, that, after his retirement from the Mint, he might spend his remaining years, or so many of them as the regulations of the Department would have allowed him to spend, in its service. It was possible that he cherished the hope that the erection of the new buildings on the other side of Exhibition Road might have afforded him the opportunity he had long desired, that of creating and equipping a metallurgical laboratory which should be worthy of this country and of an Empire whose sons are engaged in metallurgical work in almost every part of the globe. But if this was not to be, he has at least erected a monument to himself in the record of his past achievement; in the thoroughness and fulness of his teaching; in the scientific enthusiasm with which he sought to lay bare and illumine the problems of physical metallurgy. During the two-and-twenty years he held his chair, he trained a succession of men holding important positions at home and in many parts of the world, who are grateful to him for the stimulating influence of his teaching, who will recall many acts of personal kindness and good will, and who, now that his place in the subterranean lecture-room he loved so well and in which, with all the quickening zeal of a born teacher, he had spent some of the happiest hours of his life, knows him no more, will mourn his loss as that of a dear friend, and will continue to cherish his memory and recall the many kindly traits of head and heart which characterised him.

In the outset of his career as an investigator, Roberts-Austen occupied himself with a number of minor problems in inorganic chemistry, and there is little continuity of thought or effort to be traced in much of his 'prentice work. But there is invariably the note of originality. All his life through, he was strongly attracted by what is odd, uncommon or *bizarre*. Perhaps it was the Celtic blood which ran in his veins which predisposed him to the mysticism which was undoubtedly a feature of his character. Had he lived three hundred years ago, he would have been a typical alchemist and have spent the skill and energy he showed in assaying and minting gold in vain attempts to make it. Science, however, would certainly have been the richer for his efforts, for he was a very acute observer, and although occasionally his preconceptions were liable to run away with him for a time, especially in the direction of scientific heterodoxy, he was staunchly loyal to his facts. Much of his work was influenced by his strong artistic sense and by his passionate regard for beauty of form or colour. The secrets of oriental metallurgy had a singular fascination for him. He would literally gloat over some triumph of Japanese art, and the discovery of by what kind of "pickle," or by what kind of treatment, the lustre or colour or effect on a bronze had been obtained was a delight to him as intense as if he had lighted upon a new metal. The artistic side of his nature found frequent exercise in his work at the Mint, especially in medal-striking. He occasionally chafed under the necessity of having to make use of designs for which he had no sympathy, but he had a real delight in reproducing, with the highest degree of excellence that the resources at his command permitted, artistic work which his trained judgment and fine critical insight perceived to be good and true. Indeed, this sense of "finish" and feeling for artistic excellence, amounting almost to fastidiousness, was seen, not only in his actual manipulative work and in the way in which he arranged and perfected his experimental illustration, but in the manner and form in which he put together and presented any account of his labours. His lectures at the Royal Institution were invariably illustrations of this. Perhaps no man since Tyndall's day ever handled a Friday evening discourse with more tact and skill than did Roberts-Austen. His matter was always fresh, his experiments always interesting, frequently daring and occasionally strikingly original. He never tried to be rhetorical or pretended to be eloquent, but there was a certain literary finish in his sayings, a feeling for epigram, a sense of proportion in arrangement, and, at times, a quiet, subdued touch of humour which altogether made him delightful to listen to.

Of his innate love for science and of the ardour with which he pursued her, innumerable instances might be given. I shall never forget the manner in which he burst into my room, when at South Kensington, and showed me the first fragment of the beautiful rose-coloured alloy of gold and aluminium he had obtained. His delight was so real and unaffected—his joy almost infantile—as he turned and twisted the glittering fragment to the light to illustrate the depth and wonderful brilliancy of its purple. And, too, it was characteristic of him that, as I shared his admiration, he should, unasked, have seized a letter-weight and knocked off a portion of his prize and bade me take it.

I remember, too, a similar occasion when he carried me off to see the first results of his inquiry into the diffusion of solid metals, and when he showed me the little beads of gold cupelled out of the several sections of the block of lead, which had been standing for days and weeks on a plate of the precious metal, all arranged at the proper intervals of the sections on a diagrammatic representation to actual scale of the leaden block. And I may be pardoned if I recall with satisfaction that, as a consequence of that visit, I was the humble instrument of determining, with the powers that were, the Bakerian lecture of 1896.

The Royal Society's Catalogue of Scientific Papers records that Roberts-Austen published some two dozen papers, for the most part singly, but occasionally in collaboration with Sir Norman Lockyer, Prof. Osmond and the late Dr. Alder Wright.

They practically all relate to metallurgical problems, or are connected with the scientific side of his duties as an officer of the Mint. They deal with the spectroscopic characters of alloys; the physical and chemical nature of alloys; the structure of metals; the connection between the properties of metals and the periodic law; and the nature of the hydrogen occluded by palladium and by electro-deposited iron.

In 1890, at the request of the Alloys Research Committee of the Institution of Mechanical Engineers, he began to investigate the effects of small admixture of certain elements on the mechanical and physical properties of the common metals and their alloys. Whilst engaged on that work, he devised the recording pyrometer, an instrument which has proved to be of the greatest value, not only to the investigator in pure science, but also to the practical metallurgist. The results of these investigations are embodied in reports to the Institution of Mechanical Engineers, which afford a mass of valuable information concerning the structure of metals and their alloys, and their behaviour under varying physical conditions.

It was in the domain of physical metallurgy that he specially excelled, and by his unwearied energy, by his skill and resourcefulness as an experimentalist, he has succeeded in clearing up much that was vague and imperfectly understood in that field of inquiry.

He is the author of an "Introduction to the Study of Metallurgy," which has been characterised as a masterly guide to a knowledge of the principles on which the art is based.

This bald outline of Roberts-Austen's scientific work gives, however, a very inadequate idea of his diligence as a man of science or of the influence which he exerted on the progress of science. Such work as he engaged in was, from its very nature, time-consuming, and results were only obtained slowly and laboriously. From his official position, too, and by reason of his attainments, he was constantly pressed to serve upon committees, councils and commissions, into the work of which he never failed to throw himself with characteristic ardour and self-sacrifice. In 1885, he was a member of the executive council of the Inventions Exhibition. In 1889, he served on the British executive council of the Paris Exhibition, and in 1893 on that of the Chicago Exhibition. In the former year, he received the Cross of Chevalier of the Legion of Honour.

He sat with the writer on the Treasury Committee which preceded the establishment of the National Physical Laboratory, and he was also a member of the Board of Trade Committee appointed to inquire into the deterioration of steel rails during use in railway traction.

Since 1899, he had been a member of the Explosives Committee appointed to investigate explosives for use in the Army and Navy and material for the construction of guns.

Concurrently with the services he rendered to the State as a public servant, he did his fair share of labour in the organisation of scientific work as an executive officer of various scientific societies. He joined the Chemical Society in 1866 and served on its council in 1879-81, and became a vice-president in 1895-8.

In 1875 he was elected into the Royal Society, and served as a member of council in 1890-2, and at the time of his death was a member and chairman of some of its committees. He was one of the founders of the Physical Society, of which he was also a vice-president, and was an active member of the Society of Arts, of which he was a member of council and vice-president. He was also an honorary member of the Institution of Civil Engineers, of the Institution of Mechanical Engineers and of the Institution of Mining and Metallurgy.

He was elected president of the Iron and Steel Institute in 1899, and held office until 1901.

In 1888 he was made a C.B., and received his knighthood in the order in 1899.

The University of Durham made him a D.C.L. in 1897, and a year or two later he received the honorary degree of D.Sc. from the Victoria University.

He was a frequent attendant of the meetings of the British Association, and served as one of the general secretaries of the council from 1897 to the year of his death.

His last public lecture was the James Forrest lecture on "Metallurgy in Relation to Engineering," given to the Institution of Civil Engineers on April 23. In special lectures of this kind, Roberts-Austen excelled. They cost him considerable effort, for he spared no trouble to make the occasion worthy of himself and of his subject, and he had his reward in the grateful appreciation of his auditory.

Indeed, no man discharged more faithfully, more honourably or more religiously the obligations he had incurred, or which, by virtue of his position, were thrust upon him. It may be truthfully said of him that whatsoever his hand found to do he did it with all his might.

No sketch of Roberts-Austen would be complete without some allusion to his remarkable social qualities. When at his best he was an admirable talker, bright, witty and amusing; he had a keen sense of humour and was a capital story-teller. He had a dangerous gift, however, which in his later years he was slow to make use of—he was an excellent mimic. In the old days—the days of Rankine, Lord Houghton, Clifford, Aitchison—when the "Red Lions" were wont to hold high carnival, Roberts-Austen occasionally would "let himself go" and exercise his gift to the uproarious merriment of jackals, cubs, lions and lion-kings alike. Indeed, it seemed at times that he was not quite conscious of the faculty he possessed. I have heard him, to my terror, in the course of a conversation gradually copy the tones and inflexions of a man's voice, and seen him reproduce his manner to his very face. There was absolutely no intention to be discourteous in this, and it was done so gradually and with such subtlety that the man was just as insensible of the fact as Roberts himself. I firmly believe that on such occasions the unconscious mimicry had its origin in sympathy.

Some years ago, Roberts-Austen acquired a small place at Chilworth, near Guildford, to which he would repair with Lady Roberts-Austen on all possible occasions. It never meant idleness to him, but there is no doubt that the occasional change from the atmosphere of Tower Hill to the breezy, invigorating air of a Surrey common had some effect in preserving him from the constant inroad he made upon his physical and mental energy. His social instincts made him a good neighbour, and he spent time and no inconsiderable amount of money in improving the lot of those around him. There was one side of his character of which only those who knew him well were made fully aware. It is reflected, however, in the beautifully decorated little chapel which he erected near his house for the benefit of the district, and in which he was wont to minister nearly every Sunday.

T. E. THORPE.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held on Monday, December 1, when the report of the Council was presented, and the members of the Council for the ensuing year, whose names have already been given (p. 35), were elected.

The first paragraph of the report refers to the formation of the "British Academy for the Promotion of Historical, Philosophical and Philological Studies" and its incorporation by Royal Charter. The President and Council of the Society were requested by the Privy Council to give their opinion upon a petition which had been presented to the Privy Council praying that the incorporation of the studies above referred to should be "provided for in some relation to the Royal Society." The report states that in the reply the Council of the Royal Society most strongly deprecated any change in organisation being imposed upon the Society from without in order that it might include within itself the studies for which the incorporation of the British Academy is asked, being convinced that such a change would destroy the independent position which the Society now enjoys as the head, in this country, of the mathematical, experimental and natural sciences. The Privy Council subsequently invited the opinion of the Royal Society upon a memorial suggesting that it would be desirable to attempt to organise officially in one institution the several branches of knowledge. The President and Council replied that they could not consent to the Royal Society forming one department of any institution or academy such as that suggested.

The statutes governing the election of Fellows under privileged conditions, under which members of the Privy Council have hitherto been admitted, have been amended. The principal amendment provides that the Council may, once in every two years, recommend to the

Society, for election as Fellows, not more than two persons who, in their opinion, have either rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society.

Among other matters, reference is made in the report to work carried on under the auspices of the Society in connection with malaria, sleeping sickness, the West Indian eruptions, the National Physical Laboratory, the International Catalogue of Scientific Literature, the Royal Society's Catalogue of Scientific Papers, Indian observatories and the International Association of Academies.

In the course of his annual address, the President made the following remarks upon the need for increased facilities and encouragement for higher scientific education and research :—

The supreme value of research in pure science for the success and progress of the national industries of a country can no longer be regarded as a question open to debate, since this principle has not only been accepted in theory, but put in practice on a large scale, at a great original cost, in a neighbouring country, with the most complete success.

The Physikalisch-technische Reichsanstalt of Berlin, largely due to the scientific foresight of von Helmholtz, was instituted in recognition of the principle that all the industrial applications of science rest on the foundation of pure scientific discovery. The institute has for its main objects, (1) the conduct of pure physical research, especially in such directions as are suggested by industrial questions; (2) the construction and supply of electrical and physical standards; (3) the verification of instruments of precision for scientific and technical purposes.

The original cost of the institute was more than 200,000*l.*, and its yearly maintenance is not less than 17,000*l.* During the five years that it has been at work, its influence upon the science and the manufacturing interests of Germany has been most remarkable. Besides the publication of numerous memoirs of original research and of papers on technical processes, the direct results of the work of the institute upon the industries of the country have more than justified the prevision of the founders; largely, we regret to say, to our own national loss, and to the almost complete passing to that country of the renown which was formerly ours in exact scientific measurements, and for the construction of standards and instruments of precision. So true is it, that the investment of public money in scientific research can only be compared to good seed cast into good ground, bringing forth in results a hundred-, or even a thousand-fold.

The sum voted by the Government for our own National Physical Laboratory, an institution second to none in its national importance, was the very modest one of 13,000*l.* for the buildings and equipment, and an annual grant of 4000*l.* for five years in aid of the expenses of conducting the work of the institution.

The supreme necessity in this country of a more systematic application of scientific methods, both in theory and in practice, to our manufactures and industries, which was so wisely insisted upon by the Prince of Wales on the occasion of his admission to the Fellowship of the Society and again in his address at the opening of the National Laboratory, has since been confirmed and enforced in a remarkable way by the individual testimonies of thirteen Fellows of this Society, in the evidence which they recently gave, from their own knowledge and experience, either as teachers of science or as leaders and technical advisers in manufactories or commercial undertakings, before a committee of the London Technical Board.

Their testimony was of no uncertain sound, but showed clearly that the Prince's words of warning were not unneeded, and that, indeed, our industries and commerce are not only in danger, but are actually passing into the hands of other countries, where scientific research is more directly cultivated under the fostering care of the State.

The undoubted present state of apathy of the national mind in relation to the importance of natural knowledge, and its consequent inability to recognise how entirely and without exception, in every undertaking, success must depend upon our so acting in conformity with the laws of Nature that we have her on our side, as our ally, and not working against us, may arise, conceivably, from either of two causes: from a natural want of enterprise and resourcefulness inherent in the national character, or from a system of education which, relatively to the educational training of other countries, fails to develop and strengthen the qualities of mind which are needed for an adequate appreciation of science.

The former of these two possible causes may surely be dismissed at once. We need only look back in history to see how this small northern island, by its own innate energy, has come to be supreme over vast regions on all parts of the earth's surface, and is now the head of an empire which engirths the world.

We are, therefore, left, without power of escape, to the second alternative, namely, that it is our system of higher education which is in fault, clearly through being too mediæval in spirit. In accordance with the traditions of the past, our higher national education deals with words rather than with things; it is based too exclusively on the memory of what is known, and too little, if at all, on individual observation and reasoning.

The evidence seems clear that the present inappreciative attitude of our public men, and of the influential classes of society generally, towards scientific knowledge and methods of thought must be attributed to the too close adherence of our older Universities, and through them, of our public schools, and all other schools in the country downwards, to the traditional methods of teaching of mediæval times. The incubus of the past makes itself felt, especially in the too strict retention of educational methods in which the first importance is given to the reproduction of knowledge from memory, to the acquiring and applying of what is already known; with little, if any, guidance and encouragement to the undergraduate student in the direction of research and of independent reasoning.

With the experience of Germany and the United States before us, the direction in which we should look for a remedy for this state of things would seem to be for both the teacher and the student to be less shackled by the hampering fetters of examinational restrictions, and so for the professor to have greater freedom as to what he shall teach, and the student greater freedom as to what line of study and research he may select as being best suited to his tastes and powers.

Into the dry bones of the present academic system of reading and examination must enter the living breath of the spirit of research, that is to say, of the individual efforts of each mind, for itself and in its own way, to seek to extend our knowledge in the direction most suited to its powers, by means of original observation and reasoning, and aided by the imagination—it may be in the field in science, of history and literature, or of art.

One way of bringing about reform in this direction would be to make individual research an indispensable condition of proceeding to degrees higher than the B.A.

In addition to the intellectual influence of a training in research upon the students themselves, the official recognition by the Universities of an original investigation of some subject, as a necessary condition of obtaining the higher academical honours, could scarcely fail to bring about in the public mind a more appreciative attitude in regard to the importance of original reasoning and discovery, and so to a better understanding of the meaning to be attached to natural science and to scientific methods.

It is obvious that with a fuller knowledge and appreciation of science on the part of the nation, a complete change of its practical attitude in respect to science and science questions would necessarily follow, for under such conditions public money would be liberally voted by the Government.

The work of this year's medallists was described as follows :—

COPLEY MEDAL.

Lord Lister, F.R.S.

The Copley Medal is awarded to Lord Lister in recognition of the value of his physiological and pathological researches in regard to their influence on the modern practice of surgery.

When in 1880 a Royal Medal was awarded to him, it was acknowledged that his researches had "not only reformed the whole art of surgery, but given a new impulse to medical science generally." The experience of another twenty years has written out that judgment in still larger letters. Lister's researches have made the world a wholly different world from what it was before.

The main result of those researches, namely, the definite proof that the suppuration of wounds, no less than putrefaction, was the work of living organisms, was not reached as a happy accident; it was the natural outcome of long-continued scientific observation and reasoning, the fruit of the labours of a well-trained scientific mind. Beginning with purely histological and physiological investigations having only an indirect relation to medicine and perhaps still less to surgery, he was gradually led, without changing his method or his mode of thought, to that which has so profoundly influenced both. His work has been a shining example of that which the Royal Society was founded to advance, the shaping of a new philosophy which is for the good of man.

RUMFORD MEDAL.

The Hon. Charles Algernon Parsons, F.R.S.

The Rumford Medal is given to the Hon. Charles Algernon Parsons for his success in the application of the steam turbine to industrial purposes, and for its recent extension to navigation.

The work of Mr. Parsons is of a kind which specially comes under the terms and conditions of the Rumford Medal, as consisting "of new inventions and contrivances by which the generation and preservation and management of heat and of light may be facilitated," and as "shall tend most to the good of mankind."

By his invention and perfection of the steam turbine, he has not only provided a prime mover of exceptional efficiency working at a high speed without vibration, but has taken a step forward which makes an epoch in the history of the application of steam to industry, and which is, probably, the greatest since the time of Watt. The success of the turbine is due to the experimental skill and inventive ability which have enabled him to overcome all difficulties, and to contrive a multitude of details without which the general idea of compound working could not have been translated into practice.

The use of the steam turbine for dynamo driving has been in operation for some time and is rapidly becoming common. Machines of 2000 horse-power and over are now being built. In accordance, however, with the conditions of the Rumford Trust, that the medal shall be awarded for work done within the previous two years, his claims to favourable consideration are based specially on the recent application of the steam turbine to marine navigation. The use of the steam turbine, as is well known, enabled the *Viper* and the *Cobra* to attain speeds hitherto unattainable. It has now been introduced within the last few years in vessels for mercantile purposes on the Clyde, and is being applied to ocean-going vessels.

ROYAL MEDAL.

Prof. Horace Lamb, F.R.S.

A Royal Medal is awarded to Prof. Horace Lamb for his investigations in mathematical physics.

Prof. Lamb has been conspicuous during the last twenty years by the extent and value of his contributions to mathematical physics. His writings have been distinguished by clearness, precision and perfection of form. His early work related to hydrodynamics, the "Treatise on the Motion of Fluids," published in 1879, being one of the first adequate accounts of the modern progress of that subject.

From 1881 to 1884, he published a series of memoirs dealing with the application of harmonic analysis to vibrational problems connected with spheres and other forms of bodies.

In these papers, subjects such as the subsidence of oscillations in viscous matter, the vibrations of spherical elastic solids, free electric vibrations and forced alternating currents were treated with full application to actual phenomena. In the memoirs on electrical motions and oscillations, he developed with remarkable completeness the application of Maxwell's electric theory in this department—including such topics as the surface-concentration of alternating currents—some years before the progress of the applications of electricity had led to independent experimental discovery of the importance of these phenomena.

In 1889–90, he published (*Proc.* Math. Soc. and *Phil. Mag.*) a number of valuable papers on the elastic deformation of plates and shells, which involved many new results, and also did much towards elucidating difficulties that had been encountered in this intricate subject.

Recent work has also included a discussion "On Reciprocal Theorems in Dynamics" (*Proc.* Math. Soc., 1888), a solution of the problem of the diffraction of a train of electric waves by a wire grating (*Proc.* Math. Soc., 1898), and memoirs on the dynamical theory of the refraction and selective absorption of light by gaseous media (*Trans.* Camb. Phil. Soc., 1899, *Proc.* Math. Soc., 1900). In the latter subject, he traversed ground in which he afterwards found that he had been, to a considerable extent, anticipated (in Danish) by L. Lorenz.

His treatise on "Hydrodynamics," 1895, 604 pp. demy octavo, is universally recognised as the standard presentation of that subject. It maintains the best traditions of the British school of mathematical physics.

ROYAL MEDAL.

Prof. Edward Albert Schäfer, F.R.S.

The other Royal Medal is conferred upon Prof. Edward Albert Schäfer for his researches into the functions and minute structure of the central nervous system, especially with regard to the motor and sensory functions of the cortex of the brain.

Prof. Schäfer has contributed to animal physiology much work in various lines of research, and his discoveries regarding the nervous system have been especially numerous, from the time of his demonstration of nerves in the disc of medusa to his late work on the relation of the cerebral cortex of the ape to the sensory functions of the skin. Altogether, his neurological researches rank among the most important of contemporary British contributions to that branch of physiology. It is, however, especially for his work upon the functions of one of the ductless glands—the supra-renal—that he has a claim to recognition as a Royal Medallist. In 1894 he, in conjunction with Dr. G. Oliver, succeeded in demonstrating the existence in the cortex of the supra-renal gland of a substance, called now *adrenalin*, which is the most powerful known stimulant to the cells of visceral and vascular muscles. The discovery has since been confirmed by numerous workers, British and foreign; the original researches were, however, so accurate and exhaustive as to leave little further to be added by any means available at present. The work incidentally revealed absence of this active principle in the diseased supra-renal glands in *Morbus Addisonii*, a malady considered invariably fatal. The investigation laid the first real basis for knowledge of the functions of the supra-renal gland. Recently Prof. Schäfer has, working on lines similar to his adrenalin research, extracted from another ductless gland, the pituitary, a substance exhibiting marked properties as a diuretic.

DAVY MEDAL.

Prof. Svante August Arrhenius.

The Davy Medal is awarded to Prof. Svante August Arrhenius for his application of the theory of dissociation to the explanation of chemical change.

It is not easy to over-estimate the importance of the service rendered to chemistry by Prof. Svante Arrhenius through the publication of his memoir, presented to the Swedish Academy of Sciences on June 6, 1883, entitled "Recherches sur la Conductibilité Galvanique des Électrolytes." As far back as 1886, Sir Oliver Lodge, in referring to the second part of Prof. Arrhenius's memoir, in the Report to the British Association of the Committee on Electrolysis, spoke of it as a distinct step towards a mathematical theory of chemistry, and went so far as to say that "the title affixed to it is 'The Chemical Theory of Electrolytes,' but it is a bigger thing than this—it really is an attempt at an *electrolytic theory of chemistry*." This judgment has since been amply confirmed. Whether the theory be true or not in substance, it has proved to be a working hypothesis of the utmost value, having provided chemists for the first time with the means of fully discussing the phenomena of chemical interchange in dilute solutions of electrolytes mathematically.

Since 1883, Arrhenius has been constantly occupied in extending the application of the views put forward in his first paper.

The conception of the almost complete dissociation into their ions of strong acids and bases and of many salts in dilute solution was fully developed by him in 1887, almost simultaneously with van 't Hoff's extension of the gaseous laws to solutions.

The work of the two philosophers was, in fact, complementary, and the extraordinary development in recent years of physical chemistry must be attributed to the cooperative influence of their concurrent views.

DARWIN MEDAL.

Mr. Francis Galton, F.R.S.

The Darwin Medal is conferred upon Mr. Francis Galton for his numerous contributions to the exact study of heredity and variation contained in "Hereditary Genius," "Natural Inheritance," and other writings.

The work of Mr. Galton has long occupied a unique position in evolutionary studies. His treatise on "Hereditary Genius" (1869) was not only what it claimed to be, the first attempt to investigate the special subject of the inheritance of human faculty in a statistical manner and to arrive at numerical results, but in it exact methods were, for the first time, applied to the general problem of heredity on a comprehensive scale.

The work thus begun was continued and extended in a long series of publications (*see* Bibliography in "Natural Inheritance," pp. 219–20), conspicuously in "Natural Inheritance" (1889), a publication which marks a distinct advance in these studies, both by definition of the problems of variation and heredity and by the introduction of novel methods. Subsequently Mr. Galton, with a greater emphasis, enunciated (Roy. Soc. *Proc.*, vol. lxi., 1897, p. 401) the central conclusion to which his long investigations had led him, in the form universally familiar to biologists as "Galton's Law of Heredity," a principle now recognised as of wide application in nature.

Contributing to the total of Mr. Galton's work, numerous other subjects might be mentioned, which he has elucidated with a genius peculiarly Darwinian. In all his researches he has been a pioneer, and indeed, with the single exception of Quetelet, we may almost say that no one preceded him. His work is generally acknowledged to constitute a new departure in biology, and to form a natural continuation of Darwin's labours. Besides their intrinsic value, the special charm of his writings has exercised a notable influence on the minds of others, stimulating them to work in the same fields. It may safely be declared that no one living has contributed more definitely to the progress of evolutionary study, whether by actual discovery or by the fruitful direction of thought, than Mr. Galton.

BUCHANAN MEDAL.

Dr. Sydney A. Monckton Copeman.

The Buchanan Medal, awarded every five years for distinguished services to hygienic science or practice, is given to Dr. Sydney A. Monckton Copeman for his experimental investigations into the bacteriology and comparative pathology of vaccination.

Dr. Copeman is well known, both in this country and abroad, for his contributions to the scientific basis and practice of preventive medicine. His earliest work in this field was an investigation into lead poisoning from drinking water in Yorkshire. The importance and value of his "Report to the British Medical Association" was such as to at once attract the notice of the late Sir George Buchanan, and he was shortly after appointed one of Her Majesty's Inspectors on the Local Government Board. Then he commenced, and in such leisure time as official duties have left him has continuously prosecuted with remarkable success, important researches into the nature of the vaccine *virus*, and on the contaminations, bacterial and other, of vaccine lymph. His work has, besides results of theoretic importance, brought practical results in the form of great improvements in the storage and preservation of lymph used in this country. He has also shown the possibility of obtaining useful vaccine lymph by passage through animals other than the calf. It may also be added that he has contributed a considerable amount of knowledge to the physiological chemistry of animal pigments, and has elaborated a test for distinguishing between the blood pigment of man and that of other mammals, a test which is practicable for medico-legal inquiries.

HUGHES MEDAL.

Prof. Joseph John Thomson, F.R.S.

The Hughes Medal is awarded to Prof. Joseph John Thomson in recognition of his contributions to the advancement of electrical science, especially in connection with the phenomena of electric discharge through rarefied gases.

The explanation of the brilliant and remarkable phenomena attending electric discharge through highly rarefied gas has long remained an enigma, though it was early recognised by Maxwell and other philosophers that the simplicity of the conditions that must prevail in rarefied matter would probably some day furnish the key to much that is fundamental in electrical action. Following at a considerable interval the earlier work of Plücker and Hittorf, the improvement in the production and regulation of high vacua led Crookes into the exploration of a new and very striking class of phenomena, those grouped around the kathode rays, and he adduced much evidence, backed by the authority of Sir George Stokes, to show that these rays consist of streams of electrified particles projected from the kathode to the electric current. The nature and origin of these torrents of particles remained an unsolved question. Though Schuster showed that some kind of subpermanent dissociation of electrolytic character accompanied the electric discharge, his admirably planned attempt to determine the relation between the charges and masses of the kathode particles did not lead to decisive results; while the advances made by Goldstein, Hertz and others in Germany were dominated by the view that the phenomena were due to disturbances propagated in the ether rather than to projected particles. When, in 1889, Prof. J. J. Thomson announced, as the result of his measurements of the magnetic deflection of the kathode rays, their relation to the rays of Lenard, and other properties, that each kathode particle carried the normal electrolytic molecular charge and moved with a velocity which was a considerable fraction of that of radiation, and more especially that the mass of the particles was only about the thousandth part of the mass of the chemical atom, it was felt that, if these conclusions were confirmed, experiment had forced a way into the very ultimate foundations of physical phenomena, into regions which might fairly have been thought to be beyond human scrutiny. Weighty evidence had indeed already been adduced on theoretical grounds that any complete and consistent rationale of the known electrical laws almost demanded that electricity should be of an atomic character, like matter itself; and the magnetic action in spectra, discovered by Zeeman, illustrated and directed attention to this result; but no presumption was anywhere entertained that the electrical atom could so soon become the subject of direct experiment. By virtue of Prof. Thomson's own investigations, and of many others inspired and stimulated by him, this new field of knowledge has been widely extended. It is now known that the conductivities induced in gases by the Röntgen radiation, by chemical action, by radio-active substances, even by a hot wire, are closely connected in character and all take place by electric convection of such ultimate atomic charges.

It can hardly be doubted that the progress of this new department of knowledge will gradually enable us to see one whole stage deeper into the sources of physical phenomena.

NOTES.

AT the meeting of the Royal Society on November 27, the following were elected by ballot foreign members of the Society:—Prof. Waldemar Christofer Brögger, Prof. Gaston Darboux, Prof. Ewald Hering, Mr. George William Hill, Prof. Albert Abraham Michelson, Baron Ferdinand von Richthofen, Graf H. zu Solms-Laubach, and Prof. Julius Thomsen.

THE Emperor of Germany never neglects an opportunity of expressing his appreciation of the important part which science plays in national progress, and his remarks are not only encouraging to workers in all departments of natural knowledge, but also of value in determining the attitude of the public towards scientific work. In a speech at Aix-la-Chapelle in June last, he described the German Empire as mainly intellectual and scientific, and on November 28 he alluded to the same point in the course of a speech delivered at Görlitz, where a "hall of fame" has been erected. From a translation of the text of his

speech given by the Berlin correspondent of the *Times*, we take the following extract:—"We stand on the threshold of the development of new forces; our age demands a race which understands it. The new century is dominated by science—which includes technical skill—and not, like the last century, by philosophy. We must be men of the age. Great is the German in scientific investigation, great in his capacity for organisation and discipline. The freedom of the individual, the strong tendency towards development of individuality which is inherent in our race, is conditioned by subordination to the whole for the good of the whole. May the future, therefore, see the growth of a generation which, in the full recognition of these facts, develops in the course of joyous labour individuals who subordinate themselves to the good of the whole, to the good of the people and of the fatherland. Freedom for thought, freedom in the further development of religion and freedom for our scientific investigation—that is the freedom which I desire for the German people and would win for them."

DR. DESLANDRES, astronomer at the Meudon Astro-physical Observatory, has been elected a member of the Paris Academy of Sciences in succession to the late M. Faye.

PROF. E. B. POULTON, F.R.S., will deliver the juvenile lectures at the Society of Arts this year, and has selected as his subject "Means of Defence in the Struggle for Life among Animals." The dates of the lectures will be December 31 and January 7.

WE regret to announce that Prof. Ladislava Celakovského, professor of botany in the Bohemian University at Prague, died on November 24, at sixty-nine years of age.

THE *Times* reports that the Swedish Academy of Sciences has conferred the Nobel prize of the year 1902 for chemistry on Prof. Emil Fischer, professor of chemistry at the University of Berlin, where he succeeded Prof. von Hofmann in 1892.

THE Cape *Agricultural Journal* announces that Dr. A. Loir, of the Pasteur Institute, Paris, has proceeded to Bulawayo to establish a branch of the Institute there for the treatment of rabies by the anti-rabic inoculation method. Dr. Loir is a nephew of the late M. Pasteur, and has been engaged in the establishment of branches of the parent Institute at Sydney, N.S.W., and Tunis.

THE death is announced of Prof. O. N. Rood, known by his work in experimental physics. We learn from *Science* that Prof. Rood was born in 1831, and was professor of chemistry and physics at Troy University from 1858 to 1863. For the past thirty-nine years he had been professor of physics in Columbia University. He had been vice-president of the American Association for the Advancement of Science and was a member of the National Academy of Sciences.

THE committee of the class including agricultural practice and agricultural statistics at the Paris Exhibition of 1900 has decided to make a grant of 2400 francs to the agricultural section of the Paris Society for the Encouragement of National Industries, to be employed in agricultural research in such a manner as the committee of the Society determines. In his letter to the president of the Society, M. Tisserand, on behalf of the exhibition committee, expresses satisfaction that such a grant is possible as the outcome of the work of the section of the exhibition represented by him.

THE HON. F. M. ALLEYNE, member of the Legislative Council of Barbadoes, writes to say that in Barbadoes great success has been achieved in the cultivation of sweet potatoes and yams of the very best quality, and an endeavour is now being made to introduce these into this country as vegetable foods. Messrs. W. Pink and Sons, of Portsmouth, are importing regular supplies, and with every parcel receipts are sent for various ways of cooking both sweet potatoes and yams.

A REUTER telegram from Kingstown, St. Vincent, announces that the Soufrière was in violent eruption on November 26. Georgetown and Château Belair have again been deserted. Telephonic communication was interrupted early in the day owing to the fierce lightning. Rumblings could be heard and volcanic clouds seen from Kingstown. According to a telegram from St. Thomas, the steamer *Jare*, which has arrived there, reports that when she passed Mont Pelée on the morning of November 26, the volcano was in violent eruption.

Science states that Prof. J. J. Thomson has been invited to be the first lecturer at Yale University on the Silliman foundation. This lectureship, endowed by the late Benjamin Silliman with 85,000 dollars, is somewhat similar to the Gifford lectures of the Scottish universities, providing for a course of lectures "the general tendency of which may be such as will illustrate the presence and wisdom of God as manifested in the natural and moral world." The lectures, however, must not be "on topics appropriate to polemical or dogmatic theology."

THE lecture which Sir Oliver Lodge delivered to the Institution of Electrical Engineers on November 27 was followed with much interest by a large and appreciative audience. The subject was "Electrons," and the lecturer made it his aim to expound the work which had been done in recent years, work in which the names of Crookes, J. J. Thomson, Stoney and Larmor stand out preeminent, rather than to attempt any new contribution to the theory. This was no easy matter before an audience composed chiefly of engineers, but Sir Oliver Lodge's powers were fully equal to giving a simple exposition of a difficult subject and making clear to his listeners the lines of reasoning involved and the legitimate inferences to be drawn from the experimental work.

REUTER'S AGENCY understands that the work of the Commission dispatched to Uganda some months ago by the Royal Society and the Foreign Office to inquire into the cause of the mysterious malady known as "sleeping sickness," which has made such ravages in Central Africa, has not yet been completed. Dr. Low, the pathologist of the Commission, having finished his portion of the work, is returning home, but Dr. Castellan is continuing his bacteriological investigations in the country, and Dr. Christy, the third member of the Commission, as at present arranged, will pursue his studies along the Upper Nile, by which route he will return to England.

M. CALMETTE has claimed that antivenin, the anti-serum for snake-poison, is to a large extent non-specific, that is to say, cobra anti-serum, for example, would neutralise the venoms of other snakes, though perhaps not so actively as it would cobra venom. This view has been called in question by Prof. Martin and by Captain Lamb, and more recently Dr. Tidswell has found (*Australasian Med. Gaz.*, April 21) that Calmette's antivenin has little or no neutralising power when tested against the venom of the Australian tiger snake.

AT a meeting held last week at the Polyclinic in connection with the Prince of Wales's Leprosy Fund, Mr. Jonathan Hutchinson, F.R.S., gave an exposition of his views upon the propagation of leprosy. He stated that he had come to the conclusion, after much study of the question, that the disease is spread only to a very small extent by anything of the nature of personal contagion, and that it is a food-disease, the living bacillus being received into the body by way of the stomach. The one article of food which was to be suspected was badly cured fish, eaten without sufficient cooking. Mr. Hutchinson,

who has only recently returned from South Africa, is shortly starting for a tour in Ceylon and India in order to investigate the ætiology of leprosy.

WE have received an advance copy of the second edition of Merck's Index. The bulk of the work is devoted to an alphabetical list of the multitude of substances which have been introduced of late years for medicinal use and the majority of which are not to be found in the pharmacopœias. Under each heading, the nature, chemical composition and physical properties, the uses and doses of the substance are indicated. Another useful list gives the composition of various test-solutions that are usually referred to under authors' names and the formulæ for which are often difficult to discover. Other tables give the nature and derivation of the organic substances of the materia medica, nature and composition of minerals, indicators, &c. Altogether, the work is a most useful one, both for the practising physician and for the chemist and physiologist, and should find a place in every laboratory.

A COPY of the catalogue of Aurora Borealis observed in Norway from the earliest times until June, 1878, has been received (xxiii + 422 large quarto pages, Christiania, 1902). This comprehensive catalogue was compiled by Prof. M. Tromholt; he died in 1896, and the laborious task of revising the manuscript and preparing the work for publication was undertaken by his friend, Prof. J. F. Schroeter, of the Christiania Observatory. The first portion of the catalogue gives, in chronological order, the year, month and day on which aurora was observed, together with the district and place, a short description of the phenomenon and the source from which the information was obtained, while a second section contains special descriptions of individual displays. The discussion of the results shows that, as regards the whole country, a maximum in the yearly period occurs about the times of the equinoxes (October and March), separated by a minimum in mid-winter. For the northern part of the country, north of 68° 30′, the yearly period resembles that of the polar regions, with a maximum about the winter solstice. South of latitude 65°, the periods resemble those of middle latitudes. Prof. Schroeter has also tabulated the observations of Dr. Rubenson's catalogue of Swedish auroræ, and shows that the same results hold, for the yearly period, for the whole of Scandinavia, and for individual districts, as obtain for Norway only.

SOME tests on an interesting battery, in which the depolariser is atmospheric oxygen, are described by G. Rosset in a recent issue of the *Centralblatt für Accumulatoren-Elementen*. The cell consists of a zinc electrode dipping into a solution of salammoniac surrounding a porous jar; a semi-permeable membrane of ferrocyanide of copper is formed in the interstices of the jar, which contains a carbon rod dipping into an ammoniacal solution of cupric oxide. When the cell is discharging, the cupric oxide is reduced to the cuprous state, but this diffuses to the surface and is reoxidised by the atmospheric oxygen. The tests show that the depolarising liquid serves for several discharges without renewal in any way, and the constancy of the E.M.F. during discharge is very good. The starting E.M.F. is about 1·25 volts, and this falls slowly to about 0·78 at the end of twenty or thirty days; the internal resistance is about 2·5 ohms. If the air is kept from the depolariser, the E.M.F. falls considerably, but recovers on its being readmitted.

THE Cambridge Scientific Instrument Company has sent us a pamphlet on the measurement of temperature by electrical means, which describes the different types of resistance and thermoelectric thermometers which they manufacture. These thermometers possess the advantage, not only of being suitable for measuring any temperature up to 1000° C. or 1500° C., but also of enabling the reading to be made at any distance from the place at which the high temperature exists. They thus do for thermometry what electrical instruments have done for electrical measurements; it is possible, for example, to read the temperature, say, of a hospital ward in the engine-room instead of in the ward itself, just as it is possible to read in the central station the electrical pressure at the consumers' terminals. The apparatus described in the list before us ranges from the simple thermoelectric couple or resistance wire in a suitable protecting tube to the elaborate Callendar recorders. Instruments reading direct in degrees centigrade can be supplied with the thermometers. The different purposes for which electric thermometry is the best, and often the only, means of measuring temperature are too numerous to mention; the convenience and high accuracy of the method will further recommend it to all who have under their control operations involving temperature regulation.

READERS of NATURE are familiar with the work which has been done by Prof. Kahlenberg tending to disprove the dissociation theory of electrolysis. A short paper summarising the principal arguments against the theory was read by Prof. Kahlenberg before the American Electrochemical Society last April. We commend this paper to all interested in electrochemical theory, especially to those who believe firmly in "ionisation." Briefly, the charges against the hypothesis of Arrhenius are the following. The very generalisation which gave birth to the theory, that abnormal osmotic pressure indicated an electrolyte, and the converse, has not been supported by further experiment. The theory, if it accounts for anything, only accounts for the behaviour of dilute solutions, and is consequently of very limited applicability. There is no experimental evidence, worthy the name, justifying the application of the theory to fused electrolytes. There is no question but that these charges are well supported, and that the ionic theory, if it has given rise to much useful work, has also greatly checked development in some directions, notably that of research with concentrated solutions. It is also a regrettable fact that writers on electrochemical subjects seem to take a pleasure in expressing *facts* in terms of the ionic theory when there is absolutely no necessity for so doing, which, doubtless, to the non-discerning, gives confirmation, in reality fictitious, thereto; without going so far as Prof. Kahlenberg and asserting that the doom of the dissociation hypothesis is already sealed, we believe that those who write in this way are running a great risk of rendering their contributions unintelligible to future generations of electrochemists.

STATISTICS of the mineral production in India for the years 1892 to 1901 have been issued by the Department of Revenue and Agriculture (Calcutta, 1902). The output of coal has increased from 2½ to more than 6½ millions of tons. In the same period, the production of gold has trebled, being 531,766 ounces in 1901, the value being about two millions sterling.

WE have received the general report by the director, Mr. C. L. Griesbach, on the work of the Geological Survey of India for the year ending March 31, 1902. There are brief reports on the field-work carried on in the Madras Presidency, in Burma, Assam, the Punjab, the Himalayan Ranges, Baluchistan and Sind. Inquiries into the occurrence of gold, copper and coal were made in certain districts, without, however, any important economic results. Some of the so-called old workings for gold which abound in Chota Nagpore are nothing more than old prospecting shafts and trenches, and were probably abandoned without the discovery of any paying reefs. One narrow reef gave encouraging results, but only a small outcrop was observed. Prof. R. Zeiller has completed a report on the flora of the Lower

Gondwana Series (permo-Triassic), and this is published with seven plates in the *Palaeontologia Indica* (new series, vol. ii., 1902).

THE annual report of the Geological Commission of the Cape of Good Hope for 1900 (dated 1902) has only just been received. The operations of the Survey were naturally hampered by the war, and the main work was in the districts on the west of the Karoo, including the Cederbergen and part of the country between these mountains and the sea. It was carried on by Messrs. A. W. Rogers and E. H. L. Schwarz, under the direction of Dr. Corstorphine, who has since resigned his position. Their labours have resulted in the discovery of a new formation, the "Ibiquas Series," comprising slates, sandstones and conglomerates, which overlie the Malmesbury beds and underlie the Table Mountain Sandstone. Evidence of local glacial action has been met with in the Table Mountain Sandstone. The Dwyka Conglomerate has been found to rest with marked unconformity on the older rocks as it is traced northwards. Basic dykes and sheets of the same type as those intrusive in the younger rocks of the central Karoo, have been found in nearly all of the older series of strata.

WE have received a report on the Terlingua quicksilver deposits of Brewster County, Texas (*Bulletin* No. 4 of the University of Texas Mineral Survey, 1902), by Mr. B. F. Hill, under the direction of Prof. W. B. Phillips. It is mentioned that at Comanche Spring, a small "seep," seven miles north of the Rio Grande, the limestone bluffs have been covered in a number of places with rude paintings of characteristic Indian design. The artists were without doubt the Comanche Indians, and the vermilion pigment was prepared from cinnabar. Of late years, researches have been made in the district which show that cinnabar and also native mercury occur in the Cretaceous limestones, clays and shales. These strata are invaded by eruptive rocks, to the presence of which the quicksilver deposits are considered to be indirectly due, the ore having been formed from hot springs. The cinnabar is found in definite crystals and in large amorphous masses; other mercury compounds likewise occur, while the native quicksilver is generally mixed with crystalline masses of calcite, and occupies the interstices between them sometimes in a quantity weighing twenty pounds.

THE second part of the *Aarbog* of the Bergen Museum for the current year contains a paper, by Mr. D. Bergendal, on Arctic nemertine worms, in the course of which several new generic and specific types are described. One of the former, Hubrechtella, is named in honour of the illustrious professor of zoology at Utrecht.

BY the discovery of those of the great black species (*Calyptorhynchus macrorhynchus*), which are laid in the hollow branches of gum-trees, Mr. D. le Souëf (*Victoria Naturalist*, vol. xix. No. 6) has succeeded in filling the one remaining gap in our knowledge of the eggs of Australian cockatoos.

ASYMMETRICAL development of the tracheal tubes in the fore-wings of a female specimen of the North American moth *Telea polyphemus* affords, according to Dr. G. Enderlein (*Zool. Jahrb.—Abtheil. für Anatomie*), important evidence as to the phylogeny of the Saturniidæ and the developmental history of the Lepidoptera in general.

MORPHOLOGISTS will be much interested in a paper, by Mr. E. Starks, on the shoulder-girdle of the hemibranchiate fishes (sticklebacks, flute-mouths, trumpet-fish, &c.), published in No. 1301 of the *Proceedings* of the U.S. Museum. Many emendations on previous determinations are made, and it is urged that the group is certainly entitled to rank as a suborder of equal value with the Percesoses.

THE phylogeny of the Proboscidea forms the subject of a paper by Dr. F. Ameghino published in vol. vii. of the *Anales* of the Buenos Aires Museum. The author attempts to show that the Patagonian genius Pyrotherium, which he regards as of Upper Cretaceous age, is the proximate ancestor of the group in question. This form, or its descendants, migrated into Africa, where it gave rise to the recently discovered Palæomastodon and Mæritherium, the former of which is admitted to be the progenitor of the mastodons; the latter spread over the world until one of them reached South America, the home of its ancestors! If, as is quite possible, Pyrotherium is really a proboscidean, it has to be proved, before the author's views can be accepted, first, that it is of Cretaceous age, and, secondly, that it is not itself an immigrant from Africa. It will be unnecessary to follow the author in his attempt to derive Pyrotherium—and so elephants—from a Jurassic (?) South American marsupial.

THE *Monthly Review* for December contains the first part of a contribution by the Rt. Hon. Sir Edward Fry, F.R.S., on the age of the inhabited world and the pace of organic change.

THE annual report of the Liverpool Astronomical Society, a copy of which has just been received, contains an interesting address by the president, Mr. W. E. Plummer, upon the various departments of astronomy in which observers, with or without telescopes, may do useful work if they are inspired by the true scientific spirit.

WE have received numbers 6-11 of vol. xi. and numbers 1-8 of vol. xii. of the *Transactions* of the Academy of Science of St. Louis. The separate parts are each devoted to a single subject, and there is no regular interval of time between the publication of consecutive issues. Many of the contributions are of direct interest only to American men of science, while others will appeal to scientific workers everywhere. Among the latter class in the numbers of this year may be mentioned Mr. A. S. Chessin's essays on the true potential of the force of gravity and on the motion of gyroscopes; and in vol. xi., the reviews of the progress in physics and botany in the nineteenth century, by Prof. F. E. Nipher and Dr. William Trelease respectively, and the paper on some interesting molluscan monstrosities, by Mr. F. C. Baker.

THE October number of the *Journal* of the Sanitary Institute (vol. xxiii. part iii.) contains the addresses to the various sections at the Manchester congress of the Institute. Sir James Crichton-Browne spoke upon the dust problem, and gave an analysis of the dust from a bedroom which contained more than 50 per cent. of organic matter, fragments of animal and vegetable fibres, epithelial scales, starch granules and pollen. Prof. Delépine discussed the epidemic of arsenical poisoning which occurred in the north in 1901, and stated that with Reinsch's test less than one part of arsenious acid in 10,000,000 parts of beer can be detected. Prof. Sherrington gave an interesting address upon school hygiene, and Dr. Shaw one upon the treatment of smoke, printed in NATURE of October 30 (vol. lxvi. p. 667). The popular lecture by Sir W. J. Collins was entitled "The Man *versus* the Microbe," in which he suggests that our views upon the specificity of disease and the immutability of bacteria should be modified in the light of the doctrine of evolution.

THE thirty-fifth volume of the "Journal and Proceedings of the Royal Society of New South Wales," covering the year 1901, provides convincing evidence of the scientific activity which exists in many of the important countries of the British Empire. From time to time, similar portly volumes are received from various colonies, all containing numerous important contributions to science, and it becomes increasingly difficult for a worker in any branch of knowledge to acquaint himself even with the new researches of British men of science. The volume before

us contains, in addition to the annual address by the retiring president, Prof. A. Liversidge, F.R.S., three contributions by the new president, Mr. H. C. Russell, F.R.S., one of which briefly discusses the relation between the moon's motion in declination and the quantity of rain in New South Wales, in which the author is convinced that "seeing the rain is shown so clearly to come in times of abundance, when the moon is in certain degrees of her motion south, and when the moon begins to go north, then droughty conditions prevail for seven or even eight years, a phenomenon repeated for three periods of nineteen years each, that it is either a marvellous coincidence, or there is a law connecting the two phenomena." Mr. R. H. Mathews contributes an important paper on "The Thurrawal Language," and shorter accounts of some aboriginal tribes of Western Australia and of rock-holes used by aborigines for warming water. Mr. J. H. Maiden, Government Botanist and Director of the Botanic Gardens, Sydney, gives an exhaustive summary of the gums, resins and other vegetable exudations of Australia, as well as interesting historical notes relating to the death of Captain Cook. Mr. G. H. Knibbs also writes two important papers, that on a theory of city design being of wide interest. These papers by no means exhaust the important contributions to science contained in the volume, but since reports of the proceedings of the Society regularly appear in our columns under "Societies and Academies," it is unnecessary to refer at any greater length to the scientific work being done in New South Wales.

THE additions to the Zoological Society's Gardens during the past week include two Vervet Monkeys (*Cercopithecus lalandii*) from South Africa, presented by Miss Barlow; an Equine Antelope (*Hippotragus equinus*) from Bechuanaland, presented by Major Chas. Fredk. Minchin, D.S.O.; three Fat Dormice (*Myoxus glis*) European, presented by Dr. L. H. Gough; a Mongoose Lemur (*Lemur mongoz*) from Madagascar, two Mexican Snakes (*Coluber melanoleucus*) from Mexico, deposited; two Snake Fishes (*Polypterus senegalus*) from Fashoda, received in exchange.

ERRATUM—In parenthesis near the end of letter on "Summer and Winter" (p. 81), "The average mean temperature of summer below 61°·2," for *below* read *being*.

OUR ASTRONOMICAL COLUMN.

OBSERVATIONS OF THE PERSEID SHOWER.—Herr Koss, director of the Pola Observatory, communicates to No. 3830 of the *Astronomische Nachrichten* the results of the observations of Perseids made at that observatory on August 8, 9 and 10.

The times of appearance, the exact path, the magnitude and the time of duration of each meteor are recorded for ten Perseids seen on August 8, sixteen seen on August 9, and thirty-three seen on August 10. In addition to these, thirteen Perseids and sixteen sporadic meteors were seen, but not mapped.

The position of the radiant point for August 9 and for August 10 was estimated to be $\alpha = 2h.\ 32m.$, $\delta = +56°{\cdot}5$ and $\alpha = 3h.\ 2m.$, $\delta = +54°{\cdot}5$, respectively.

NEW VARIABLE STAR, 16, 1902, DELPHINI.—From photographs taken at Moscow by M. S. Blakjo, Madame Ceraski has found that the star B.D. + 16°·4290, having the position $\alpha =$ 20h. 25m. 59s.·5, $\delta = +16°\ 57'{\cdot}2$ (1855), is a variable.

In the catalogue, the magnitude of this object is given as 9·3, and this was confirmed on a negative taken on August 18, 1900. On a plate obtained on August 17, 1901, however, the star does not appear, and, according to the magnitudes of the neighbouring stars which do appear, it must therefore have been fainter than the eleventh magnitude. Visual observations confirmed this latter value (*Astronomische Nachrichten*, No. 3830).

EVOLUTION OF AËROGRAPHY.—In No. 170 of the *Proceedings* of the American Philosophical Society, Mr. Percival Lowell reviews the various steps which have taken place in our knowledge and mapping of the surface of Mars.

By a series of twelve maps, arranged in chronological order, he shows the gradual development in the amount of detail seen and recorded, from the map of Beer and Madler, published in 1840, to that published by himself in 1901. From comparisons of these maps, he divides the history of aërography into three periods, viz., 1840–1876, large dark and light markings shown; 1877–1892, "canals" in bright regions detected; 1893–1902, "canals" in the dark regions detected; and also draws the following three deductions therefrom:—(1) The series agree fundamentally. (2) The regularity of the "canals," as recorded by Schiaparelli, was not due to any predisposition on the part of that observer, but was gradually forced upon him as he became more familiar with the surface of the planet. (3) All the maps show a general evolution, from simple to complex, in the detection of the surface markings of the planet.

A SIMPLIFIED FORM OF FOUCAULT'S PENDULUM.—The reinstallation of Foucault's famous experiment at the Pantheon by MM. Berget and Flammarion has, according to M. D'Arsonval, called forth many ingenious devices for proving the same result by means of a simpler apparatus.

Of these devices, M. D'Arsonval describes, in the *Comptes rendus* for November 17, the one which, in his opinion, is the simplest and best.

The main point of this device is the simplicity of the method of suspension. A steel wire, 0·035mm. in diameter, carries a leaden ball, which is covered with copper and weighs about 2¾ lbs., and is fixed to the ceiling by an ordinary nail. Its upper end is then clamped in a metal block, so that it is immovable above the lower face of the block, but free to swing about the point where it enters this face from below, and the block is then screwed to the ceiling or other suitable support. A pendulum suspended in this manner is capable of swinging for about three hours.

The whole apparatus is contained in a small wooden box, which also carries the sand in which the pendulum pointer marks the trace of its plane of swing, and is accompanied by a small model pendulum, which may be used to illustrate the principle of the invariability of the plane of oscillation.

The simplicity, the compact form and the low price (20 francs) of this device should render possible its use in schools and colleges, where hitherto the students have had to depend upon descriptions and illustrations for their knowledge of this important experiment, or else pay a visit to the western galleries of the Victoria and Albert Museum, where a large model may always be seen and, if formal representations be made to the authorities, demonstrations may be given.

PHYSICAL CHEMISTRY APPLIED TO TOXINS AND ANTITOXINS.

A VERY important contribution to our knowledge of the toxins and antitoxins is contained in the "Festskrift" recently published to celebrate the inauguration of the State Serum Institute at Copenhagen, in the form of a paper with the above title by Arrhenius and Madsen. In passing, we note with pleasure that English has been chosen as the international linguistic medium for the entire contents of the volume. The necessity for collaboration between the representatives of different branches of science for the satisfactory study of many of the complex problems of physiology, bacteriology and pathology is gradually becoming generally recognised, and in the present instance we have a striking example of the joint work of two celebrated investigators on a subject lying on the common boundary of their special provinces of knowledge and experience.

It is well known that tetanus toxin, prepared by filtering off the bacteria from a broth culture and saturating with ammonium sulphate, contains two distinct toxic substances, a *spasmin*, which produces the characteristic convulsions, and a *lysin*, which hæmolyses the red blood corpuscles of many animals. In the same way, the antitoxin produced in the serum of animals immunised against tetanus contains two distinct antitoxic substances, an *antispasmin* and an *antilysin*.

It has, moreover, been shown by Madsen that experiments on the properties and mutual relationships of the tetanus lysin and antilysin can be performed with great facility and comparatively great accuracy on blood *in vitro*, the uncertainty attendant upon animal experiments and the great expenditure of time required by them being thus avoided.

The aim of the present investigation was to study the hæmolytic action of tetanus lysin and its reaction with antilysin in the light of ordinary chemical reactions, and to compare both these phenomena with similar actions brought about by substances of known molecular weight, constitution and purity.

The method of estimating the hæmolytic power, which was employed in all the experiments, consisted in allowing the substance under examination to act for a given time upon an emulsion in normal saline, or other liquid, of a known quantity of well-washed blood corpuscles, and then estimating the amount of hæmolysis produced colorimetrically by comparison with standard tubes prepared from varying quantities of the same blood by complete hæmolysis with distilled water.

The investigation falls naturally into two parts, the first of which deals with the hæmolytic action of tetanus lysin compared with that of caustic soda and ammonia.

The hæmolysis of a blood corpuscle by a base such as caustic soda or by tetanus lysin is a phenomenon of considerable complexity and appears to take place in two stages—the combination of the hæmolytic agent with the material of the corpuscle, and the hæmolysis of this compound by the "lysin" which remains free. The three substances under investigation differ from each other in the rate at which they unite with the corpuscles and also in the stability of the compounds which are produced.

Caustic soda combines very rapidly and forms a very stable compound; the consequence of this is that when a certain definite number of blood corpuscles are present, practically the whole of the alkali is taken up and very little hæmolysis occurs. With small amounts of blood, hæmolysis is complete, but as the amount of blood is increased beyond the amount which can be completely hæmolysed, the alkali is thereby withdrawn in increasing amounts from the solution, so that the extent of hæmolysis rapidly diminishes. Tetanolysin, on the other hand, combines much more slowly with the corpuscles and forms a much less stable compound, which is partially decomposed into its constituents, or hydrolysed, by the water of the solution. Hence, in the case of the lysin solutions, there is always some free lysin to effect the hæmolysis of the lysin-corpuscle combination, and, as a consequence, the falling off after the maximum is not nearly so marked. Ammonia takes up a position intermediate between caustic soda and lysin.

All these hæmolytic actions are affected by the presence of certain foreign bodies, among which salts, albumin and serum have hitherto been examined. It seems probable that salts have two distinct effects. In the first place, they probably render the corpuscles more susceptible to the attack of the hæmolytic agent, and hence tend to increase hæmolysis. This tendency is not counteracted in any way in the case of the tetanus lysin, and hence an increase in the action is in this case observed. The compounds of the alkalis with the corpuscles, on the other hand, are affected by salts containing the same ion, much in the same way as a weakly dissociated salt, in which case the dissociation is decreased and the salt then enters less readily into reaction. Hence the caustic-soda combination is affected in this way by sodium salts and, since the diminution of hæmolysis thus produced outweighs the increase due to the effect of the salt on the corpuscles, a nett decrease of action is observed. The ammonia combination is less strongly dissociated than the soda combination, and is therefore still more strongly affected by the presence of ammonium salts.

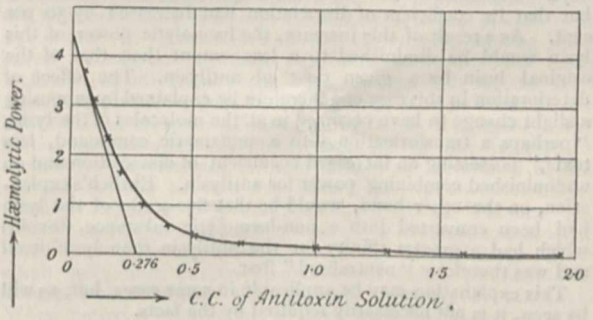
The dissociation spoken of in this case is the electrolytic dissociation of a salt or salt-like compound into its ions, and must not be confused with the hydrolysis mentioned above. Thus a salt-like sodium carbonate is at the same time partly dissociated into its ions, and partly hydrolysed by the water of the solution into caustic soda and carbonic acid; sodium chloride, on the other hand, is much more completely dissociated into its ions, but is practically not hydrolysed at all.

The effect of egg albumin and normal serum is also to diminish the hæmolytic power, both of the bases and of tetanus lysin, but whilst the effect on the bases is very slight, that on the lysin is considerable. It would seem that in each case the albumin combines with the hæmolytic agent, forming a compound in which the hæmolytic power is modified to a certain extent. The properties of caustic soda and ammonia are only slightly affected; those of the tetanus lysin, on the other hand, are more profoundly modified. This explanation is confirmed by the fact that the further addition of albumin exerts no appreciable effect after a certain limit has been reached. Normal serum, on the other hand, has a progressively increasing effect on the lysin, and in fact behaves like a mixture of a large amount of albumin with a small amount of an antitoxin.

Further information is gained as to the nature of the hæmolytic action by the determination of the velocity of the change, and this reveals a still greater complexity. The reaction exhibits a very decided *period of induction*; when the substances are first mixed, the change begins to take place at a very low rate, which gradually increases as the change proceeds. Such a period of induction occurs in certain well-known chemical reactions, although its exact significance is not perfectly understood. In the case under consideration, the authors suggest that it "depends on the circumstance that the red blood corpuscles' cellular membrane must be destroyed before hæmolysis can occur." The actual velocity is found to be proportional to the concentration of the hæmolytic agent, so that if the dose be doubled, the time required to produce a given amount of hæmolysis is halved. This result is of great importance because it shows that the hæmolytic action of bases is not due to the hydroxyl ions, in which case the velocity would be proportional to the square root of the concentration. The same thing is shown by the fact that ammonia acts more rapidly than caustic soda, although it is much less strongly dissociated.

The second part of the investigation deals with the important subject of the action of the antilysin on tetanus lysin.

When increasing quantities of antilysin are added to a fixed amount of lysin, the hæmolytic power of the mixture is not diminished in direct proportion to the amount of antilysin added, but the effect of each successive portion of antilysin is less than that of the preceding one, the diminution of hæmolytic power being rapid at first and then becoming more and more gradual. If the results be plotted with the amounts of



antilysin added as abscissæ and the hæmolytic powers of the resulting mixtures as ordinates (the amount of lysin being constant throughout), a curve of the form shown above results. This curve represents what is usually know as the *toxin spectrum* of Ehrlich.

When we compare this phenomenon with the action of an acid on an alkali, we find that it does not resemble what occurs when an equivalent of hydrochloric acid is added to caustic soda, for in this case the alkalinity diminishes in direct proportion to the acid added, the last portion of acid having exactly the same neutralising effect as the first.

On the other hand, it corresponds precisely with the phenomena observed when a base such as ammonia is treated with a weak acid, like boric acid. In fact, if ammonia be treated as a lysin and boric acid as an antilysin, and hæmolytic experiments be made in precisely the same way as with tetanus lysin and antilysin, the curves of hæmolytic power produced in the two cases are of precisely the same kind. Now the phenomena which occur when boric acid is added to ammonia and in similar cases have been carefully examined by physical chemists, and they are known to be due to the fact that, in a solution of this kind, the ammonium borate which we should expect to be formed is partially hydrolysed by the water into its components, so that the liquid contains ammonium borate, water, free ammonia (ammonium hydrate) and free boric acid. The case is susceptible of mathematical treatment according to Guldberg and Waage's law, and the equivalents of the substances and the coefficient of dissociation can be calculated from the observations.

Precisely the same can be done for the tetanus lysin and antilysin, and the natural conclusion is that these two changes are of the same kind, a reaction taking place in each case between two molecules and resulting in the formation of two molecules of the products. It does not in any way follow that the *substances* concerned are of the same chemical type, and in fact other considerations render this very improbable.

In the particular experiment quoted, the amount of antilysin solution which was chemically equivalent to the lysin employed was 0·276 c.c. When this quantity of antilysin was added, however, the hæmolytic power remained equal to 36 per cent. of the original, whilst even after the addition of seven times the equivalent, the power was still 1·8 per cent. of the original. These facts, nevertheless, do not indicate the presence of a series of lysins of different hæmolytic powers and affinities for antilysin, any more than the precisely similar phenomena observed with ammonia and boric acid indicate the presence of a series of bases possessed of different hæmolytic powers and affinities for boric acid. It is therefore unnecessary to suppose, as Ehrlich has done for diphtheria toxin, that proto-, deutero- and trito-toxins as well as toxones are present.

All the phenomena are explained by the presence of a single lysin, the compound of which with its antilysin is partially decomposed into its constituents by water. Recent experiments of Dreyer and Madsen show that these conclusions may fairly be extended to the constitution of diphtheria toxin.

The deterioration of tetanus lysin is a subject of great interest in connection with the theory of toxins, and its study has also yielded interesting results, although it has not yet been pushed very far. The examination of an altered lysin by the method described above serves to indicate which of its constants—the equivalent or the coefficient of dissociation—has been altered. To take a single example, the hæmolytic power of a solution of lysin was found to have diminished to one-sixth in about five days. Examination showed that its equivalent had not altered, but that its coefficient of dissociation had increased by 50 per cent. As a result of this increase, the hæmolytic power of this lysin would be diminished to a less extent than that of the original lysin by a given dose of antilysin. The effect of deterioration in this case can therefore be explained by supposing a slight change to have occurred in all the molecules of the lysin, "perhaps a transformation into a metameric compound, less toxic," possessing an increased coefficient of dissociation and an undiminished combining power for antilysin. Ehrlich's explanation, on the other hand, would be that five-sixths of the lysin had been converted into a non-hæmolytic substance (toxoid) which had a greater affinity for the antilysin than lysin itself and was therefore "neutralised" first.

This explanation may be applicable in some cases, but, as will be seen, it is not necessarily required by the facts.

A further point of interest is that lysin and antilysin unite slowly and at a rate which can be measured. The investigation of this reaction has been carried out to a certain degree, and its further examination will probably throw more light on the nature of the change which occurs.

If the results of the authors are accepted, a great simplification of the present ideas as to the constitution of toxins will be necessary. A point which is of fundamental importance and appears to call for further examination is the mode of action of the lysin molecule in hæmolysis. In other words, does hæmolysis take place between the lysin-corpuscle and free lysin, as is the case with caustic soda, or does the lysin molecule which forms the combination bring about the hæmolysis by means of another group contained in its molecule?

A. HARDEN.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—An important change has recently been made in the regulations for Responsions. The change affects the examination in the Elements of Geometry. Instead of Euclid's Elements Books i. and ii., with Euclid's axioms and Euclid's sequence of propositions, the subject will in future be defined as the subject-matter of certain specified portions of Euclid's Elements Books i., ii., iii., and the papers will contain elementary questions on this subject-matter and easy deductions from the specified propositions. The regulations state that any method of proof will be accepted which shows clearness and accuracy in geometrical reasoning, and that algebraical proofs of certain propositions in Book ii. will be allowed. The change is to come into force in the Michaelmas term of 1904. The announcement made by the Board of Studies for Responsions, in the *University Gazette* for November 25, reads as follows:—"In the regulations as to the Elements of Geometry (*Examination Statutes*, 1902, p. 18), the words 'Euclid's Elements, Books i., ii. Euclid's axioms will be required, and no proof of any proposition will be admitted which assumes the proof of anything not proved in preceding propositions of Euclid,' have been struck out, and the following words substituted:—'Elementary questions, including propositions enunciated by Euclid and easy deductions therefrom, will be set on the subject-matter contained in the following portions of Euclid's Elements, viz., Book i., the whole, excluding propositions 7, 16, 17, 21; Book ii., the whole, excluding proposition 8; Book iii., the whole, excluding propositions 2, 4–10, 13, 23, 24, 26–29. Any method of proof will be accepted which shows clearness and accuracy in geometrical reasoning. So far as possible, candidates should aim at making the proof of any proposition complete in itself. In the case of propositions 1–7, 9, 10, of Book ii., algebraical proofs will be allowed.' This change will come into force at the examination of Michaelmas term, 1904."

Sir Oliver Lodge has been appointed the Romanes lecturer for next year.

ON Wednesday evening, December 10, a paper on "French Rural Education, and its Lessons for England," will be read by Mr. Cloudesley Brereton at the Society of Arts.

THE clerk of the Privy Council has sent an official notice to the authorities at University College, Liverpool, fixing the hearing of the petition in regard to the proposed Liverpool University for Wednesday, December 17.

THE annual meeting of the Association of Technical Institutions will be held at the Goldsmiths' Hall, London, on Tuesday, January 6, 1903. The president, Lord Avebury, will occupy the chair, and an address will be given by the president-elect, Sir John Wolfe Barry, K.C.B., F.R.S.

MR. J. S. MACDONALD has been appointed to succeed Prof. Myers-Ward in the chair of physiology at Sheffield University College. Mr. Macdonald, who is at present assistant lecturer in physiology at Liverpool University College, takes up his new appointment in January next. Prof. Myers-Ward goes to Charing Cross Hospital as lecturer in physiology.

THE *British Medical Journal* announces that the Board of Trustees of Cornell University, New York, has arranged to purchase sixteen additional acres of land, and to erect new buildings, including the Hall of Physics, for which Mr. John D. Rockefeller gave a quarter of a million dollars, and a Hall of Arts and Humanities, upon which a like amount is to be expended. In connection with this University, it is of interest to notice that professors of the University who reach the age of seventy years will hereafter be retired with a pension. Their salary will be continued for one year, and they will thereafter receive 1500 dollars a year for four years, which time will doubtless be extended. They will act as special lecturers with such duties as may be assigned to them.

WE regret to see that Sir Michael Foster has written to the chairman of his Parliamentary Committee to say he feels compelled to resign his seat as member of Parliament for the University of London. He hoped to be relieved of his duties in the House of Commons at the beginning of the present term, but now, at the request of his committee, has deferred his actual resignation until the close of the present session. Among the names mentioned in connection with the vacancy thus caused are those of Sir Henry Roscoe, for some time vice-chancellor of the University, and Sir John Williams.

WRITING to the *Times*, Mr. A. C. Holzapfel points to the striking difference between English and German fees for scientific instruction. One of his sons studied chemistry at Aachen, and the fees for lectures, laboratory work, breakages, &c., were between 6*l.* and 7*l.* yearly. Another son attended King's College, London, for a course of work similar to that

his brother had had in Germany, and the fee was 47*l.* 13*s.* 9*d.* for a year. The explanation is given by the secretary of the London college, who pointed out in a letter to Mr. Holzapfel that "the continental colleges are endowed by the State, but in England they have to live on the fees of students for the most part, with a very small grant from the State in some cases and what they can raise voluntarily from the public." But it is evident that while the highest form of instruction in science can be obtained at so small a cost, there will never be a lack of properly trained men to look after the manufactures of Germany.

FULL particulars have now been published of the first annual conference of persons in the north of England concerned in primary, secondary, technical and other forms of higher education, which was announced in our issue for July 17. The conference will be divided into four sessions—two meetings on each of the days January 2 and 3, 1903—presided over respectively by Mr. M. E. Sadler, director of special inquiries to the Board of Education; Prof. H. E. Armstrong, F.R.S., Prof. Smithells, F.R.S., and Prof. L. C. Miall, F.R.S. There will be a reception by the Lord Mayor of Manchester of members of the conference on January 2, in the Municipal School of Technology, Manchester, where the meetings will be held, after which various papers will be read. Miss S. A. Burstall, head mistress of the Manchester High School for Girls, will take up the subject of the curriculum in different types of schools. Dr. Kimmins, at the afternoon meeting of the first day, deals with the coordination and delimitation of science teaching in various grades of schools. The methods of teaching experimental science in its early stages will be discussed on the morning of January 3, Mr. W. French, principal of the Storey Institute, Lancaster, taking up physics, and Mr. R. L. Taylor, of the Central School, Manchester, considering chemistry. At the last meeting, Mr. H. W. T. Wager will introduce the subject of methods of nature-study. Great care has been taken to encourage discussion at each meeting; the names of well-known teachers are included in the programme as having promised to contribute to the debates. In connection with the conference, there will be an exhibition of apparatus, preparations and diagrams, such as teachers themselves have prepared or which pupils have made, to illustrate methods of nature-study and the teaching of experimental science. A class-room, fitted up as a model of what it is desired should be provided for the teaching of physics and chemistry in their early stages, will form part of the exhibition. The admission to the conference will be free, by ticket, to be obtained from the honorary secretaries, Dr. H. Lloyd Snape, Director of Education to the Lancashire County Council, and Mr. J. H. Reynolds, Director of Technical Instruction for the city of Manchester and principal of the Manchester Municipal Technical School, which is the office of the conference.

SCIENTIFIC SERIALS.

Transactions of the American Mathematical Society, vol. iii. No. 4 (October).—G. A. Miller, on the groups of order p^m which contain operators of order p^{m-2}. It appears that if $p>2$ and $m>5$, there are two and only two such groups not containing either an invariant cyclic subgroup of order p^{m-2} or else an abelian subgroup of type $(m-2, 1)$. These two groups are conformal respectively with the abelian groups of type $(m-2, 2)$ and of type $(m-2, 1, 1)$.—C. A. Scott, (1) on the circuits of plane curves; (2) on the real inflexions of plane curves.—J. Hadamard, on the theory of plane elastic plates.—E. J. Wilczynski, covariants of systems of differential equations, and applications to the theory of ruled surfaces. The system considered is $y''+p_{11}y'+p_{12}z'+q_{11}y+q_{12}z=0$ and another similar equation with z'' for y''. All covariants can be expressed in terms of three, together with invariants.—A. S. Gale, on the rank, order and class of algebraic minimum curves.—H. F. Blichfeldt, on the determination of the distance between two points in space of m dimensions. Without assuming the continuity and independence of the coordinates, but assuming that distance-relations exist, a series of axioms is laid down and possible forms deduced for the analytical expression for the distance between two points.—H. Maschke, on superosculating quadric surfaces.—E. H. Moore, a definition of abstract groups.—A. Emch, algebraic transformations of a complex variable realised by linkages.

American Journal of Mathematics, vol. xxiv. No. 4 (October).—M. Bôcher, on systems of linear differential equations of the first order. This contains proofs of some existence-theorems by a method of successive approximation.—T. M. Putnam, on the quaternary linear homogeneous group and the ternary linear fractional group. The determinant being unity, and the group being symbolised by substitutions, the canonical forms of the generators fall into eleven principal types, with various subdivisions. The periods of the substitutions are considered, and different commutative subgroups investigated.—A. N. Whitehead, on cardinal numbers. The results of this paper are all expressed in Peano's symbolism, on which there is an introductory section.—G. A. Miller, on a method of constructing all the groups of order p^m (p being any prime).—H. F. Stecker, non-Euclidean properties of plane cubics and of their first and second polars. This is a continuation of a former paper in vol. xxii. of the same journal.

Annals of Mathematics (2) vol. iv. No. 1. (October).—G. A. Bliss, on the geodesic lines on the anchor-ring. The author obtains explicit formulæ, involving elliptic functions, which define a doubly infinite family of geodesics. He also shows that, according to Mangoldt's classification, the points on the inner equator are of the first kind and all others of the second kind. Good illustrative diagrams are given.—H. F. Blickfeldt, proof of a theorem concerning isosceles triangles.—L. E. Dickson, an elementary exposition of Frobenius's theory of group-characters and group-determinants.—E. V. Huntington, on Mr. Ransom's mechanical construction of conics.

SOCIETIES AND ACADEMIES.

LONDON.

Chemical Society, November 19.—Dr. J. Emerson Reynolds V.P.R.S., president, in the chair.—The "dynamic isomerism" of thiourea and ammonium thiocyanate. When the ammonium salt is heated, there is formed a definite compound of this with 25 per cent. of thiourea formed from it; further, melting-point curves of mixtures of these two substances show that other molecular combinations occur.—Isomeric partially racemic salts containing quinquevalent nitrogen; part 8, resolution of the hydrindamine camphor sulphonates, by Dr. F. S. Kipping. The author has confirmed the theory proposed by him in 1899 to account for the existence of these salts by the resolution of the partially racemic salt into four isomerides.—The oxime of mesoxamide and some allied compounds, by M. A. Whiteley. A description of the disubstituted derivatives of mesoxamide, all of which possess the characteristic properties of furnishing yellow alkali salts and purple ferrous compounds.—Interaction of ketones and aldehydes with acid chlorides, by F. H. Lees. When methyl *n*-nonylketone is acted upon by benzoyl chloride, there is formed β-benzoxyundecylene; this reaction has been extended to other ketones, and a series of benzoxyolefines so produced.—The synthesis of αα-dimethylglutaric acid, hydroxy-αα dimethylglutaric acid, and of the *cis*- and *trans*-modifications of αα-dimethylglutaconic acid, by Dr. W. H. Perkin and A. E. Smith.—A reaction of some phenolic colouring matters, by A. G. Perkin and C. R. Wilson. Potassium derivatives of a number of naturally occurring colouring matters have been prepared by interaction with potassium acetate.—Note on mixtures of constant boiling point, by Dr. S. Young. The composition of the mixture of carbon tetrachloride and methyl alcohol having the minimum boiling point is shown to contain 80 per cent. of the former.—The vapour pressures and boiling points of mixed liquids, part 2, by Dr. S. Young and E. C. Fortey. Part 3, by Dr. S. Young. An investigation of the formula proposed by the authors expressing the relation between the vapour pressure of the mixture and those of its constituents. Note on the condensation points of the thorium and radium emanations, by E. Rutherford and F. Soddy. When the emanations from thorium and radium compounds are passed through a copper spiral immersed in liquid air, they are condensed and retained in the copper tube and are volatilised when the temperature is raised to −125° in the case of thorium emanation and to −130° in the case of radium.—Note on the action of barium hydroxide on dimethylvioluric acid, by M. A. Whiteley. The principal product of this action is isonitrosomalondimethylamide.—The determination of strychnine and brucine in nux vomica, by E. Dowzard. The brucine is determined by colorimetric estimation of the tint produced by the solution of the alkaloidal residue in nitric acid.

Entomological Society, November 5.—The Rev. Canon Fowler, president, in the chair.—Mr. H. J. Elwes, F.R.S., exhibited, on behalf of Mrs. Mary de la Béche Nicholl, a collection of butterflies made by her in February, March and April in Southern Algeria; also a collection of butterflies afterwards made by her in the Picos de Europa in Spain; the latter collection comprised about 85 species and was made in 25 days. Mr. Elwes remarked that these collections contained several interesting species of Erebia, Lycæna and other genera, and included three species from Algeria not at present represented in the British Museum collection.—Dr. Chapman exhibited, and made remarks on, two butterflies taken last July at Bejar, in West Central Spain, both notable as being very decidedly larger than any forms of the same species recorded from any other locality. He stated that one of them belonged to a form of *Lycaena argus* (the *L. aegon* of the British list). They were taken about one-and-a-half miles east or south-east of Bejar on July 9 and following days.—Mr. R. South exhibited four specimens of a large form of *Cupido minima* (*Lycaena minima*) from Cumberland, sent to the Natural History Museum by Mr. Mousley, of Buxton. He also exhibited, on behalf of Mr. J. H. Fowler, of Ringwood, a series of *Lithosia deplana*, Esp., from the New Forest, showing interesting variations in both sexes, but especially in the females. It was stated that Mr. Eustace Bankes had recently recorded somewhat similar aberrations of the species from the Isle of Purbeck.—Mr. Hamilton Druce exhibited a specimen of *Limenitis populi*, L., caught whilst being chased by a small bird in July, 1901, near Riga, Russia; also a specimen of *Sesamia nonagrioides*, Lefeb., bred from a larva found feeding in the interior of a banana.—Mr. J. H. Carpenter exhibited a gynandromorphous specimen of *Lycaena icarus*, having the coloration of the male on the left side and that of the female on the right side, captured on Ranmore Common, Surrey, in June last; also several aberrations of this species from Ranmore Common and the Isle of Wight. He also showed specimens of *Vanessa antiopa*, bred from German larvæ, including a remarkable aberration in which the usual blue spots on the upper wings were entirely absent.—Mr. H. St. J. Donisthorpe exhibited a foreign specimen of *Quedius suturalis*, lent him by Mr. Keys, of Plymouth, and a British specimen taken by himself at Gravesend in 1891; also for comparison a specimen of *Quedius obliteratus* taken at Plymouth. He said that most of the specimens of, so-called, *Quedius suturalis* in British collections were really *Q. obliteratus*.—Mr. Pickett exhibited a remarkable series of *Angerona prunaria*, the result of four years' inter-breeding between dark males from Raindean Wood, near Folkestone, and light-coloured females from Epping Forest; also unicolorous light orange-yellow males, light yellow females, dark orange males sprinkled with black, and other unusual aberrations.—Prof. E. B. Poulton, F.R.S., exhibited a series of lantern slides prepared from negatives taken by his assistant, Mr. A. H. Hamm, of the Hope Department, and Mr. Alfred Robinson, of the Oxford University Museum. The slides represented a series of the larvæ and imagines of British moths photographed under natural conditions.—Prof. Poulton also showed a representation of the pupa of *Limenitis populi* prepared from Portschinski's figure and description, and explained the highly ingenious hypothesis by which the appearances are accounted for by the Russian naturalist.—Mr. C. O. Waterhouse communicated a paper by Mr. L. R. Crawshay entitled "On the Life-History of *Drilus flavescens*, Rossi."

Zoological Society, November 18.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Dr. Henry Woodward, F.R.S., exhibited two photographs of the heads of stags of the red deer (*Cervus elaphus*) bred in New Zealand, lent to him for exhibition by Mr. Lewis Karslake. Dr. Woodward read an extract from a letter from Mr. D. Russell, hon. sec. to the Otago Acclimatisation Society, giving an account of the successful naturalisation of the red deer in New Zealand. Two stags and six hinds had been turned out in 1868, and their offspring now numbered between 4000 and 5000 individuals. The carcases of some of these deer weighed from 500 to 600lb.—Mr. J. L. Bonhote exhibited some hybrid ducks which he had bred during the past summer, and pointed out in what manner the crosses partook of their parent forms. Three of the specimens exhibited were crosses between three species, viz. the Indian spot-billed duck, the wild duck and the pintail, both the parents being themselves hybrids, thus proving, with regard to the species enumerated, that the hybrids were perfectly fertile *inter se*.—Mr. Oldfield Thomas, F.R.S., exhibited and made remarks upon a stuffed male and the skull of a female of the East-African representative of the Bongo antelope, recently described by him as *Boocercus euryceros isaaci*, which had been obtained by Mr. F. W. Isaac in the Mau Forest and presented by him to the national collection.—Mr. Thomas also exhibited, on behalf of Mr. Lydekker, the mounted skin of an adult male of the Peking deer (*Cervus* [*Pseudaxis*] *hortulorum*), recently presented by the president and the Duchess of Bedford to the British Museum. Mr. Lydekker believed that an adult specimen of this fine stag had not hitherto been figured. The specimen was in full summer dress.—Dr. A. Smith Woodward, F.R.S., gave an account of excavations for the discovery of early Pliocene mammalian remains which he had recently made near Concud, in the province of Teruel, Spain. The bones had proved to be very abundant in a bed of freshwater marl, but they were in a much more fragmentary condition than those found at Pikermi, in Greece. He had discovered evidence of Hipparion, Rhinoceros, Mastodon, and of several small antelopes, and exhibited some jaws of the first of these genera.—Mr. F. E. Beddard, F.R.S., exhibited the stuffed skin of an Indian elephant still-born in the Society's menagerie in August last, and made some remarks thereon.—A communication was read from Mr. R. Lydekker, F.R.S., containing a description of the Cabul race of the markhor (*Capra falconeri megaceros*).—Dr. Forsyth Major read a paper on the specimens of the okapi that had recently arrived in Brussels from the Congo Free State. The author stated that these specimens, whilst presenting the same specific characters as the specimens formerly received by the Congo State authorities, showed conclusively that the male was alone provided with horns, and that the mode of their development was the same as in the giraffe. The okapi seemed to be a more generalised member of the Giraffidæ than the giraffe, sharing not a few features of alliance with the Upper Miocene Palæotragus (Samotherium). In several characters, it was intermediate between the giraffe and the fossil forms; but, apart from these, some features were pointed out in which it appeared to be even more primitive than its fossil relatives. These last characters went some way to support the assumption that Africa was the original home of the Giraffidæ.—A communication was read from Mr. G. A. Boulenger, F.R.S., containing an account of a second collection of fishes made by Dr. W. J. Ansorge in the Niger Delta. The species—fifty-six in number—were enumerated, four of them being described as new.—A communication from Dr. A. Günther, F.R.S., contained a final account of the fishes collected by the late Mr. R. B. N. Walker, on the Gold Coast. Several new species belonging to the families Chromidæ, Siluridæ and Cyprinidæ were described.

Anthropological Institute, November 25.—Dr. A. C. Haddon, F.R.S., in the chair.—Dr. C. S. Myers read a paper on anthropometric investigations among the native troops of the Egyptian Army. The investigations were confined to the privates and non-commissioned officers of the Egyptian Army. By permission of the Sirdar, 1005 men in the Egyptian battalion quartered at Cairo and 189 men in the Soudanese battalions at Khartoum and Omdurman were examined. Photographs were obtained of 176 Egyptians and thirty-one Soudanese soldiers bare to the waist; two photographs, one full-face, the other profile, were taken of each individual. In both Egypt and Soudan, the subjects measured had been drawn from a very wide area, extending as far westward as Bornu and Barū, and southwards as far as Uganda. It now remained to determine whether definite differences of type exist among the Egyptians from various regions of the Nile valley and among the tribes of the Soudan; also whether the Coptic (pre-Mohammedan) people noticeably differ from the general Moslem population of Egypt. Before publishing the results of this inquiry, the permission of the Sirdar has to be obtained. The material collected will supply the necessary data to permit of the preparation of a report on the physical efficiency of the Egyptian Army.—The Hon. John Abercromby read a paper on the oldest Bronze-age ceramic type in Britain; its close analogies on the Rhine; its probable origin in Central Europe. The oldest type of pottery in Britain is the "drinking cup," for which it is proposed to substitute the shorter term "beaker." Fifty-three of Thurman's three types were shown. Twenty-five interments were described in which the beaker was accompanied by ancient objects; three with large flint daggers, three with buttons with the V-shaped perforation below and five with stone wrist-guards, all of which objects belong to the later Neolithic period on the con-

tinent. None of the objects found with the remaining fourteen interments are of later date than the thin, flat, broad knife-dagger. As no other ceramic type in Britain can show such a pedigree, it is clear that the beaker is the oldest, though before it died out several other types of fictilia came into use.

Royal Meteorological Society, November 19.—Mr. W. H. Dines, president, in the chair.—Mr. F. Campbell Bayard read a paper on English climatology, 1881–1900, which was a discussion of the climatological data printed in the *Meteorological Record* from the forty stations of the Royal Meteorological Society, which have been continuous for the whole of the twenty years. The elements dealt with by the author are:—(1) temperature at 9 a.m.; (2) mean minimum temperature; (3) mean maximum temperature; (4) relative humidity; (5) amount of cloud; (6) rainfall; and (7) number of rainy days. The results form a valuable contribution to the climatology of the British Isles.—A paper by Mr. C. V. Bellamy, on the rainfall of Dominica, was also read. This was in continuation of a former paper on the subject, and dealt with all the available rainfall data for the Island of Dominica. From this it appears that the mean annual rainfall of the island is 110 inches. In the neighbouring island of Montserrat, a remarkably heavy rainfall occurred during the night of November 28–29, 1896, when as much as 20·13 inches fell in the space of six or eight hours.

CAMBRIDGE.

Philosophical Society, November 10.—Dr. Baker, president, in the chair.—Notes on a vibration magnetometer, and on the ball-ended magnets of Robison, by Mr. G. F. C. Searle. The comparison of the horizontal components of magnetic fields by the method of vibrations presents no difficulty when each field is so nearly uniform that a vibrating magnet several centimetres in length may be used. But when the fields are far from being uniform, the magnet must be quite short. The magnet must in any case be slender, for unless its length be at least ten times its diameter, the magnetic moment varies appreciably when the field varies, even for fields comparable with that of the earth. A simple magnet 1·5 cm. in length and 0·15 cm. in diameter is in many ways practically inefficient. In the vibration magnetometer exhibited to the Society, the magnet is 1·5 cm. in length and 0·15 cm. in diameter. The time of vibration is increased from 1·4 to 6·3 seconds by attaching the magnet to a pointed plumb-bob the mass of which is about fifty times greater than that of the magnet. The bob also carries an aluminium pointer to magnify the motion; this enables the time of vibration to be very exactly determined. Ball-ended magnets were devised by Prof. John Robison, of Edinburgh, about 1770; the author was led, independently, to the same design.—On cavitation in liquids, and its occurrence in lubrication, by Mr. S. Skinner. If water is run into the space between two lenses, arranged so as to show Newton's rings, and if one of the lenses is rolled on the other, a crescent-shaped cavity is developed when the velocity of rolling exceeds a certain critical value. The cavity fills as soon as the rolling ceases. With more viscous liquids, such as lubricating oils or glycerine, the formation of the cavity is more marked. With colourless liquids, the production of the cavity is observed by taking advantage of total internal reflection or by using sodium light and observing the Newtonian rings formed in the cavity. With deeply coloured liquids, the effect may be observed by transmitted light. Instantaneous photographs have been obtained of the effects with lenses rolling on planes, lenses sliding on planes and in some other cases. The effects are shown to agree with Osborne Reynolds's theory of the viscous origin of friction when copiously lubricated surfaces move over one another (*Phil. Trans.* A, 1886). That the maximum negative pressure occurs at some distance from the point of nearest approach is confirmed by these observations, and it appears that the layer of lubricant which separates the surfaces at the point of nearest approach is thinner than the wave-length of sodium light. Cavities of the same character probably occur in all sufficiently lubricated bearings.—On the coral reefs of Pemba Island and British East Africa, by Mr. C. Crossland. The paper shows that the island of Pemba, though very similar in structure to that of Zanzibar, is of separate origin to the mainland, whereas the latter island is a part of the mainland barrier system. The fringing reef of the east coast of Pemba represents an early stage in the formation of that of Zanzibar, while a barrier reef, also a result of erosion, not of growth, encloses large bays on the west coast which are comparable to the lagoon of the Bermuda atoll. The mainland of East Africa is bordered by both fringing and barrier reefs, both of which are formed entirely of dead rock, in which physical agencies have in some cases produced miniature atolls. Wherever growing coral occurs in the East African region, it is seen that the physical conditions (*e.g.* the absence of big waves) are not such as to allow the formation of typical reefs. Finally, some observations on the conditions favourable to coral growth were given, which conditions are present round an oceanic atoll to a much greater degree than near a continental area.—On the theory of aggregates, by Mr. A. N. Whitehead.

PARIS.

Academy of Sciences, November 24.—M. Albert Gaudry in the chair.—The velocity of light and the solar parallax, by M. Perrotin. An account of experiments at the Observatory of Nice on the velocity of light. Fizeau's method was used, the total distance traversed by the light being 92 kilometres. As the emission telescope, the 72 cm. objective of the Observatory was utilised, with a 38 cm. objective as collimator. The mean result of 1109 observations was 299,860 kilometres per second in a vacuum. By combining this with the observations on the planet Eros, from which a value of 8″·805 was deduced for the solar parallax, the coefficient of annual aberration was found to be 20″·465, the exact number adopted by the International Astronomical Conference of 1896 at the instance of MM. Lœwy and Newcomb.—On the origin and geographical dispersion of *Lagomys corsicanus*, by M. Ch. Depéret.—Report on the work accomplished by the Brazilian Commission, under the direction of M. Cruls, on the exploration of the principal sources of the Javary, and for the determination of the geographical co-ordinates of several points in this region at points common to Peru, Brazil and Bolivia, by M. Lœwy.—Observations of the sun made at the Observatory of Lyons with the Brunner 16 cm. equatorial during the third quarter of 1902, by M. J. Guillaume. Tables are given showing the number of spots, their distribution in latitude and the distribution of the faculæ in latitude.—On monodrome functions with an isolated essential singular point, by M. Edmond Maillet.—On an extension of the notion of periodicity, by M. E. Esclangon.—On an automatic carburettor for explosion motors, by M. A. Krebs. A theoretical investigation as to the manner in which the area of the orifice air should vary with the pressure of the air and the height of the petrol in the reservoir. Following the indications thus obtained, an apparatus has been constructed in which these conditions are fulfilled, and it has been found that the velocity of the motor can be varied suddenly between very wide limits, an absolutely constant gas mixture being obtained.—On the construction of electrodiapasons with long variable periods, by M. E. Mercadier.—On the ionisation of a salt flame, by M. Georges Moreau. The ionisation of the salt flame was found to decrease according to an exponential function of the distance between the electrodes, and the conclusion is drawn that the unipolar conductivity of a saline vapour is analogous to that of a mass of hydrogen surrounding an incandescent carbon filament, or that of a gaseous mass in contact with a metal illuminated by ultra-violet radiations.—Some observations on uranous oxide, by M. Œchsner de Coninck. Uranyl bromide, ignited in a current of air, loses its bromine, thus differing from the behaviour of the corresponding chloride.—On the combinations of the complex cyanides with fatty amines, by M. P. Chrétien. A study of the salts obtained by the action of hydroferrocyanic acid upon the primary iso-amylamines.—A method for the estimation of glycerol in wine, by M. A. Trillat. The method is based upon the solvent powers of pure acetic ether for glycerol. The glycerol extracted is much purer than that obtained by the usual alcohol-ether method.—On the structure of the muscles of *Anomia ephippium*, by M. Jobert.—On some new or slightly known forms of Rhabditis, by M. Aug. Michel.—The theory of phytons in Gymnosperms, by M. G. Chauveaud.—On the mode of vegetation and reproduction of *Amylomyces Rouxii*, the fungus of Chinese yeast, by M. J. Turquet.—The actual production of native sulphur in the subsoil of the Place de la République, in Paris, by M. Stanisla, Meunier. In the course of the excavations for a railway tunnels native crystallised sulphur has been found in a black clay. Reasons are given for supposing that this deposit has been formed during the last two centuries.—On the general theory of the action of some diastases, by M. Victor Henri. Two hypotheses are examined; supposing that a portion of the ferment

combines with a part of the body undergoing hydrolysis, another part combining with a portion of the products of hydrolysis. It may be supposed either that it is the non-combined part of the ferment which acts upon the bodies to be split up, or, on the other hand, that the unstable compound formed is itself decomposed, regenerating a part of the ferment. It is remarkable that both these hypotheses lead to the same law. Experiments are given showing the action of invertin upon saccharose alone and mixed with invert sugar, and of emulsin upon salicin.

NEW SOUTH WALES.

Royal Society, October 8.—Prof. Warren, president, in the chair.—Occurrence of the mineral gadolinite at Cooglegong, Pilbarra District, West Australia, by Mr. Bernard F. Davis.—Pot experiments to determine the limits of endurance of different farm crops for certain injurious substances, part i. (wheat), by Mr. F. B. Guthrie and Mr. R. Helms. The authors describe experiments to test the effect upon the growth of the wheat-plant of certain substances occasionally found in the soil and in manures, and known when present in excessive quantities to act as plant poisons. The following table summarises the principal results obtained.

Effect upon germination and subsequent growth of wheat of different percentages of injurious substance in the soil.

	Germination affected.	Germination prevented.	Growth affected.	Growth prevented.
NaCl	0·05	0·20	0·05 to 0·15 (recovered)	0·20
Na_2CO_3	0·30	0·5 to 1·0	0·10	0·40
NH_4CNS	0·005	0·01	0·001	0·005
$NaClO_3$	above 0·01	0·05	0·001	0·003
As_2O_3	0·05	0·50	0·05	0·10

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 4.

ROYAL SOCIETY, at 4.30.—(1) On the "Blaze-Currents" of the Incubated Hen's Egg; (2) On the "Blaze-Currents" of the Crystalline Lens: Dr. A. D. Waller, F.R.S.—A Contribution to the Question of "Blaze-Currents": Dr. A. Durig.—On the Similarity of the Short Period Pressure Variation over Large Areas: Sir Norman Lockyer, F.R.S., and Dr. W. J. S. Lockyer.—Isomeric Change in Benzene Derivatives. The Interchange of Halogen and Hydroxyl in Benzenediazonium Hydroxides: Dr. K. J. P. Orton.—On the Vibrations and Stability of a Gravitating Planet: J. H. Jeans.

LINNEAN SOCIETY, at 8.—New and rare Corals from Funafuti: G. C. Bourne.—On the Morphology of the Flowers and Fruits of the Xylosteum Section of Lonicera: E. A. Newell Arber.—Note on *Carex Tolomiei*, Boott: B. Clarke, F.R.S.—New and old Phalangidæ from the Indian Peninsula: C. With.

RÖNTGEN SOCIETY, at 8.30.—An Observation bearing upon the Therapeutic Action of the Focus Tube: Dr. D. Walsh.—X-Rays in Ophthalmic Work: Stephen Mayou.—Mr. Isenthal will show the Nodon Electric Valve for converting Alternating into Continuous Current.

CHEMICAL SOCIETY, at 8.—The Absorption Spectra of Metallic Nitrates. Part II.: W. N. Hartley.—The Specific Heats of Liquids: H. Crompton.—(1) Studies in the Camphane Series. Part X. The Constitution of Enolic Benzoylcamphor; (2) Note on the Isomeric Benzoyl Derivatives from Isonitrosocamphor: M. O. Forster.—The Constitution of the Products of Nitration of Meta-acetoluidide: J. B. Cohen and H. D. Dakin.

AËRONAUTICAL SOCIETY, at 8.—Presidential Address. Recent Aëronautical Progress: Major B. F. S. Baden-Powell.—The Contributions of Balloon Investigations to Meteorology: Dr. W. N. Shaw, F.R.S.—The Kite Equipment of the Scottish National Antarctic Expedition: John Anderson.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Extra Meeting for the Inaugural Address by the President, Mr. J. Swinburne.

FRIDAY, DECEMBER 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Erection of Steel Bridges, Sheffield Extension of the London and North-Western Railway: A. Reynolds.

GEOLOGISTS' ASSOCIATION, at 8.—On the Formation of Chert: Miss Catherine A. Raisin. Illustrated by Lantern Slides.—A List of the Fish Remains from the Middle Bagshot Beds of the London Basin: A. K. Coomaraswamy.

SATURDAY, DECEMBER 6.

ESSEX FIELD CLUB (Essex Museum of Natural History, Stratford), at 6.30.—The Non-Marine Mollusca of the River Lea Alluvium at Wathamstow: A. S. Kennard and B. B. Woodward.—Demonstration of the Lumière Process of Colour Photography and its applications to Natural History Work: Edward R. Turner.

MONDAY, DECEMBER 8.

SOCIETY OF ARTS, at 8.—The Future of Coal Gas and Allied Illuminants: Prof. V. B. Lewes.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Three Years' Exploring Work in Central Asia: Dr. Sven Hedin.

TUESDAY, DECEMBER 9.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion of paper on* High-Speed Electrical Generating Plant: T. H. Minshall.

WEDNESDAY, DECEMBER 10.

SOCIETY OF ARTS, at 8.—French Rural Education and its Lessons for England: Cloudesley Brereton.

THURSDAY, DECEMBER 11.

ROYAL SOCIETY, at 4.30.—*Probable papers*:—On Certain Properties of the Alloys of the Gold-Silver Series: The late Sir William Roberts-Austen, F.R.S., and Dr. T. K. Rose.—Abnormal Changes in some Lines in the Spectrum of Lithium: H. Ramage.—An Error in the Estimation of the Specific Gravity of the Blood by Hammerschlag's Method, when Employed in Connection with Hydrometers: Dr. A. G. Levy.—Quaternions and Projective Geometry: Prof. C. J. Joly.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Photometry of Electric Lamps: Dr. J. A. Fleming, F.R.S.

SOCIETY OF ARTS, at 4.30.—Domestic Life in Persia: Miss Ella C. Sykes.

INSTITUTE OF ACTUARIES, at 5.30.—Lecture on Statistics (Measurement of Groups): A. L. Bowley.

MATHEMATICAL SOCIETY, at 5.30.—Application of Matrix Notation to the Solution of Linear Differential Equations: Dr. H. F. Baker.—The Expression of the Double Zeta and Gamma Functions in Terms of Elliptic Functions: G. H. Hardy.—Sets of Intervals. Part II., Overlapping Intervals: W. H. Young.—Series connected with the Enumeration of Partitions: Rev. F. H. Jackson.—The Abstract Group simply Isomorphic with the Group of Linear Fractional Transformations in a Galois Field.

FRIDAY, DECEMBER 12.

ROYAL ASTRONOMICAL SOCIETY, at 5.

CONTENTS.