THURSDAY, DECEMBER 6, 1906.

VIVISECTION.

Experiments on Animals. By Stephen Paget. Third and revised edition. Pp. xii+387. (London: J. Nisbet and Co., Ltd., 1906.)

THE new edition of Mr. Paget's well-known book appears in time for the inquiry now being made by a Royal Commission on the subject of vivisection. It is now exactly thirty years since the first Royal Commission on the subject of experiments on animals made its report. A glance at this report is, to us of this generation, a revelation of the enormous progress that has been made in medical sciences during the last thirty years. In the report the attention of the commissioners, as well as of the witnesses, was almost entirely taken up with the question of physiological experimentation. The leading men of the medical profession testified to the dependence of advance in medicine on advances in our knowledge of the workings of the body in a state of health, a proposition which must seem to every scientific man self-evident. For the conversion to this view of the ordinary man, who does not think scientifically, the examples adduced by these witnesses must seem to us at the present time very scanty. Again and again we have brought up in evidence the discovery of the circulation of the blood by Harvey and of the functions of the anterior and posterior roots by Bell and Majendie, and certain experiments on the growth of bone and on the absorption of ligatures in regard to their surgical application.

Although the experiments of Villemin and Chauveau on tubercle are mentioned, the tubercle bacillus was as yet undiscovered. Lister had already, for nearly twenty years, been endeavouring to discover the best method of prevention of wound infection, and had introduced antiseptics into surgery; but the antiseptic method had not yet been generally accepted. Pasteur was still carrying out his researches on the nature of wound infection, but in 1878, three years after the Commission was appointed, his views had not yet received general acceptance. Mr. Paget gives a graphic description of a memorable discussion which occurred in this year at the French Academy of Medicine on the subject of puerperal fever. In the middle of a long discourse by a doctor on the causes of this mysterious visitation, Pasteur interrupted with the statement that the epidemic was due entirely to microbes conveyed by the doctor and his assistants, and jumping up and going to the blackboard he drew the streptococcus on it, saying, "Tenez, voici sa figure." Bacteriology, in fact, was just being born, and few in this country had recognised the marvellous part it was to play in modifying the relations of man to his environment.

From the development of bacteriology during these few years has grown the antiseptic and aseptic treatment of wounds, which is responsible for the saving annually of hundreds of thousands of lives, and for the practical abolition of pain from the surgical wards.

The discovery of the tubercle bacillus by Koch has enabled us to deal successfully with numerous cases of tuberculosis in its manifold forms; "we have no longer to reckon with a nameless something, but with a definite parasite whose conditions of life are for the most part already known, and can be further studied." In this way we are in a position, in many cases, to shut off the sources of infection, and so to attain the prevention of this most fatal of all disorders.

Since this time one disorder after another has been studied, and has given up its secrets to the bacteriologists. The diphtheria bacillus was discovered in 1875, and isolated by Loeffler in 1884. In 1890, Behring and Kitasato discovered the antitoxin which is used throughout the whole civilised world, and has reduced the case mortality by one half.

The tetanus bacillus was discovered in 1880, and the tetanus antitoxin, by means of which we can protect against the disease though rarely succeed in its cure, in 1894. The horrible disease of hydrophobia was brought under our control by Pasteur in 1885. The cholera bacillus was discovered by Koch in 1883, and the method of preventive inoculation against this disease by Haffkine in 1893.

The plague bacillus was discovered in 1894. Since this time, knowing the cause of the disease, it has been possible to track out its whole natural history, and the report of the last Commission on the subject has placed in the hands of the sanitary officials all the facts which are necessary for successfully coping with the disease.

The typhoid bacillus was discovered in 1881. An emulsion of this bacillus is now constantly used in Widal's reaction, to diagnose typhoid and to distinguish it from other cases of continued fever. Successful inoculations against the disease have been carried out by Wright.

The discovery of the bacillus of Malta fever, or Mediterranean fever, by Bruce, has enabled medical men to determine the sources of infection of this disorder, and the resulting measures have this year caused a diminution of the cases from 258 in July, August, and September, 1905, to fifteen during the corresponding months of this year.,

The microorganisms of malaria and of yellow fever have been discovered, and their life-histories worked out. The part played by mosquitoes and gnats in the propagation of these diseases once having been recognised, it has been possible to wage a successful war against both these disorders. Where preventive measures have been thoroughly carried out, these diseases, which previously decimated the population, have been practically stamped out. I may mention here simply the case of Ismailia (malaria), Havana (yellow fever), and the Panama Canal (yellow fever). All these results, involving probably the saving of hundreds of thousands of lives yearly, have been accomplished by a science which has hardly attained its majority, and which is the direct outcome of the application of the scientific method for which a strong testimony was borne before the Royal Commission of 1875.

These examples, though representing the results which can be most easily appreciated by the unlettered and unscientific, make up only a fraction of the benefits that have accrued to man as the result of the continuation of experiments on animals. The control of the bodily functions must be founded on a knowledge of those functions. Medicine must repose on physiology, or be reduced to charlatanism and empiricism.

During the last thirty years our knowledge of physiology has advanced all along the line. We can now form a mental picture of every event occurring in the heart throughout the cardiac cycle. We know the nature of the impulses and the course of the nerves concerned in the multitudinous adaptations of the circulation to every change in the environment of the body or of the activities of its different organs. We can form a connected image of the chain of processes concerned in the digestion of food during its passage through the whole alimentary canal.

The localisation of function in the central nervous system, to which in 1875 Ferrier had already contributed his remarkable experiments on localisation in the cerebral cortex, has now been extended to the whole nervous system. Though in such a complex system many paths must be still unknown, experiment has enabled us to unravel much of its complex character, and to form a clear conception of the possible paths open to almost any impression which may play upon the surface of the body. Comprehension of the coordination of movement, and of the processes involved in every movement of a limb, has only lately been revealed to us by the researches of Sherrington. An examination of medical literature shows us that the clinical physicians are alive to the close connection which exists between the study of disease and the study of physiology. Every new fact in physiology is tested with reference to the conditions in disease. Although in many cases the observations on man are too inexact to enable a complete utilisation of the facts of physiology, yet these clinical methods are being improved day by day, and the science of medicine is taking a larger and larger part as a guide to the practice of the art.

In his evidence before the Commission, Sir John Burdon-Sanderson expressed his profound conviction that "A future will come—it may be a somewhat distant future—in which the treatment of disease will be really guided by science. Just as completely as mechanical science has come to be the guide of the mechanical arts, do I believe and I feel confident that physiological science will eventually come to be the guide of medicine and surgery."

There is a danger that the striking utilitarian success gained by the pursuit of experimental investigations along certain definite lines may encourage the fallacy that any true distinction can be drawn between utilitarian and scientific researches. Even now a clamour has been raised by certain agitators for a restriction of experiments to those which can be shown to have a direct utilitarian object. Such a restriction is impossible. Science has taught us again and again that any increase in our knowledge must finally add to our powers. The so-called purely scientific researches are those dealing with general relations, and have as their object the discovery of laws which must affect our conceptions of the science in a number of its ramifications. It is the purely scientific researches which have effected the greatest revolutions in man's relation to his environment, and have placed within his hands the largest powers of control. Moreover, these researches must be undertaken in a spirit of pure curiosity, from a love of knowledge itself. The man who is always seeking a practical outcome for his experiments will have his field of vision narrowed, and the scope of his researches limited thereby.

The present Commission has been appointed largely as a result of an agitation on the part of those by whom every advance in science, and every change in the relations of man to his surroundings, are regarded as improper or even impious; and these persons, by misleading statements appealing to the better feelings of a credulous and unlearned public, have succeeded in arousing a feeling of resentment against those who are engaged in the advancement of the science of life by experiment. There can be no doubt that a marshalling by the Commission of the true facts of the case will show the slender grounds for the allegations made by the anti-scientific agitators, and will demonstrate the remarkable benefits to man attained during the last thirty years at the cost of the infliction of a trifling amount of pain on some animals.

It has been said, with truth, that the amount of pain inflicted in all the laboratories in this country in the course of a year is not equal to that suffered by the birds in one day's shooting *battue*, carried out, not primarily for food or for the benefit of man, but to amuse a few rich men. Yet noble "sportsmen" take a prominent place among the patrons and vice-presidents of the various anti-vivisection societies which, by leaflets and paid lecturers and letters to the Press, disseminate misleading and lying statements throughout the country in furtherance of their malignant campaign against science. Mr. Paget has been well advised in appending to this new edition a part iv., entitled "The Case against Anti-vivisection," in which he deals at some length with the unscrupulous methods of these societies and of their paid agents. It is sincerely to be hoped that the Royal Commission will inquire, not only into experiments on animals, but also into the morality of the anti-vivisectionists themselves. E. H. S.

SENSE-PERCEPTION IN GREEK PHILOSOPHY.

Greek Theories of Elementary Cognition from Alcmaeon to Aristotle. By John I. Beare. Pp. viii +354. (Oxford: Clarendon Press, 1906.) Price 12*s.* 6*d.* net.

THIS volume, from the pen of the regius professor of Greek in Dublin, continues the kind of work so well begun for English readers by Prof. Burnet's "Early Greek Philosophy." It deals with the various theories entertained in regard to the five senses, sensa-

tion in general, and lastly the Sensus Communis, and its method is under each head to give as consistent a view as possible of what was severally taught by Alcmaeon, Empedocles, Democritus, Anaxagoras, Diogenes of Apollonia, Plato, and Aristotle. There is little or no attempt to criticise these writers from the standpoint of modern philosophy. But the statement is very clear, the discussion of disputed points scholarly, the facts are well arranged, and the literature—to judge from the footnotes and the list of books consulted—seems to have been thoroughly studied; although one misses a reference to one recent work on the "De Anima"—that of Rodier, whose commentary, if not his translation, has been regarded by competent judges as indispensable.

As dissection was practised as early as Alcmaeon—he is stated to have been a pioneer in this direction—there is perhaps room for our wonder that the Greeks did not in their swift way attain some more consistent and conclusive theory regarding the working of the senses and the nervous system as a whole. Possibly they were encumbered with the armour of pre-suppositions with which they went forth to encounter nature—Empedocles and Anaxagoras with their respective doctrines that like is perceived by like, and contrary by contrary; Aristotle with his antitheses of form and matter, of *dynamis* and *energeia*; nearly all of them with a disposition—to which Aristotle, worse advised than Plato, succumbed—to regard the heart and not the brain as the physical centre of the intellectual life. But at the same time one notes in this volume how little right we have to throw stones at them; *e.g.* how modern physics (to quote Prof. Beare's words) "is as helpless to explain colour as physiology to explain olfactory function," or, again, that "the psychology of taste has advanced little beyond the popular and superficial stage at which Alcmaeon left it." Still, when all is taken into account, the final impression is one of admiration for the insight—which is genius—of an Aristotle, *e.g.* when "he rejected as if by anticipation the Newtonian emission theory of light"; for the skill, too, with which he could produce a theory that would do justice to all the valuable elements in earlier philosophy, *e.g.* when he harmonised Empedocles and Anaxagoras by his statement that perception is a relation in which what was unlike becomes like.

The occasional inconsistencies in Aristotle—those spots in the intellectual sun—are well discussed by our author. Aristotle's views, or possible views, on biological development have always been a difficult, if interesting, subject, for in one passage of the "De Sensu" the master rejects Democritus's account that each of the other senses is "a kind of touch"; but while Dr. Ogle, on the ground of that passage, hesitates to credit Aristotle with the belief "that the remaining special senses are but modifications of touch or general sensibility," Prof. Beare, on the other hand, finds it "hard to suppose that Aristotle—the pioneer, in *general* terms, of the theory of evolution not only physical but physiological and psychological—should in this particular application of his theory have failed to recognise it, or have denied its truth simply because it was a doctrine of Democritus." On every account this volume is to be commended to those interested in the development of theories of sense-perception.

GRAVITATIONAL ASTRONOMY.

The Collected Mathematical Works of G. W. Hill. Vols. ii., iii. Vol. ii., pp. v+339; vol. iii., pp. 577. (The Carnegie Institution of Washington, 1906.)

THE second and third volumes of Hill's works carry to 1890 the republication of his papers prepared for the American ephemeris and his miscellaneous writings. The latter volume, which is entirely devoted to the theory of Jupiter and Saturn, is probably without parallel as a piece of calculation. It is a splendid and enduring monument to ten years' incessant labour, and the nicety of agreement of its predictions with observation continues to justify the pains spent upon it. It replaced Leverrier's theory, which was published while this was in course of production, and Hill found himself unable to point to any definite omission or flaw in Leverrier's theory which would account for the much inferior accuracy of its results; it seems to be due to accumulation of almost impalpable differences, and if some of Hill's work strikes one as over-elaborated, one can always look to the "Theory of Jupiter and Saturn" for justification.

At the same time, one cannot help feeling in turning over some of these papers that to an adept straightforward calculation becomes an end in itself. The memoir, No. 48, on the lunar inequalities due to the spheroidal figure of the earth is an example. This is entitled also a supplement to Delaunay's theory of the moon. The theoretical additions are fairly obvious, and the main part of 143 pages is occupied with the steps required for determining 165 terms in the moon's longitude and 209 in latitude which are factored by the earth's ellipticity. Not the fiftieth part of these terms reaches $0''.1$ in amplitude, and not the tenth of $0''.01$. Most people will regard this as more striking in its proof of the author's colossal patience than in any other quality.

Probably no writer of the same originality has been content to follow his predecessors' models, upon occasion, so closely as Hill. They owe him much. The paper referred to above is the most elaborate application of Delaunay's method outside Delaunay's own work. Hill's "Jupiter and Saturn" is the greatest monument in existence to the power of Hansen's methods, Hansen's own Lunar Theory not excepted. It was to the problem of these two great planets that Hansen first made serious application of his methods in 1831. But, as Hill puts it, he "seems to have been carried away by the ambition of applying his method of treatment to the lunar theory," and never returned to it. If anyone would disabuse his mind of the common misapprehension that Hansen's ideas are uncouth and his methods formless, and gain at the same time a concrete view of Hansen's method, he could not do better than follow out the steps of the *Auseinandersetzung* as applied by Hill. Hill's modifications, few though important, are no obstacle. The truth be-

comes patent that Hansen was a master of beautiful mathematical device. The bewildering detail ceases to obscure it when put into arithmetical form.

The problems of exact solution of the secular perturbations and of finding integrals of the equations of motion, which hold good for indefinite spans of time, must in the future occupy more and more attention.

Lately Hill has published an important memoir upon the subject (*Astronomical Journal*, vol. xxv.); two papers, Nos. 37 and 47, in the present volume show that his interest is not of recent date. No. 41, "Reply to Mr. Neison's Strictures on Delaunay's Method," shows him as a critic—a formidable though reserved antagonist not without ironic humour. No. 44, "On the Interior Constitution of the Earth as Respects Density," is a beautiful example of what he can do when working without the fetters of exact astronomy. Eventually the paper is a solution of the well-known equation for the density of a spherical aggregation of gravitating gas at constant temperature. The question had been treated before, but Hill's method is out of all measure more striking and complete than had been given previously.

NEOLITHIC MAN.

Neolithic Man in North-East Surrey. By Walter Johnson and William Wright. With a chapter on Flint by B. C. Polkinghorne. Cheaper re-issue. Pp. viii+200. (London: Elliot Stock, 1906.) Price 3*s.* 6*d.* net.

THIS book is the result of several years of archæological investigation in the north-east corner of Surrey. The area visited measures about 14½ miles by 13 miles; it would fall between the Thames on the north and a line drawn between Boxhill and Oxted on the south. Within these limits the researches of our authors have been patient and unwearying; they have sought for traces of Neolithic man in field after field, on height after height. Set down in their pages is a large amount of information as to his homes (Worms Heath, Croham Hurst, Barrow Hill, &c.) and burial-places; as to his methods of work, agricultural and domestic; as to the food he ate and the implements he used, celts, hammer-stones, arrow-heads, scrapers, &c. Some space too has been devoted to his track-ways and fortifications; in most cases the same ground was occupied at a later period by Roman roads and works, or those of other invaders less skilled in engineering.

The main subject is prefaced by an account of the various inhabitants who have succeeded one another in this country, especially the Neolithic and bronze-using peoples, and by a survey of the geological features of Neolithic Surrey. Our authors are certainly right in holding that the "ages" overlapped or merged into one another; the terms "Stone, Bronze, Iron age" are, in fact, merely conventional; they can only be applied to the phases in development during which stone, bronze, or iron began to be worked, side by side with the material already in use, not of necessity replacing it. In Lancashire, for example, where the hills to the north prevented ready retreat in that direction, stone, bronze, and even iron seem to have been used contemporaneously at one period (see "Victoria County History of Lancashire"). Generally speaking, these opening chapters are highly instructive and accurate; they form a useful introduction to the story of Neolithic man. If they have a fault it is that they are perhaps a trifle too technical. Being a cheap re-issue, the present edition is obviously intended for the local student, to whom—not, of course, to the specialist—this preliminary information might be expected to be of service. In these circumstances the authors might have done better to leave out words like artifact, homotaxial, &c.; even geological terms like patina and Pleistocene, or at any rate to give their meaning. To leave them unexplained is to presuppose knowledge which is only too often to seek.

We have neither the space nor the necessary local knowledge to enter into a detailed criticism of the main subject. If we may venture a suggestion, we should recommend greater caution in the use of arguments based on etymology. We doubt very much whether all the authors' results (*e.g.* in chapter x.) would stand the scrutiny of a trained philologist. Only those who have made a special study of place-names are able to realise how dangerous and misleading this kind of evidence is apt to be.

There can be no question that the book is a valuable one. The extent of general knowledge displayed in it, and its high standard of scholarship, place its authors far above the ordinary run of local archæologists. Their work is only popular in the sense that it is inexpensive. In addition to the maps and illustrations by Sidney Harrowing and Frank Percy Smith, it has an index and a list of the authorities referred to in each chapter. Mr. B. C. Polkinghorne contributes a supplementary chapter on the constitution and alterations of flint, with reference to the subject of flint implements.

OUR BOOK SHELF.

In the Days of the Comet. By H. G. Wells. Pp. 305. (London: Macmillan and Co., Ltd., 1906.) Price 6*s.*

THOUGH the actual collision of the earth with the head of a comet is an extremely improbable event, it is not beyond the bounds of possibility. In 1861 the earth passed through the tail of a comet; and the showers of meteors occasionally observed near the end of November are probably due to encounters with fragmental remains of Biela's lost comet. The disc-like appearance of Holmes's comet in 1892 gave rise to the suggestion that the comet was approaching the earth head-on, and we believe Mr. Wells then used the idea in one of his clever short stories. In any case he would have no difficulty in finding justification for the supposed collision with a comet which forms the *deus ex machinâ* of the present romance.

The comet which springs from Mr. Wells's imaginative brain is seen in its early days by an enthusiastic amateur astronomer who forms one of the minor characters of the story as a "quivering little smudge of light among the pin-points," while the spectroscope showed "an unprecedented band in the green." The unknown element which this peculiar green radiation

represented proves to be the Divine afflatus that lifts the human race out of selfish individualism into socialism understood in its finest sense. The struggle for existence and the survival of the fittest no longer express operations of natural law, and the world becomes a place where the prevailing spirit is "all for all and each for each." Love is transfigured, hate perishes, war and all other manifestations of our animal nature are rendered unthinkable after the earth has passed through the comet. The change which evolution can scarcely anticipate in the distant future is brought about in a single night.

The idea is a noble one, and Mr. Wells has dealt with the phenomenal and sociological aspects of the transformation in a masterly manner. What is the destiny of the human race cannot yet be foreseen, but what man might become when "a new heaven and a new earth" have been created is a worthy subject of speculation; and when the theme is developed, as it is in this book, with scientific knowledge, prophetic insight, lofty purpose, and human sympathy, it almost persuades us that the gospel it conveys points the way to the millennium. The message may not be understood, but the story in which it is presented cannot fail to excite interest and stimulate thought.

The Elements of Chemical Engineering. By Dr. J. Grossmann, with a preface by Sir W. Ramsay, K.C.B., F.R.S. Pp. viii+152. (London: C. Griffin and Co., Ltd., 1906.) Price 3*s.* 6*d.* net.

IT can scarcely be said that our system of technical education is satisfactory, so far as chemical technology is concerned. Our technical colleges and universities turn out annually a large number of students who have received a fairly good training from the theoretical point of view, but have very little knowledge of apparatus or processes as conducted on the manufacturing scale. It is obviously impossible for teachers who have not themselves been engaged in factories to teach chemical technology successfully. Our German competitors have fully realised this, and some of the larger chemical manufacturers have combined and founded an institution specially devoted to the education of teachers, all the operations being carried out on the manufacturing scale. In the absence of some educational establishment of this kind we must assume that the education of most of our students is defective from the practical point of view, and means must be found to convey the requisite knowledge before they can be entrusted with the supervision of manufacturing operations.

Dr. Grossmann's book has been specially written with this end in view, the object of the author being to make the student familiar with those factory appliances which are the equivalents of the apparatus used in the laboratory. To render the comparison still more easy, the plant described is classified according to the supposed laboratory appliance which it represents. It is not always easy to ensure parallelism under such an arrangement; for instance, the chapter on "The Funnel and its Technical Equivalents" deals mainly with filtration, which is not the primary function of a funnel. The remarks on the materials used in chemical engineering are practical, and will be of great use to students, whose knowledge on this subject is usually very defective.

Among the useful features in which this work differs from similar manuals may be mentioned the price list of chemicals, which will be of great service to beginners, although, as Dr. Grossmann rightly remarks, the prices are liable to frequent fluctuations. How great these fluctuations may be is shown by the fact that copper is now twice and antimony three times the price quoted in the list. The price given for amyl acetate, 4*l.* 14*s.* 6*d.* per lb., is evidently an error.

As Sir William Ramsay says in his preface, the author has given a simple and lucid statement of the difficulties that a student may expect to meet with, and the book may be recommended as an introduction to the practical work of the factory.

Crystal Gazing. Its History and Practice, with a Discussion of the Evidence for Telepathic Scrying. By Northcote W. Thomas. With an introduction by Andrew Lang. Pp. xlvii+162. (London: Moring, Limited, 1905.) Price 3*s.* 6*d.* net.

THE practice which gives its name to this book is only one of a number of devices which have been employed to assist the appearance of visual hallucinations. Mr. Thomas gives a popular account of the various methods which have been used in classical, mediæval, and modern times, and describes the practices of various savage or barbarous peoples, such as the use of blood by the Maories and Pawnees, of quartz by the people of Sarawak, and of mirrors by the members of more advanced races.

The subject has two distinct aspects. One deals with the nature of the psychological processes involved in the appearance of the visions, and, treated from this point of view, crystal gazing is brought into line with other psychological processes, such as visual imagination, hypnogogic and hypnotic illusions and hallucinations, &c.

The other aspect deals with the question whether the visions of the scryer provide any evidence in favour of telepathy. On this aspect Mr. Thomas gives accounts from many sources, and concludes that, though fragmentary and unsatisfactory, the evidence is, on the whole, in favour of telepathic crystal visions. It must be pointed out, however, that his data provide perhaps equally strong evidence in favour of prophetic scrying. The book has an introduction in which Mr. Andrew Lang gives an account of the circumstances which first led him to take an interest in crystal gazing and of many experiments with which he has had to do. Mr. Lang regards his own ventures in this field as those of an amateur, and he appeals to professed psychologists to undertake the further investigation of the subject. His own attitude, however, is so eminently judicial that it is a matter for regret he cannot himself give more attention to this line of work, for the judicial mind is not too common either in the more academical or the more amateur students of this field of research.

The History of the Collections contained in the Natural History Departments of the British Museum. Vol. ii., Separate Historical Accounts of the Several Collections included in the Department of Zoology. Pp. 782. (London: British Museum, 1906.) Price 30*s.*

IN this volume officers of the various sections of the Zoological Department have given accounts of the collections under their respective charge, tracing the evolution of each from small beginnings to its present condition. Each account is complete in itself; but a remarkable degree of diversity is noticeable in regard to the amount of space occupied by the different histories, the notice of the bird collection far exceeding all the others in length. At the end of each account is a biographical list of the various donors and collectors who have contributed to the section. This involves a large amount of repetition, and some discrepancies are noticeable when the different lists are collated. In many portions of the volume the editorial blue pencil might have been used freely with great advantage, and in some places the prolixity is so great that it is exceedingly difficult to winnow out the grain from the chaff. Nevertheless, the volume contains a great mass of valuable information with regard to

the progress of natural history in this country and the evolution of the collections in the Museum which it would be very difficult, or impossible, to obtain elsewhere. Despite a lamentable loss of early collections, like those formed during Cook's voyages, owing to lack of knowledge of their value and indifferent curatorship, the Museum is particularly rich in type-specimens, more especially of species presenting well-marked characteristics of their own. In many cases particular attention is directed to these and other specially interesting specimens in the collection, although in these matters, again, a great diversity of treatment is noticeable in the different accounts.

Science and Religion. By the Rev. Lord William Gascoyne Cecil. Pp. 105. (London: Hodder and Stoughton, 1906.) Price 3*s.* 6*d.* net.

FIVE addresses delivered in substance at St. Lawrance Jewry during Lent, together with an explanatory foreword, make up the contents of this volume. The author lays claim to "no scientific qualifications at all," and therefore "can only speak as one of the crowd," to use his own description of himself. The sermons follow lines which are already familiar to students of science acquainted with the literature which has grown up round the attempt to "reconcile" traditional theology with results of scientific study.

How to Learn on Shore the Rule of the Road at Sea. By E. W. Owens. Pp. 40+23. (London: George Philip and Son, Ltd., 1906.) Price 3*s.* 6*d.* net.

THIS excellent little book meets a great want, and is strongly recommended for use in all training schools and ships. It is arranged in a convenient manner, and the explanations are simple and good. Part ii., which consists of extracts from the Merchant Shipping Act and the latest regulations for preventing collisions at sea, special lights for fishing craft, &c., makes the book not only useful in the class-room, but a great convenience on the bridge of any ship as an *aide mémoire*. H. C. LOCKYER.

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.*]

Absorption of the Inert Gases by Charcoal.

IT may interest some of your readers to know that Prof. Rutherford, in a private letter addressed to myself, has given a full explanation of the circumstances that led him to infer that the absorption of the inert gases by charcoal was exceptional. Fully appreciating the difficulties that beset Prof. Rutherford at the time he wrote the letter to NATURE (vol. lxxiv., p. 634, October 25), I exonerate him from all blame in the matter, and willingly cancel all the expressions of regret he has been pleased to make.

With regard to the latent heat question, I ought to mention that Prof. Rutherford will not commit himself to the view that the electrometer readings recorded in the paper I quoted are proportional to the partial pressures of the emanation. He says:—"I do not know how far the electrometer readings may be taken as a measure of the partial pressures of the emanation, but naturally measurements over a range of temperature of 1° or 2° cannot be vouched for with any certainty." This would be a strong criticism provided any manometric measurements had been attempted, but if the electrometer measures directly the relative concentration of the emanation in a given volume of gas, the method is so sensitive that the increase caused by a narrow range of temperature is less liable to error. It is clear, however, that new determinations will have to be made before the question can be settled.

In the meantime, I can only wish Prof. Rutherford success in the applications of charcoal to the study of the emanations of radio-active bodies, and take the opportunity of expressing my gratification at seeing charcoal becoming of such scientific utility in the hands of workers like the Hon. R. J. Strutt, the French chemists Moureu and Biquard, not to mention others: the more especially as my own labours have been interrupted for reasons given in my former communication.

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Radium, Actinium, and Helium.

IN NATURE of November 29 Dr. B. Walter discusses the theory of Prof. Rutherford that in radio-active change accompanied by the emission of an α particle the atomic weight is diminished by 4, the atomic weight of helium. According to this assumption, the transformation of uranium (238·5) into radium (225) is due to the loss of *three* helium atoms. Now uranium gives one α particle in changing to uranium X, so that only two such changes remain for any subsequent transformations. If we accept the result of Profs. Moore and Schuldt (*Phil. Mag.*, October) that uranium X gives out α rays, two changes are accounted for, and only one is left for intermediate products.

In NATURE of November 15 Mr. Boltwood brings forward experimental evidence in support of the view that actinium is an intermediate product between uranium and radium; but in the case of actinium and its derivatives four changes, accompanied by the emission of α particles, occur. Thus, on the assumption that the α particle is a helium atom, there is no room for these products.

The difficulty can be removed by adopting another alternative, suggested by Prof. Rutherford, that the α particle is *one-half* of the helium atom carrying a single ionic charge (*Phil. Mag.*, p. 366, October). In this case we should have the following series possible:—

Series I.	*Series II.*
Uranium (238·5)—α	Uranium (238·5 —α
↓	↓
Uranium X (236·5)—α, β, γ	Uranium X (236·5)—α, β, γ
↓	↓
Actinium (234·5)	Unknown (234·5)—α
↓	↓
Radio-actinium (234·5)—α	Actinium (232·5)
↓	↓
Actinium X (232·5)—α	Radio-actinium (232·5)—α
↓	↓
Actinium emanation (230·5)—α	Actinium X (230·5)—α
↓	↓
Actinium A (228·5)	Actinium emanation (228·5)—α
↓	↓
Actinium B (228·5)—α, β, γ	Actinium A (226·5)
↓	↓
Unknown (226·5)—α	Actinium B (226·5)—α, β, γ
↓	↓
Radium (224·5)	Radium (224·5)

If the atomic weight of radium were 226·5, the unknown change accompanied by the expulsion of an α particle must be removed from the series. One or more rayless changes may also occur.

It is interesting to note that the atomic weight of actinium, according to Series II., comes out as 232·5, that is, exactly the atomic weight of thorium. These two substances closely resemble one another in their radio-active properties, giving transformation products of very similar character. This suggests as an analogous case the similarity between nickel and cobalt, two elements of practically the same atomic weight. H. S. ALLEN.

King's College, London, November 30.

Mira Ceti.

IT may be well to note that this variable star is exceptionally bright at its present maximum, the magnitude being about 2·0. As usual when the star is bright, it is less red than its average. T. W. BACKHOUSE.

West Hendon House, Sunderland, December 1.

A GEOLOGICAL HISTORY OF DEVONSHIRE.[1]

THE title of this book requires some explanation, for the subject-matter is not a description of the existing scenery of Devon, or of the manner in which its various features have been developed out of the rock-surfaces which last rose above the sea. It is mainly a description of the physical and geographical conditions under which the rocks of the south-west of England were formed; it is an endeavour (as indicated by the subtitle) to follow the geographical evolution of the region, and to picture the successive stages in the development of its physical geography.

The aim of the author has evidently been to present what is known of the geological history of Devonshire in as interesting a form as possible; hence, as stated in the preface, he has used "the minimum of technical language with the object of making them (his pages) suitable for the beginner and the ordinary reader who has no previous knowledge of the subject, but who cares to know how Devonshire came to be what it is."

Moreover, he has contrived to include much general information regarding the rocks of the British Islands, and since many modern geologists consider that professorial teachers of geology have dwelt too much on the lithological and structural branches of the science, and too little on its connections with physical geography, such a book as this ought to find a welcome in many quarters.

After an introductory chapter devoted to "Protozoic" time, "we reach the date when the history of Devon begins to be readable from its own records," this, of course, being the Devonian period. Having first indicated the probable geography of Britain at this time, the author describes the rocks of North Devon, indicating the great compression and contortion to which they have been subjected. He mentions the diverse views which have been held regarding their succession, and wisely remarks that further investigation is required before this matter can be settled.

The next chapter is devoted to the Devonian of South Devon, of which a good description is given, with a glance at the schistose area of the Start, laying stress on the fact that the results of compression and metamorphism become greater in the direction of these crystalline rocks. It was perhaps to be expected that he would repeat the statement that the Devonian limestones are essentially of coralline origin, and are to be regarded as ancient coral-reefs, for he could quote a recent Geological Survey memoir to that effect. Nevertheless, its truth has more recently been questioned, and it has been shown that large parts of the limestone are crinoidal, while others are chiefly made up of Stromatoporoids; moreover, we do not know whether any Palæozoic corals were reef-builders.

In chapter vi. we find a general account of the Carboniferous rocks before coming to those of Devon, the description of which is not very satisfactory, because it is entirely based on the old view that the Coddon Hill cherts overlie the limestones, and that the whole group represents the lowest part of the Carboniferous Limestone of Bristol and South Wales; whereas good reasons were given by Dr. W. Hind in 1904 for placing the cherts below the limestones, and for regarding both as the equivalents of the Pendleside

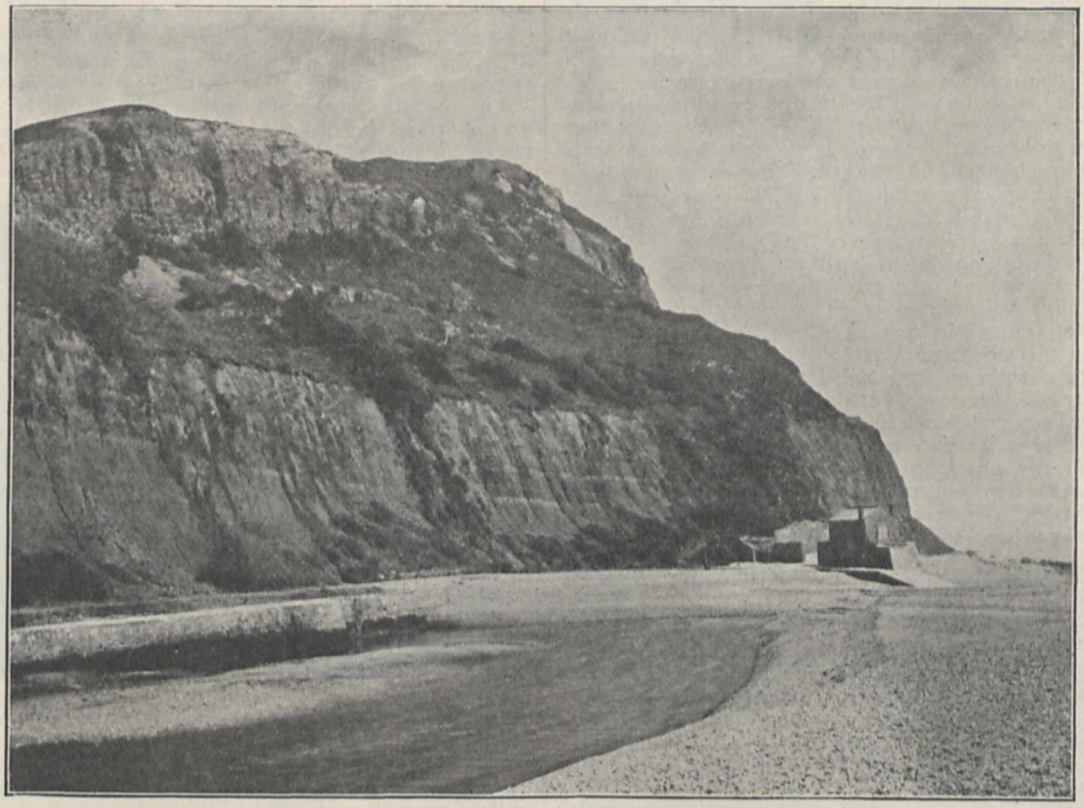

FIG. 1.—The Haven Cliff, Axmouth. Greensand on eroded surface of Keuper Marls. From "The History of Devonshire Scenery"

[1] "The History of Devonshire Scenery—An Essay in Geographical Evolution." By A. W. Clayden. Pp. 202; with 41 photographic illustrations and some diagrams. (Exeter: J. G. Commin; London: Chatto and Windus, 1906.) Price 10s. 6d. net.

beds which overlie the great mass of the midland Carboniferous Limestone.

For the next two chapters we have nothing but commendation. They deal with the time represented by the great gap between the Culm and the Permian rocks. The first is entitled "The Great Upheaval," and gives a clear and sufficient account of the post-Carboniferous mountain-ranges which are known as the Hercynian or Armorican system, and of the subsidiary Pennine range. This is illustrated by a restoration of the physical geography of the British area at this time. The succeeding chapter is devoted to volcanic rocks, with especial regard to the Carboniferous and post-Carboniferous volcanoes.

In the discussion of the Dartmoor granite in chapter vii. the author is faced by a problem which has given rise to many diverse expressions of opinion. He practically adopts the view advocated by the late R. N. Worth, and sets himself to show "that the granite mass of Dartmoor is really the solidified upper part of the cooled lava reservoir from which the Carboniferous volcanoes of Devon were fed." We think he states the case for this theory with somewhat of over-confidence, for the dissolving of sedimentary rock in the granitic magma is thought by some to be very improbable, and the temperature at which the granite solidified is still a disputed point, while the actual evidence for the existence of volcanoes over the Dartmoor granite is by no means strong. Prominence is, of course, given to the occurrence of peculiar volcanic rocks in the Permian breccias, the origin of which is also dealt with in this chapter.

In the chapter on the "Salt Lake Period" (chapter viii.), an excellent account is given of the Devon Trias and of the conditions under which its successive beds were deposited, the proofs of its salinity and of its barren desert-surroundings being well brought out. The illustrations, too, are especially good, including photographs of "red marl with salt-crystals," "the base of the Budleigh pebble-bed," and "the tea-green marls overlain by the Rhætic bone-bed."

The dawn of Jurassic time and the great climatic change produced by the irruption of the sea into the salt lake are set forth in the opening page of a chapter entitled "The Age of Reptiles." In this the Lias and the Liassic sea are duly described, and the subsequent sequence of Jurassic rocks is briefly indicated, with some remarks on the erosion to which the surrounding land must have been exposed during the whole period, and especially during its closing scenes, when the British area was again upraised, and the sea retreated far to the south and north-east.

Under the title "The Return of the Sea," chapter x. deals with the beginning of the great Cretaceous subsidence. The stratigraphy of the Gault and Greensand is briefly but clearly described, and there are excellent views of the two cliff sections near Seaton Haven cliff and Whitecliff, the former of which we have selected as an example. Then follows a chapter on "The Chalk," in which the peculiar Devon development of an arenaceous Cenomanian overlain by Middle Chalk and a portion of the Upper Chalk is fairly well described. We notice, however, that there is no mention of the "Beer Stone," another Devon speciality, which differs greatly from ordinary chalk and has been largely used as a building stone from Norman times to the present day.

Mr. Clayden appears to be unaware of the views published in the Geological Survey memoir on the Cretaceous rocks of Britain respecting the physical conditions under which the different parts of the Chalk were accumulated. When, therefore, he observes that the facts "are inconsistent with the idea of a deep sea," and assumes that the Chalk (as a whole!) was formed "in a shallow sea perhaps less than 100 fathoms deep," we can only express our surprise.

Chapters xii. and xiii. deal with Eocene time, describing the "Plateau Gravels" and the Bovey deposits, which latter the author considers to be essentially lacustrine, and to have been formed in "the Bovey lake." Chapter xiv., entitled "The Rivers of Devon," is the most original portion of the book, and we only wish that the author had developed this subject at greater length. When we say that he believes the drainage of the whole of northern and central Devon in early Tertiary time to have been carried off by one great river flowing eastward, it will be obvious that such a supposition raises many interesting questions. We are inclined to regard it as a very probable theory, but undoubtedly its details require fuller consideration than he gives them.

The modern scenery of the county, how it is partly an uncovered Permian surface and partly one carved out of an Eocene peneplain, is briefly described in the final chapter. Dartmoor also comes in for further mention, and its type of scenery is well illustrated, as will be seen from the illustration selected.

FIG. 2.—The Crown of the Moor: Yes Tor. From "The History of Devonshire Scenery."

In conclusion it may be said that Mr. Clayden has succeeded very well in the accomplishment of his general intention. The book appeals to a much wider circle than the few readers who may be found in Devon and Cornwall. It really treats of the whole of southern England from Dover to Bude, and should be in the hands of all those who are interested in the geology and the physical geography of our southern counties.

THE UNCIVILISED CHILD.[1]

"THE explanation is rather artistic than scientific"—so the author admits about what he has written on the origin of the "couvade." It is a way of saying that he has found his explanation does not accord with the facts gathered by anthropologists concerning this custom. Such is the keynote of the

[1] "Savage Childhood: a Study of Kafir Children." By Dudley Kidd. Pp. xvi + 314. (London: Adam and Charles Black, 1906.) Price 7s. 6d. net.

book: it is artistic rather than scientific. It is a life-history of the Kafir child, an excellent record of many facts concerning customs, practices, games, songs, sayings; and it may be particularly commended for the number of capital photographs which illustrate it. But the scientific possibilities in all this field of observation have been practically untouched. The Kafir baby has not been studied from the Darwinian standpoint, the superstitions which affect him have hardly been looked at with the folklorist's knowledge, racial customs and practices have scarcely been viewed in the light of anthropology.

One must have expected to find in savage children many instances of those Simian characters which have been noted among European children; even—because the Kafir child is on a lower scale—to find them more pronounced. But the author says nothing about them, and his photographs give very little in this way. One picture—it is the frontispiece in the book—shows a shy child, who has instinctively assumed an attitude of self-defence, and has its arm raised as if to ward off a blow, and especially to protect the eyes. Now, as fear is the natural basis of shyness, this attitude is very happy. It is an inherited instinct, no doubt, but not necessarily Simian; yet if the author had been on the watch for exhibitions of inherited instinct he would certainly have obtained many which were truly Simian in their origin.

Had the author been more fully acquainted with folklore results he would not show so many doubts about accounting for various customs. For instance, he notices (pp. 41, 42) the practice of a Kafir mother protecting her child by leaving a ring of her milk round it, or by squeezing "a few drops of her milk on to its head." He suggests two explanations; but from folklore research he could learn that the second is more nearly correct—that the milk forms a connecting link with the mother; or, rather, that the milk is actually the mother herself present. As Mr. Hartland says in discussing the life-token, "the external object is believed to be, or to contain, a part of the man himself" ("Legend of Perseus," ii., p. 51). The word "part" there is hardly sufficient. The external object, the detached portion of a person, or anything which has absorbed a portion of a person, is believed to be more than a part: it is rather looked on as the *alter ego*, subject to all his disabilities, endowed with all his potentialities; and just as destruction of the *alter ego* involves destruction of the *ego*, the very basis of witchcraft, so the power to watch and ward, which the *ego* possessed, is supposed to be also inherent in the *alter ego*. The mother's milk is as capable a protector as the mother herself.

The basis of the same superstition—that a part of self is the other self—is further illustrated by the author in "Confusion of Self with the Clothing and Possessions," "with the Shadow," "with the Picture," "with the Name," and so on (pp. 66 *et seqq.*); and he gives quite the right explanation of these. The man's shadow is but another form of himself, and anything done to his shadow is done to him. The "native doctors apply medicine to people's shadows as well as to their bodies" (p. 70), that is, application to the shadow is quite as efficacious as to the body. So a man refused to be photographed; because the person having the photograph would have a hold on him (p. 71).

The secret burning of the child's sleeping mat (p. 84) is another case. The mat is burnt to prevent it falling into the hands of any evil-disposed person, who could then work ill on the child. Here we have the apparent contradiction that meets us in such customs. One would at first think that the destruction of the mat would mean the killing of the child. So it would, if done with evil intent; because the intention with which an action is done makes all the difference.

To conclude, one may quote some admirable remarks of the author on the unfortunate result of ignorant European interference with Kafir customs. When it is considered how terrible a failure individualistic civilisation is, at any rate for some millions of our population, and that the remedy is declared to be Socialism, it is quite possible to echo the author's protest against forcing individualism on people who appear to have got great enjoyment out of life under Socialism. The author says (p. 129),

FIG. 1.—Boys playing "King of the Castle" on an ant-heap near the Zambezi. From "Savage Childhood," in which the photo. is about an inch longer and wider than this illustration.

"While English magistrates are above suspicion as to the justness of their decisions from a Western point of view, yet the natives complain not a little concerning the injustice of our government. . . . In olden days no Kafir felt it to be unjust on the part of a chief to make his subjects work for white men, and yet give their money to him (the chief). To Europeans this is essentially unjust, for it is an infringement of the rights of the individual. To the native the rights of the corporate clan are vastly more important than those of the individual. Consequently, when in

our haste we impose Western conceptions of justice . . . on people who are still in the clan-stage of society, our judgments seem to such people absurdly unjust, and even pernicious. . . . There are few things the old people grumble about so much as the way the proximity of Europeans, with their new-fangled ideas of justice, undermines the characters of young Kafirs. In olden days there were regular courts of investigation, consisting of a dozen old women of the kraal. All the girls were medically examined by these women before and after large dances; and thus certain forms of vice were impossible as they would be so speedily detected. Nowadays the young women will not submit to such examination, and threaten to complain to the nearest magistrate when it is suggested. Consequently, so the old people say, ancient restraints have been removed, and no new ones have been substituted by white men. The result is disastrous. . . ."

"The case of 'mixed bathing' of the children is another example of a somewhat similar thing. According to Western conceptions of morality this practice is indelicate and liable to lead to immorality. So missionaries advised natives to abandon it. The natives now declare that the abandonment of this custom has led to an increase of immorality, and say that it introduces new vices amongst the people."

Mr. Kidd is not the only author who has pointed out the injury to health and to morals inflicted on native races by forcing upon them European ideas and customs. People know too little of anthropology and of evolution. They are not aware that the practices, which are as second nature to themselves, have only become so by a course of selective action through thousands of years, and that to force changes on natives whose course of evolution has been so different is almost certain to be disastrous. Changes take time; Nature will not be hurried; and it is particularly necessary to understand, not only the native customs, but the reasons which have determined them. As a contribution to this end, a work with many interesting observations and a considerable array of facts, Mr. Kidd's book may be commended.

ANNIVERSARY MEETING OF THE ROYAL SOCIETY.

THE anniversary meeting of the Royal Society was held as usual on St. Andrew's Day, November 30, when the report of the council was presented, the presidential address was read, and the new council already announced (p. 36) for the ensuing year was elected. The annual dinner was held in the evening at the Hôtel Métropole, the chair being taken by Sir William Huggins, K.C.B., in the absence of the president, Lord Rayleigh, owing to illness.

The main features of the activity of the Royal Society during the session 1905–6 are described in the report of the council. Among other subjects referred to is the preparation of the reports on the scientific results obtained by the late National Antarctic Expedition. The council has decided that these reports shall be published in quarto form, uniform with the Philosophical Transactions and the *Challenger* publications.

In May last the council learned that the funds (36,000*l*.) provided by the British South Africa Company for the South African meridian arc had been exhausted. The arc had been extended beyond the Zambezi towards Lake Tanganyika, but a gap of 120 miles existed in the middle of it. It was estimated that 1600*l*. was required to fill this gap, and the matter was most urgent in view of the pending disbandment of the surveying parties. The officers had intimated by authority from the president that the Royal Society would probably be able to subscribe 300*l*. from its private funds on condition that the remainder of the money required were provided; and, on the strength of this information, Sir G. Darwin obtained a promise of 800*l*. from the British South Africa Company, 100*l*. from the Royal Geographical Society, 100*l*. from Wernher, Beit and Co., and cabled to Sir D. Gill that the surveying party was to proceed, thus assuming responsibility for the remaining 300*l*. This 300*l*. has since been subscribed by the British Association from its special South African fund.

The council of the International Association of Academies met in Vienna at the end of May last, Prof. Schuster attending as representative of the Royal Society. Two proposals submitted by the society received considerable support. Regarding one of these, which aims at the establishment of a uniform lunar nomenclature, the council resolved to recommend to the general assembly of the association the appointment of a committee to consider the subject. The proposal that the association should allow itself to be placed at the head of the bodies constituting the International Union for Solar Research was considered, and, while sympathy was expressed with the wishes of the Solar Union, the council felt a difficulty in recommending a scheme that might involve the association in responsibilities which it had no legal power to incur. Prof. Schuster undertook to bring the matter forward again next year in a modified form.

On the suggestion of the Academy of Sciences of Paris, the council agreed to recommend a scheme for the organisation of meteorological stations at different points of the earth's surface.

The subject of international cooperation in the reduction and standardisation of seismological observations has engaged the attention of the council. In accordance with the decision of the International Association of Academies, the proposition made by the German Government and referred to in the last report of the council has, during the present year, been carried into effect. The conditions suggested to the Treasury by the Royal Society, on which the concurrence of this country should be given, have been fulfilled. Both the Governments of France and the United States agreed to send representatives to the first meeting of the permanent commission of the International Seismic Association, and on the recommendation of the council Prof. Schuster was deputed by the Treasury to attend that meeting as delegate from this country. The various representatives of the different countries which agreed to take part in the operations and deliberations of the commission met in Rome on October 16 last. The chief business of this meeting was the organisation of the work of the association. One of the principal results of the discussion was a resolution to use a portion of the funds at the disposal of the association for the establishment of a seismological station in the Arctic regions. The permanent commission is to meet every two years, and the first general meeting of the association has been arranged to be held next year.

The progress of the Indian magnetic survey, under the direction of Major H. A. D. Fraser, R.E., is reported from time to time to the observatories' committee of the society. Preparations are also in progress for the reduction and publication of the very long series of magnetic records accumulated at Bombay, under the superintendence of Mr. Moos, the director of the observatory.

A magnetic survey of South Africa has been in progress for some years, under the direction of Prof.

Beattie, of Cape Town, and the field work is now practically completed. In reply to a request that the results might be published under the auspices of the Royal Society, the council willingly expressed its assent, as uniformity would thereby be secured with the British survey executed by Rücker and Thorpe, and with the magnetic surveys, in which the Royal Society is concerned, proceeding in other parts of the Empire. The council agreed to undertake the publication of a separate volume, uniform with the Philosophical Transactions, on condition that the expenses were repaid by the Colonial Government concerned. The society has since been officially informed that the sum of 600*l.* is held by the Public Works Department at Cape Town to meet the expenses of publication of the magnetic survey of South Africa.

The council has also taken steps to secure that the magnetic survey of New Zealand, now nearly completed, under the direction of Dr. Coleridge Farr, and to be published by the Government of New Zealand, shall appear in a form uniform so far as possible with the above.

In the absence of the president, Lord Rayleigh, the presidential address, which is reprinted below almost in its complete form, was read at the anniversary meeting by Mr. A. B. Kempe, treasurer and vice-president of the society.

In the report of the council there has been laid before you an account of the work of the council and of various committees in a very wide field. The investigation of the terrible disease known as sleeping sickness has unhappily been marked by the tragic death of Lieut. Tulloch, who has fallen a victim to his zeal in studying the disease in Uganda. Vigorous efforts are being undertaken to discover some therapeutic remedy for the malady. In the case of Malta fever, too, the investigation of which was entrusted to the Royal Society by the Colonial Office, good progress has been made. It has been ascertained by the society's commission in Malta that the main source of propagation is the milk of infected goats. When this discovery was made the authorities of the island were at once warned of the danger in the milk supply, and the necessary precautions were taken. Since then the number of cases of fever in the hospitals has so greatly diminished as to afford good hope that this disease, which has been so great a scourge in Malta, may ere long be reduced to insignificant proportions or altogether exterminated.

I observe that a movement has been started in this country in aid of the Greek Anti-malaria League. Prof. Ronald Ross, than whom there is no higher authority, bears witness to the unexpected prevalence of the infection in most of the localities examined, and he is confident that practical results of the highest value would follow expenditure in combating the disease on lines already laid down. Although I speak only from general knowledge, I cannot let this opportunity pass without emphasising my sense of the enormous importance of this class of work. If men knew where their real interests lie, our efforts in this direction would be doubled or quadrupled. In this way discoveries, which the future will certainly bring, might be accelerated by decades, giving health and life to thousands or millions who now succumb. Willing and competent workers would soon offer themselves; the principal obstacle is the want of means.

The preparation of the "Royal Society Catalogue of Scientific Papers" for the remaining portion of the nineteenth century, which has proved a task so much more gigantic than can have been contemplated by the originators of the catalogue nearly half a century ago, has been actively pushed forward. In consequence of the increased expenditure, now at the rate of nearly 2000*l.* a year, the funds available are again approaching exhaustion. The difficulties of the president and council and of the catalogue committee on this subject have once more been promptly resolved by the action of our fellow, Dr. Ludwig Mond, who, after consultation with the officers, has again made himself responsible for a further subsidy amounting to 2000*l.* a year for three years. It is hoped that with the balance in hand and other sources of income, including the Handley fund of the Royal Society, the income of which is devoted to this purpose, this subvention will suffice for the preparation of the work and for passing it through the press. Since the Royal Society took this great national task in hand, there has already been spent on it more than 23,500*l.*, while on each occasion of financial stress Dr. Mond has come forward with the means of relief, his direct contributions, including that just promised, now amounting in the aggregate to 14,000*l.* This great work when published will thus be a tangible memorial of Dr. Mond's practical insistence on the importance of adequate indexes of the vastly increasing literature of science.

Of the activities working under the Royal Society, the one with which I have been especially connected is the National Physical Laboratory. As the result of a memorial to the Chancellor of the Exchequer, signed by about 150 Members of Parliament, the grant for building and equipment for the year was increased from 5000*l.* to 10,000*l.*, and this has enabled the committee to take in hand some urgently needed extension.

Buildings are now in course of erection for metrology and for metallurgical chemistry, while the engineering laboratory is being doubled in area. The two last additions were called for in great measure in consequence of an arrangement with the India Office whereby the testing work required for the Indian Government, hitherto carried on at Coopers Hill, is to be transferred to the laboratory. The Indian Government provide the testing machine and other appliances required for the work, and, in addition, have intimated their intention of placing in the charge of the committee the very admirable electrical equipment now at Coopers Hill.

Towards the equipment of the metallurgical laboratory the Goldsmiths' Company have made a very generous donation of 1000*l.*, while the Governments of New Zealand and Western Australia have contributed 100*l.* each to the equipment of the metrological laboratory.

A question of importance has arisen as to the performance at the laboratory of tests, partaking of a routine character, on the physical and mechanical properties of specimens of material. To this objection has been taken on the ground of competition with the work of private establishments. In one of its aspects the question is financial. But the executive committee are of opinion that, even if the pecuniary loss were recouped, the efficiency of the laboratory would suffer from the abandonment of this work. While anything like unfair competition with private establishments should be avoided, the execution of tests is good practice for the staff, and tends to keep them in touch with the manufacturers and with the practical problems which may demand examination. In view of the difference of opinion that has manifested itself, the Treasury has decided to appoint a small committee to inquire into the working of the laboratory, with a special reference to this question.

On a former occasion, my distinguished predecessor, Sir William Huggins, directed attention to some of the more important matters on which the society in the past had initiated, supported or given advice about scientific questions in connection with the State, and in other ways had made its influence felt strongly for the good of the country. It would hardly become me, with my short experience of the working of the society, at least in recent years, to pursue this theme. The function of the society which lies most open to the observation of an incoming president is that exercised at the ordinary meetings. I am impressed with the difficulty, arising out of the ever-increasing specialisation of science, in rendering really useful the reading of papers and discussions thereupon. It is, of course, felt more severely in a society like our own, which embraces within its scope the whole scientific field. It not infrequently happens that a paper is addressed to an audience among whom there is no one competent to follow the detailed observations and reasonings of the author. I am sometimes reminded of a saying of Dalton's on similar occasions at Manchester, quoted by Sir Henry Roscoe in his genial and entertaining "Reminiscences":—"Well, this is a very interesting paper for those that take any

interest in it." A little more discretion on the part of readers of papers in having regard to the composition of their actual audience would be helpful here. In some cases experimental illustration would bring home to a larger number what is followed with difficulty from a merely verbal statement. But I am afraid that no complete remedy is within reach.

Increase of specialisation, however inconvenient in some of its aspects, is, I suppose, a necessary condition of progress. Sometimes a big discovery, or the opening up of a new point of view, may supersede detail and bring unity where before there was diversity, but this does not suffice to compensate the general tendency. Even in mathematics, where an outsider would probably expect a considerable degree of homogeneity, the movement towards diversity is very manifest. Those who, like myself, are interested principally in certain departments, and can look back over some forty years, view the present situation with feelings not unmixed. It is disagreeable to be left too far behind. Much of the activity now displayed has, indeed, taken a channel somewhat remote from the special interests of a physicist, being rather philosophical in its character than scientific in the ordinary sense. Much effort is directed towards strengthening the foundations upon which mathematical reasoning rests. No one can deny that this is a laudable endeavour, but it tends to lead us into fields which have little more relation to natural science than has general metaphysics. One may suspect that when all is done fundamental difficulties will still remain to trouble the souls of our successors. Closely connected is the demand for greater rigour of demonstration. Here I touch upon a rather delicate question, as to which pure mathematicians and physicists are likely to differ. However desirable it may be in itself, the pursuit of rigour appears sometimes to the physicist to lead us away from the high road of progress. He is apt to be impatient of criticism whose object seems to be rather to pick holes than to illuminate. Is there really any standard of rigour independent of the innate faculties and habitudes of the particular mind? May not an argument be rigorous enough to convince legitimately one thoroughly imbued with certain images clearly formed, and yet appear hazardous or even irrelevant to another exercised in a different order of ideas? Merely as an example, there are theorems known as "existence-theorems" having physical interpretations, the object of which is to prove formally what to many minds can be no clearer afterwards than it was before. The pure mathematician will reply that, even if this be so, the introduction of electrical or thermal ideas into an analytical question is illogical, and from his own point of view he is, of course, quite right. What is rather surprising is that the analytical argument should so often take forms which seem to have little relation to the intuition of the physicist. Possibly a better approach to a reconciliation may come in the future. In the meantime we must be content to allow the two methods to stand side by side, and it will be well if each party can admit that there is something of value to be learned from the point of view of the other.

In other branches, at any rate, the physicist has drawn immense advantage from the labours of the pure analyst. I may refer especially to the general theory of the complex variable and to the special methods which have been invented for applying it to particular problems. The rigorous solution by Sommerfeld of a famous problem in diffraction, approximately treated by Fresnel, is a case in point. We have moved a long way from the time when it was possible for the highest authority in theoretical optics to protest that he saw no validity in Fresnel's interpretation of the imaginary which presents itself in the expression for the amplitude of reflected light when the angle of incidence exceeds the critical value. In this connection it is interesting to remember that, in his correspondence with Young, Laplace expressed the opinion that the theoretical treatment of reflection was beyond the powers of analysis. The obvious moral is that we are not to despair of the eventual solution of difficulties that may be too much for ourselves.

As more impartially situated than some, I may, perhaps, venture to say that in my opinion many who work entirely upon the experimental side of science underrate their obligations to the theorist and the mathematician. Without the critical and coordinating labours of the latter, we should probably be floundering in a bog of imperfectly formulated and often contradictory opinions. Even as it is, some branches can hardly escape reproaches of the kind suggested. I shall not be supposed, I hope, to undervalue the labours of the experimenter. The courage and perseverance demanded by much work of this nature is beyond all praise; and success often depends upon what seems like a natural instinct for the truth—one of the rarest of gifts.

Copley Medal.

The Copley medal is awarded to Prof. Elias Metchnikoff, For.Mem.R.S., on the ground of his distinguished services to zoology and to pathology, particularly for his observations on the development of invertebrates and an phagocytosis and immunity. From 1866 to 1882 Prof. Metchnikoff's work was exclusively zoological, and mainly during that period he produced a series of brilliant memoirs dealing with the early development and metamorphoses of invertebrates.

Although his name stands in the first rank of investigators of these subjects, the most celebrated of his discoveries are those relating to the important part played by wandering mesoderm cells and white blood-corpuscles in the atrophy of larval organs, and in the defence of the organism against infection by bacteria and protozoa. It was on these researches that he based his well-known "phagocyte theory." Metchnikoff's fundamental observations were made in Messina in 1882, and were published in the following year. In these he showed that the absorption and disappearance of the embryonic organs of echinoderms were effected by wandering mesoderm cells, which devoured and digested the structures which had served their purpose and become effete. The observation that white blood-cells accumulate in an inflamed area after infection by bacteria suggested that these cells might also devour and thus destroy the invading microbes, and that the process of inflammation was really a physiological and protective reaction of the organism against infection. The study of the infection of Daphnia by *Monospora bicuspidata* entirely justified this prediction. The account of the phenomena of infection as seen in this transparent crustacean was published in Virchow's *Archiv* (vol. xcvi.) in 1884, while, later in the same year, Metchnikoff published another paper extending these observations to vertebrates, and showing the universal applicability of his generalisation as to the essential character of the inflammatory process.

During the twenty years which have elapsed since the publication of the "phagocyte theory," Metchnikoff, with the assistance of a host of pupils and disciples from all parts of the world, has been continuously engaged in the study of the reaction of the organism against infection, and in investigating the essential features of immunity in the light of the illuminating generalisation laid down in 1884.

Though of limited range, and therefore inferior in scientific importance to the more fundamental researches carried out by him previously, Metchnikoff's recent work on infection by the microorganism of syphilis and the attainment of protection and immunity against this disease may be mentioned on account of its important practical applications.

It is not too much to say that the work of Metchnikoff has furnished the most fertile conception in modern pathology, and has determined the whole direction of this science during the last two decades.

Rumford Medal.

The Rumford medal is awarded to Prof. Hugh Longbourne Callendar, F.R.S., for his experimental work on heat.

Prof. Callendar has devoted his attention chiefly to the improvement of accurate measurement in the science of heat by the application of electrical methods. His first paper, "On the Practical Measurement of Temperature," Phil. Trans., 1887, paved the way for the application of the electrical resistance thermometer to scientific investigation. In a later paper, written in conjunction with

Griffiths, "On the Boiling Point of Sulphur, &c.," Phil. Trans., 1891, the application of his method was further extended, and a simple method of standardisation was proposed. In continuation of this work Prof. Callendar has written a number of subsidiary papers dealing with details of construction of instruments, and applications to special purposes. The results of this thermometric work have since been confirmed by Chappuis and Harker, Phil. Trans., 1889, at the Bureau International, Paris, and by other observers, and are now generally accepted.

More recent developments in accurate electrical thermometry have been described by Prof. Callendar in later papers. He has also devised a special type of "gas-resistance" thermometer, depending on the increase of viscosity of a gas with temperature, which is the exact analogue of the electrical resistance thermometer, and possesses peculiar advantages for high temperature measurements.

The application of electrical resistance thermometers and thermo-couples to the observation of rapid variations of temperature has been utilised by Prof. Callendar in the study of the adiabatic expansion of gases and vapours, and in the observations of the cyclical changes of temperature of the steam and of the cylinder walls in a steam-engine. The latter research was undertaken in conjunction with Prof. Nicholson, with a view to elucidate the theory of cylinder-condensation.

The researches of Rowland and other experimentalists on the specific heat of water and the mechanical equivalent of heat had shown that grave uncertainties affected the value of this most fundamental physical constant, which could not be removed satisfactorily without a complete investigation of the variation of the specific heat of water between 0° C. and 100° C. Prof. Callendar devised a continuous electrical method of attacking this problem, possessing many important advantages as compared with older methods. He was assisted by Dr. Barnes in carrying out this work, the results of which form the subject of papers by Callendar and Barnes in the Phil. Trans. Roy. Soc., 1901. As an illustration of the probable accuracy of their results it may be observed that, whereas by any of the older formulæ accepted for the variation of the specific heat of water, the values of Rowland and of Reynolds and Moorby for the mechanical equivalent are seriously discordant, they are brought into perfect agreement by the work of Callendar and Barnes.

In the subject of conduction of heat Prof. Callendar has contributed many original methods described in various minor papers, and, in addition to the thermal investigations with which his name is chiefly associated, has carried out some purely electrical researches.

Royal Medals.

One of the Royal medals has been awarded, with the approval of His Majesty, to Prof. Alfred George Greenhill, a fellow of the society, on account of the number and importance of his mathematical investigations produced between the year 1876 and the present time. They embrace a variety of mechanical and physical subjects, including dynamics, hydromechanics, electricity, and gunnery. He is the author of two treatises on hydromechanics, both remarkable for originality of treatment.

The subject, however, to which he has devoted most time and attention is the theory of elliptic functions. His work on this subject may be placed in two classes:—(1) Investigations in which he has extended the subject into new fields, as in the series of memoirs on the "Transformation and Complex Multiplication of Elliptic Functions," contributed to the Proceedings of the London Mathematical Society (vols. xix., xxi., xxv., xxvii.), and in the memoir on the "Third Elliptic Integral and the Ellipsotomic Problem," in the Phil. Trans. (vol. cciii.). (2) Applications to mechanical problems, mainly dynamical, for purposes of calculation or illustration. In this class may be placed his treatise on the elliptic functions, as well as numerous papers in journals and the proceedings of scientific societies.

All Prof. Greenhill's work is characterised by much originality, and by a rare power and skill in algebraic analysis.

His Majesty has also approved the award of a Royal medal to Dr. Dukinfield Henry Scott, also a fellow of the society, for his investigations and discoveries in connection with the structure and relationship of fossil plants. Dr. Scott began the very important work which he has accomplished in this subject by helping the late distinguished palæobotanist, Prof. W. C. Williamson. In this cooperation he greatly enhanced the value of Williamson's work. He not only added many new discoveries, but, what was more important, demonstrated the value of the work in relation to phylogeny.

Dr. Scott has since added much of first-rate importance. He has discovered and elucidated many important types, his work constituting a most valuable acquisition to botany from the evolutionary point of view. It is not only in the accurate investigation of difficult structures that Dr. Scott has been so successful; not the least of his merits lies in the philosophical treatment of the problems suggested by his discoveries. His position as one of the leading palæobotanists in the world is well recognised. He has, both by his personality and by his writings, exercised a well-marked and widespread influence on the work of other botanists. The fact that he has created in this country a vigorous school of palæobotanists may be regarded as an additional claim for the honour now conferred upon him.

Davy Medal.

The Davy medal is given to Prof. Rudolf Fittig, professor of chemistry in the University of Strassburg, who began to publish scientific work as early as 1858, and in 1864 discovered the method for the synthesis of hydrocarbons homologous with benzene, which has ever since borne his name. Up to about 1880 he worked chiefly on benzene derivatives, but his attention was gradually attracted to the study of lactones and acids, both saturated and unsaturated, which has largely formed the subject of his numerous published papers down to the present day.

Fittig has been a remarkably active worker. The Royal Society Catalogue contains under his name alone ninety-six papers, and, jointly with students and others, seventy-one more down to 1883. Since that time a number about equally large has been recorded in the indexes of the chemical journals. The work of Fittig and his students on lactones and acids, and particularly the intermolecular changes which many unsaturated acids undergo, may be said to be classical, and it has had an important influence on the progress of theoretical chemistry.

Darwin Medal.

The Darwin medal has been awarded to Prof. Hugo de Vries, For.Mem.R.S. Prof. de Vries has made a series of important discoveries in connection with the manner in which new races of organisms may originate, and he has materially extended and systematised our knowledge of the laws affecting the results of hybridisation. His work is the outcome of very extensive experiments that have been carried on for many years. He has stimulated numerous investigators, both in Europe and in America, to extend these inquiries, and the results already obtained are of great importance, both from a theoretical and from a practical point of view. De Vries's work has exercised considerable influence on other branches of biology, and has suggested new lines of investigation in many directions.

Hughes Medal.

Mrs. W. E. Ayrton is the recipient of the Hughes medal, which is awarded for original discovery in physical sciences, particularly electricity and magnetism, or their applications. Her work on the electric arc has been described in a paper published in the Philosophical Transactions, and in various other publications.

Mrs. Ayrton's investigations cover a wide area. She discovered the laws connecting the potential difference between the carbons of an arc with the current and with the distance between them, and proved these to apply, not only to her own experimental results, but to all the published results of previous observers. Dealing with the modifications introduced into the arc by the use of cores in the carbons, she found the causes of these modifications. The peculiar distribution of potential through the arc was traced, and its laws were discovered by her.

Having found the conditions necessary for maintaining a steady arc, and for using the power supplied to it most efficiently, she was able to explain the cause of "hissing," and the causes of certain anomalies in the lighting power of the arc.

For the past four years Mrs. Ayrton has been engaged in investigating the causes of the formation of sand ripples on the seashore.

At the annual dinner, the Norwegian Minister, Dr. F. Nansen, proposed the toast of the Royal Society, and Sir William Huggins responded to it. Speeches were also made by Prof. Hugo de Vries, Prof. Callendar, Lord Kelvin, and the Italian Ambassador. In the course of his remarks, Dr. Nansen said:—

Ibsen, my great compatriot, has in one of his works formulated the paradox that the man is strongest who stands most alone. There is certainly some truth in this—nay, there is much truth in it so far as science is concerned. The man who, in the search for truth, goes his own way independently of other men and of other considerations, is certainly the man who is apt to find the greatest and most valuable truth. On the other hand, it is also true that science, more than most other things in life, depends on cooperation, on the help of one's fellow-beings, and this becomes more and more true every day. Many people are apt to forget what science actually is, and what they owe to science, for it is through science that modern society actually exists, and the development of society as it is to-day would be impossible if science were eliminated. Humanity is growing, but if science and the means created by science are not growing humanity certainly will have to look forward to a very miserable future. Therefore the nation that wishes to be cared for must support science and those who carry on scientific work. . . . Science will live her own life, and has done so ever since the days when Prometheus made his fatal expedition to the gods and stole the fire which is more or less burning in every one of us, and cannot be extinguished. There is something sublime in this everlasting fire of science. Generation after generation disappear; the individual is nothing, but always "Watchful in the tower man shall remain in sleepless contemplation."

NOTES.

We regret to have to record the death of Sir Edward J. Reed, K.C.B., F.R.S., on November 30, at seventy-six years of age.

It is announced that this year's Nobel prize for chemistry has been awarded to Prof. H. Moissan, and the prize for physics to Prof. J. J. Thomson, F.R.S. The prize for medicine has been awarded to Prof. C. Golgi, of Pavia, and Prof. Ramón y Cajal, of Madrid.

The Physical Society will hold an exhibition of electrical, optical, and other physical apparatus at the Royal College of Science, South Kensington, on Friday evening, December 14. Admission will be by ticket only.

It is announced that Prof. Gariel has resigned the secretaryship of the council of the French Association for the Advancement of Sciences after having performed the duties for about thirty years.

It is reported from Bombay that experiments in wireless telegraphy carried out between Landi Kotal and Peshawar have demonstrated the fact that the interposition of higher mountains does not interfere with free communication between two places in a mountainous country.

A joint committee has been formed of the county councils of the East and West Ridings of Yorkshire and the county boroughs of Bradford, Hull, Leeds, Rotherham, and Sheffield, to carry out an investigation as to the conditions of the milk supply of the district. The investigation is to be continued for twelve months, and the committee will shortly appoint a bacteriologist to make the necessary examination of samples of milk taken at various stages of transit to the consumer.

The annual meeting of the German Society of Naval Architects was held in Berlin on November 22 in the presence of the German Emperor. A paper was read by Mr. Boveri on the Parsons marine turbine, in which he gave an account of steam-turbine trials in the German Navy. In the discussion that ensued it was urged that steam turbines possess various disadvantages. They render a ship less easy to steer and control; they are more complicated than ordinary engines; and, above all, they are 60 per cent. to 80 per cent. more costly. Notwithstanding these considerations, the large cruiser which is to be laid down next year will be fitted with steam turbines.

No work in medicine is of much use unless it is in living union with the study of the natural history of disease. This was the position taken by Sir Thomas Barlow in the course of some remarks made in opening, on November 28, a new Manchester and Salford Hospital for Skin Diseases. It is only when this purpose is kept in view that any solid advance can be made; it is only by trying to find out the causes and conditions under which diseases come, and by investigating their natural evolution, that real advance can be secured. In devoting a room to study and research, and in fitting it up with modern appliances, the committee of the new hospital has done something to stamp out quackery. In connection with skin disease, English people are very benevolent, but they have not yet learnt, as the people across the Atlantic have learnt, to give money for research; they give plenty of money for asylums and for hospitals, but for research which carries on the study of disease and advances knowledge on sound and progressive lines, that is one of the things which they, practical people as they are, have not yet realised.

The following are among the lecture arrangements at the Royal Institution before Easter:—Mr. W. Duddell, a Christmas course of six experimentally illustrated lectures on "Signalling to a Distance; from Primitive Man to Radiotelegraphy," adapted to a juvenile auditory; Prof. Percy Gardner, two lectures on the sculpture of Aegina in relation to recent discovery; Prof. A. C. Seward, two lectures on survivals from the past in the plant world; Prof. W. Stirling, six lectures on the visual apparatus of man and animals; Dr. W. N. Shaw, two lectures on recent advances in the exploration of the atmosphere; Major P. A. MacMahon, two lectures on the standards of weights and measures; Prof. W. W. Watts, two lectures on (1) the building of Britain, (2) recent light on ancient physiographies; Dr. C. W. Saleeby, two lectures on biology and progress; and Prof. J. J. Thomson, six lectures on Röntgen, kathode, and positive rays. The Friday evening meetings will commence on January 18, when Sir Andrew Noble will deliver a discourse on fifty years of explosives. Succeeding discourses will probably be given by Sir Almroth E. Wright, Mr. J. J. Lister, Mr. Dugald Clerk, Prof. D. J. Hamilton, Prof. J. J. Thomson, and Prof. G. Lunge.

At a recent meeting of the Royal Photographic Society Mr. Thomas Manly described and illustrated his modification of carbon printing, "ozobrome," which is rapidly gaining appreciation. The chief advantage of the new method is that carbon prints can be made without any exposure to light if a "bromide" print of the subject is available. The reduction of the bichromate in the carbon

tissue is effected by the silver image of the print. It is only necessary to soak the hardened bromide print in water and the prepared carbon tissue or "plaster" in a solution that contains a bichromate, a ferricyanide, and a bromide, to squeegee the two together, and leave them for a short time under slight pressure. The pigment plaster is then separated and treated exactly as if it had been exposed to light under a negative. The silver of the bromide print has been converted by the process into a salt, but by treating it with a developing solution it is reduced to the metal again, and by this round of operations it will furnish "ozobrome" prints until it becomes destroyed by the handling. Mr. Manly indicated a collateral advantage of the method in that it is independent of the colour of the pigment in the "plaster," while by the usual method of exposure to light the effect of the exposure penetrates more deeply in the presence of a blue than of a red or brown pigment.

By the death of Emil Schmidt in his seventieth year a typical German anthropologist passes away. Like many of his fellows he studied medicine, and was actually in practice for some twenty years. He first directed his attention to American archæology, and dealt in particular with the Copper age. His anatomical knowledge led him to take up physical anthropology, and he possessed a considerable collection of skulls, now in the Anatomical Institute at Leipzig, where he was for a time a recognised lecturer, and later extraordinary professor. He was among the first to study the human remains at Pompeii, and a stay in Egypt enabled him to make a further study of early historic material. Some years later he visited India and Ceylon; the whole of the material which he then collected was not published, but his "Reise in Sued-Indien" and "Ceylon" contain much valuable information. In the much discussed problem of the Neanderthal skull he accepted, in opposition to Virchow, the view that it is really that of a lower human species or genus; in the question of prehistoric pigmy races, on the other hand, he held that more evidence was needed as a basis for Kollmann's speculations. In consequence of failing health he resigned his professorship in 1900, and occasional contributions from his pen appeared in *Globus* and other papers, but he knew that his life's work was done, and was seldom seen in scientific circles.

We have received from the author, Mr. J. A. Kershaw, of the Melbourne Museum, a copy of a paper on additions to the fish-fauna of Victoria, published in the *Victorian Naturalist* for October. Not any of the species are new.

The record of fourteen years' continuous breeding of the marsh-warbler in an Oxfordshire parish forms the opening article of the November *Zoologist*, the present year being the first since 1892 in which Mr. W. W. Fowler has been unable to discover a nest of the species. Ornithological notes made in Oxfordshire in 1904 form the subject of an article by Mr. O. V. Aplin, while Mr. E. Selous discourses on sexual selection in the ruff.

The slow-lorisis (Nycticebus) of the Indo-Malay countries, all of which have hitherto been generally regarded as members of a single variable species, are divisible, according to Mr. M. W. Lyon (Proc. U.S. Nat. Mus., No. 1494), into two distinct groups, in one of which a distinct sagittal crest is developed on the skull of the adult, while in the other no such ridge occurs. The second group occurs only in Borneo and Banka, and appears to be further characterised by having only one (in place of two) pair of upper incisor teeth.

Copies are to hand of the second part for 1905, and of the first part for 1906, of the *Verhandlungen des naturhistorischen Vereins* of Prussian Rhineland, Westphalia, &c., published at Bonn. The contents of the former include articles on a peculiar rock, essexit (heptorite), from Siebengebirge, on a portion of the Mayence Tertiary basin, on the ostracods of the Brunswick district, on the extinction of *Planaria alpina* in certain districts, and on some rare or exterminated plants of Rhineland. The issue for 1906 is occupied by the first portion of a synopsis of the birds of the Rhine Province, by Dr. Otto le Roi, of Bonn.

We have received Heft ii. and iii. of the "Meeresfauna von Bergen," edited by Dr. A. Appellöf (Bergens Museum, 1906, pp. 75–233, four plates, and three maps). In the first memoir Mr. O. Nordgaard reports on the Bryozoa of the west coast of Norway; in the second memoir Dr. Appellöf discusses the decapod crustaceans of the same region, with particular reference to their vertical and horizontal distribution. It is shown that conditions of temperature and salinity are of fundamental importance in determining the distribution, though other factors, such as pressure, nature of the bottom, illumination, and chemical composition of the water are also operative.

The origin of species, more especially in connection with variation and Mendelism, forms the leading feature of the issue of *Verhandlungen der Schweiz. Naturfor. Gesellschaft* for the present year. The articles on this subject relate to the evolution of species generally, Mendelism as exemplified by hybridising garden and other snails, variation in butterflies, mutation in the harts-tongue fern, and species-formation among bacteria and parasitic funguses. In the case of the garden snail (*Helix hortensis*) Dr. Arnold Lang shows that by crossing members of uniformly yellow-shelled colonies with the fully-banded strain it will be found that the progeny follows to a great extent the Mendelian law in regard to the numerical proportions of the various colour-phases. The issue concludes with a number of biographies of scientific men, accompanied by portraits.

The most generally interesting article in the October number of the *Emu* is one by C. L. Barrett, of Melbourne, on the origin of parasitic habits in cuckoos. It is stated that one American species (*Coccyzus americanus*), which is generally in the habit of building a nest and hatching its own eggs, occasionally lays in the nests of other birds. Another instance of the commencement of the parasitic habit is afforded by the Indian hawk-cuckoos of the genus Hierococcyx, five species of which lay in the nests of babbling thrushes, while the sixth is reported to make a nest of its own. In reference to the frequent resemblance between the eggs of cuckoos and those of the birds on which they are parasitic, the author cites a theory that the food of nestlings has much to do with determining the colour of the eggs which they may subsequently lay. "If such be the case," he observes, "it goes far to explain the similarity between the eggs of many species of cuckoos and those of their foster-parents." The argument is, however, scarcely carried far enough, for it is obvious that, if true, the explanation will likewise apply to "hedgesparrow-cuckoos" and "wagtail-cuckoos" in the case of the European species.

A FEW days' stay at the island of Ascension when the Scottish National Antarctic Expedition was returning home provided an opportunity for exploration. Mr. R. N. R. Brown furnishes an account of his botanical observations and collections to the second part of vol. xxiii. of the Transactions and Proceedings of the Botanical Society of Edinburgh. Of the four phanerogams regarded as indigenous, only *Portulaca oleracea* and *Euphorbia origanoides* were found, but of the cryptogams collected four provided new records for the island.

A NEW Russian botanical journal, representing the botanical section of the Imperial Society of Naturalists of St. Petersburg, has been inaugurated under the editorship of Mr. B. Fedtschenko. The first number contains a description, by Mr. W. Sukatscheff, of a new variety of *Pinus Pityusa* from the Crimea, and an ecological account of the flora of the province of the Don Cossacks is contributed by Mr. W. Droboff. A feature of some interest in the latter is the occurrence of *Utricularia minor, Sparganium minimum, Eriophorum latifolium*, and other northern types.

SEVERAL contributions concerned with the determination of Philippine plants are published as a fourth supplement to the first volume of the *Philippine Journal of Science*. The list of new asclepiads determined by Dr. R. Schlechter includes species of Tylophora, Dischidia, and Hoya, and the same writer describes an endemic Burmannia allied to *Burmannia nepalensis*. The Acanthaceæ were identified by Mr. C. B. Clarke, and the Myrsinaceæ by Prof. C. Mez. Among the second series of grasses named by Prof. E. Hackel are a curious Chionachne and a species of Ischæmum. A second list of ferns contributed by Dr. E. B. Copeland contains, among others, new species of Schizoloma, Athyrium, and Polypodium, and a collated list of Philippine fungi, prepared by Mr. P. L. Ricker, is also published.

IN the Transactions of the Institution of Engineers and Shipbuilders in Scotland (vol. l., part i.) there is an able article on the development and present status of the steam turbine in land and marine work by Mr. E. M. Speakman. The author gives some valuable general considerations affecting their adoption, and incidentally points out that, while the solution of the gas-turbine problem does not seem entirely impossible, little or no direct development can be expected until numerous difficulties of a practical nature have been overcome.

A THIRD report on the geological features and mineral resources of the Pilbara goldfield, by Mr. A. Gibb Maitland, has been issued as Bulletin No. 23 of the Geological Survey of Western Australia. It covers ninety-two pages, and is accompanied by seven geological maps and thirteen illustrations. It completes the descriptions of those mining centres in the goldfield to which no reference was made in the previous two Bulletins, and includes full details of the gold-mining districts of Tambourah, Western Shaw, Northern Shaw, and Just-in-Time, as well as of the tinfields of Wodgina and Cooglegong. It contains, in addition, an able summary of the mineral resources and future prospects of the whole goldfield. If prospecting operations are carried on with due regard to the geological conditions, there can be no doubt that the district will continue to be a gold, tin, and tantalite producer. The various tantalates and niobates of the rare earths, which exhibit marked radio-active properties, have been found to occur as primary constituents of the pegmatites such as are found at Wodgina. It is probable, therefore, that careful search may result in the discovery of various radio-active minerals. As minerals of subordinate importance, diamonds, scheelite, asbestos, and argentiferous lead ores are met with. Iron ores occur plentifully throughout the district, but at present such ores, though of high grade, are entirely beyond the reach of commercial enterprise.

VOL. xxxvii. of the *Sitzungsberichte* of the Physico-medical Society of Erlangen for the year 1905 shows a very marked increase in the activity of the society as compared with previous years. The following papers may be noticed as possessing special interest:—a detailed investigation of electric discharges, by Mr. R. Reiger (pp. 1–130); a series of papers by Prof. E. Wiedemann dealing with the history of science, and referring in particular to the early scientific knowledge of the Arabs; details of the determination of the atomic weight of tellurium by Mr. A. Gutbier, and of bismuth by Mr. H. Mehler; and a paper on radio-tellurium by Mr. F. Henrich.

SINCE the first X-ray tube was constructed by Prof. Röntgen, many modifications have been introduced of greatly increased efficiency. The most recent improvements have been directed to the purpose of making the vacuum adjustable, so as to be able to convert, for instance, a tube which has become very "hard" into a tube of a "softer" character. Mr. Rosenthal, of Munich, describes in the *Verhandlungen* of the Berlin Röntgen Congress, 1906, a new type of tube, in which, it is contended, the character of the vacuum does not undergo variation at all after prolonged working. The principle consists in absorbing all those rays which emanate from the anti-kathode and are not true Röntgen rays, by an internal aluminium "filter"; these rays do not, therefore, strike the glass walls of the tube or produce the customary heating and chemical effects which cause the vacuum to change. It is claimed that the new device is a really substantial improvement, both as regards convenience and economy.

AN interesting study of the question whether an enzyme is capable of possessing more than one kind of activity is contained in a paper by Messrs. L. Marino and G. Fiorentino published in the *Gazzetta* (vol. xxxvi., ii., p. 395). It is contended that the maltase of malt, free from emulsin and invertase, is capable, not only of decomposing maltose, but also of hydrolysing the natural and artificial glucosides which are susceptible to the action of emulsin. The absence of the latter in the maltase is held to be proved by the fact that the enzyme recovered after the action of maltase on amygdalin has taken place is almost without effect on salicin, whereas if a trace of emulsin is added to the maltase the enzyme recovered under similar conditions almost completely hydrolyses salicin. The activity of maltase appears, indeed, to be destroyed by the products of the hydrolysis of amygdalin, whilst the latter do not affect emulsin. The maltase of malt seems to be very similar to the maltase of beer yeast, as it is capable, like the latter, of producing the same isomaltose synthetically from glucose; but it differs from it in hydrolysing the β, not the α-glucosides.

THE formation of hydrocyanic acid in plants, which was first investigated in the case of bitter almonds by Liebig and Wöhler in 1837, has recently attracted attention owing to the discovery by Prof. Dunstan and Dr. Henry in certain fodder plants, known to cause cattle poisoning, of definite

glucosides susceptible of decomposition by specific enzymes with the production of the highly-poisonous prussic acid. In a communication to the Royal Academy of Belgium (Bulletin No. 8, p. 613) M. P. Fitschy adds another half-dozen common plants to the number of those already known to produce prussic acid in the early stages of their growth. Among the Ranunculaceæ are *R. repens* and *R. arvensis*, and among the grasses *Gynerium argenteum*, *Melica altissima*, *M. nutans*, *M. uniflora*, and *M. ciliata*. It remains to be ascertained whether the prussic acid is originally elaborated in each plant in the form of a definite glucoside, and whether a specific enzyme is responsible for its decomposition.

A NEW edition of Mr. Sidney Lupton's "Numerical Tables and Constants in Elementary Science" has been published by Messrs. Macmillan and Co., Ltd. The present issue is substantially similar to the last edition, but a few values have been corrected, and an addendum of two pages contains important values and constants recently obtained.

A SUPPLEMENT to the report of the Rugby School Natural History Society for the year 1905 has been published. It contains a paper by Mr. G. L. Keynes on a late Roman settlement near Somersham, Hunts, and is illustrated with photographs and drawings of the objects found during the excavation of the settlement.

MESSRS. BRADY AND MARTIN, LTD., of Newcastle-upon-Tyne, have issued the seventh edition of their well-arranged catalogue (pp. 700) of scientific apparatus. This enterprising firm is prepared to supply instruments and material for the practical study of all branches of science, and teachers will do well to examine the volume when selecting apparatus or accessories for lecture-room or laboratory.

THE use of models for the teaching of solid geometry forms the subject of two articles by M. Charles Playoust in *Cosmos* for September 8 and 15, the object being to show how easily models can be constructed out of cardboard or with strings by a teacher or student, in cases where the cost of a set of proper models would be prohibitive.

AN English version of Prof. H. Poincaré's articles on "The Value of Science" is appearing month by month in the *Popular Science Monthly*. The November article deals with "The Notion of Space." A German translation of the same book by Prof. and Frau Weber, of Strassburg, has been published by Teubner, of Leipzig.

OUR ASTRONOMICAL COLUMN.

DISCOVERY OF A NOVA.—Circular No. 121 of the Harvard College Observatory contains an account of the discovery, by Miss Leavitt, of a new star in the constellation Vela. This object was discovered on a plate taken with the 1-inch Cooke lens on December 5, 1905, and also on fourteen plates taken between that date and June 29, 1906. Its position, for 1900, is

R.A. = 10h. 58m. 20s., dec. = −53° 50′·9.

On a plate taken on July 12, 1905, showing stars down to magnitude 11·5, Nova Velorum is not to be found, nor did it appear on the 127 plates of this region taken between 1889 and December, 1905, all of which have been examined and found to show stars down to the eleventh magnitude.

So far as can be determined from the Harvard plates, the greatest magnitude attained by this Nova was 9·72, the magnitude on December 5, 1905, and January 26, 1906. There were considerable fluctuations of light during the period covered by the observations, and Prof. Pickering thinks there is little doubt that the object observed is actually a Nova.

COMETS 1906*g* AND 1906*h*.—Observations of these two comets are recorded in Nos. 4135–6 of the *Astronomische Nachrichten*. Observing at Arcetri, Prof. Abetti saw comet 1906*g* as a round, uniform nebulosity of 2′ diameter, in which neither nucleus nor any trace of a tail could be discerned. Prof. Ambronn, at Göttingen, found a feeble condensation, but no nucleus, on November 19. According to Prof. Nijland, the magnitude, as estimated from an opera-glass observation on November 19, was 7·7.

A set of elements computed by Herr M. Ebell for comet 1906*h*, and published in Circular No. 94 from the Kiel Centralstelle, shows that this body passed through perihelion on September 15. The Circular also gives an ephemeris from November 26 to December 16, which shows that the comet's brightness is decreasing.

OBSERVATIONS OF NOVA SAGITTARII.—Since May 10, 1899, Prof. Barnard has observed Nova Sagittarii on many occasions with the 40-inch refractor at Yerkes, and now publishes the results in No. 4136 of the *Astronomische Nachrichten*. This Nova was discovered from the Harvard photographs, of which one, taken on March 8, 1898, showed it to be of magnitude 4·7. Prof. Barnard's observations gave the following magnitudes for the mean dates of the years named:—1899, mag. 11·0; 1903, mag. 13·8; 1906, mag. 14·8. From these it appears that the Nova may fade entirely from view in the next few years. The published positions of this star seem rather discordant, so Prof. Barnard has investigated the matter, and gives data which will prevent the position of the Nova from being mistaken. The appearance of the Nova in the 40-inch telescope is that of a very small nebula, or hazy star, about 1″ in diameter. Extending the focus about one-quarter of an inch seemed to improve the definition, but still left the image of the Nova hazy, something like the abnormal stars in the cluster M13 Herculis.

TWO STARS WITH VARIABLE RADIAL VELOCITIES.—From spectrograms taken at the Potsdam Observatory, Prof. Hartmann has discovered that the two stars RZ Cassiopeiæ (an Algol variable provisionally designated 77.1906 Cassiopeiæ) and γ Cassiopeiæ have variable radial velocities. In the former case the spectrograms show a variation between +33·1 km. (October 1, 1906) and −111·9 km. (October 4, 1906), the first value obtaining about one-quarter of the star's period before, and the second about the same length of time after, the minimum. The measures of the spectrograms of γ Cassiopeiæ gave values between +3·1 km. (September 21, 1900) and −19·3 km. (September 27, 1901). Owing to the hazy character of the lines in the spectrum of this star, the resulting velocities are somewhat uncertain (*Astronomische Nachrichten*, No. 4135).

GRAPHITIC IRON IN A METEORITE.—In an extract (No. 1497) from the Proceedings of the U.S. National Museum Mr. W. Tassin describes the physical and chemical properties of a nodule of graphitic iron found in the Canyon Diablo meteorite. The mass was found on examination to be a septarian nodule, the septa consisting of native metals similar to the mass of iron. The interseptal portions consist of crystalline graphitic and amorphous carbon, mixed with a very fine granular or scaly troilite. There is also present a lustrous metallic substance differing from cohenite in that it is soft enough to leave a mark on white paper, is dark steel-grey in colour, and occurs in angular, foliated masses. Chemical analysis showed that this material contained iron (88·8 per cent.), nickel (4·0 per cent.), silicon (2·0 per cent.), carbon (4·3 per cent.), phosphorus (0·9 per cent.), and a trace of cobalt.

NEW VARIABLE STARS.—In No. 4126 of the *Astronomische Nachrichten* Prof. Max Wolf announces the discovery of thirty-one new variable stars in the region about β Cygni. The variability of these objects was discovered from plates taken with the Bruce telescope with exposures ranging from 150 to 220 minutes. A number of separate charts show the positions of these stars.

RECENT PROGRESS IN MAGNETO-OPTICS.[1]

IT is my intention this evening to give you a general review of the experimental researches which have occupied me during the last few years. They all refer to the relation between magnetism and light, a relation the first and fundamental example of which was discovered in this very institution by Faraday in 1845.

Surely every physicist should feel inspired by the idea of having the privilege to address an audience in the same lecture room, where so often some of nature's deeper mysteries were revealed; and I feel the uplifting force of this inspiration all the stronger, as my own work for many years has been so closely connected with one of Faraday's discoveries. Faraday discovered that the plane in which the vibrations of light take place *rotates* whenever a ray of light is propagated parallel to the magnetic lines of force through some substances, such as Faraday's own heavy glass; this fact we now indicate by the term the magnetic rotation of the plane of polarisation. The discovery of this fact opened the chapter of magneto-optics.

Faraday's mind again and again returned to the relation between magnetism and light, and incessantly he sought for closer and more intimate connections; in one experiment in March, 1862 (which is said to have been his last), he tried to observe a change in the spectrum of a flame when acted on by a magnet. The entry in Faraday's notebook, preserved in this institution with pious care, concludes with the words, "not the slightest effect on the polarised or unpolarised ray was observed." As we now know, the means of Faraday's time were not powerful enough to observe the effect sought for. Various physicists since Faraday have sought in the same direction; some have recorded their negative results, others have not, for most physicists have an almost invincible dislike for the publication of negative results, though a collection of such unsuccessful attempts, if precisely stated, would be most interesting, and should afterwards prove very valuable.

Magnetisation of the Spectral Lines.

In my own case, the thought to submit a source of light to the influence of magnetism occurred to me during a quantitative investigation of the effect discovered by Kerr concerning the light reflected by magnetised mirrors. I was working at the time in Leyden, in Prof. Onnes's laboratory. The account of Faraday's negative experiment encouraged me in my endeavours, and also an argument in 1856 by Lord Kelvin, referred to by Maxwell as the "exceedingly important remark of Sir W. Thomson." If it might be accepted that the forces operating during the propagation of light in magnetised substances exist also whenever the source of light is in the magnetic field, we can expect some direct effect of magnetism on radiation.

My own successful experiments date from 1896 to 1897, whereas three years earlier I also had recorded a negative result, not having then used adequate means.

As you know, a sodium flame chiefly emits two kinds of yellow light, and accordingly its spectrum, when analysed with one of Rowland's large concave gratings, shows two yellow lines. With a grating of medium size these lines have a distance of one millimetre; they are rather narrow as shown in the slide. In August, 1896, I found that when a sodium flame is placed between the poles of an electromagnet, and is looked at with a spectroscope in a direction at right angles to the lines of force, the yellow lines in its spectrum become somewhat wider when the magnetic field is put on.[2] This fact can be expressed in a different way by saying that, besides the original vibrations, a flame in a magnetic field emits other vibrations, of which some have a somewhat greater, and some a somewhat smaller, frequency than the original vibrations.

This observation of a small change in a spectral line was the origin of my subsequent work. I realised that this change, however small, was worth a closer examination. Indeed, it seemed clear at once that here we had a means of studying the internal vibrations of a molecule by modifying in a simple way the conditions under which they are going on. Of course, the result was verified in all directions. As there is now, I think, no doubt as to the reality of the observed changes, I shall only refer very briefly to this stage of the work. In the first place, the widening of the lines was observed in the direction of the lines of force also. Then the fact was established that to the observed *direct* effect there corresponds an *inverse* one. When white light traverses the incandescent sodium vapour we observe the absorption lines; these also are widened when the vapour is subjected to magnetic forces. Secondary influences were discarded by suitable modifications of the experiments. In one case no change was observed. The spectra of fluted bands, such as those of iodine, carbon, or nitrogen, did not show any effect, nor could Becquerel and Deslandres using increased power discover it.

Before I could answer the different questions which presented themselves, I had the advantage that the beautiful theory of the electromagnetic and optical phenomena, developed by my friend Prof. Lorentz, gave its quickening influence to my experimental work.

In this theory it is supposed that the material world is built up of three things: ponderable matter, ether, and electrons. I think it is rather superfluous to remind you here, in the land of Maxwell, Kelvin, Crookes, J. J. Thomson, Schuster, Larmor, Heaviside, and Johnstone

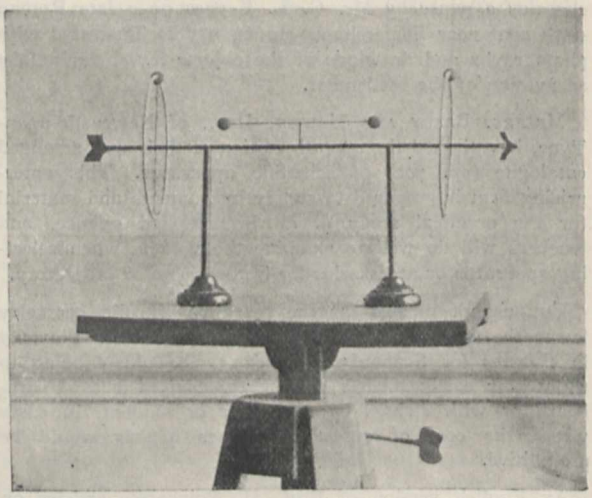

FIG. 1.

Stoney, that electrons or corpuscles are exceedingly small, electrically charged particles, which are supposed to be present in all material bodies.

These electrons can perform oscillations under the influence of the forces which attract them to their position of equilibrium. Because they are electrified they have sufficient hold on the ether to excite in it the electromagnetic vibrations which, according to Maxwell's theory, constitute light. The oscillatory periods of the electrons determine the position of the lines in the spectrum, and with every change in the period of oscillation we observe a displacement of the corresponding line.

In Lorentz's theory the explanation of the effect of a magnetic field is as simple as it is beautiful.

The forces operating on the vibrating electron in a magnetic field are fairly well known. These forces are the same which curve the path of the kathode rays in a vacuum tube which is acted on by a magnet. All motions of the electrons in the molecules of a flame may be supposed to be made up of three particular motions, chosen in such a manner that the action of the magnetic field on each of them can be easily foreseen. The light of the flame is exactly the same as it would be if the flame contained three groups of electrons vibrating in these simple ways. In this model the electrons are represented by red balls; the black arrow indicates the direction of the magnetic force (Fig. 1).

[1] Discourse delivered at the Royal Institution on Friday, March 30, by Prof. P. Zeeman.

[2] Zeeman, Verslagen Kon. Akademie v. Wetenschappen, Amsterdam, October and November, 1896. *Phil. Mag.*, March, 1897.

As a first simple motion we choose a vibration parallel to the lines of force. On the group of electrons which possess this motion the magnetic force has no influence; the period, which we call T, remains unmodified. The other two simple motions are circular motions, clockwise or anti-clockwise, in planes perpendicular to the lines of force.

An electron performing either of these rotations will be acted on by a force which is directed towards or from the centre, dependent on the direction of the rotation. The magnetic field must, therefore, cause the speed of the electron either to increase or to decrease, and so will either diminish or increase the period. Therefore, instead of one motion with period T, we get under the influence of the field three motions with periods T, $T+v$, $T-v$, v being a small quantity. To each motion of the electrons there corresponds a luminous vibration, according to the electromagnetic theory of light. Observing with a spectroscope we must, therefore, see each spectral line divided into three lines; each line becomes a *triplet*.[1]

I will show you a few examples of lines which are really divided into three components, in accordance with Lorentz's theory (Fig. 2, iron; Fig. 3, part of iron spectrum).[2] You will notice that each of the components remains very narrow; it is not a hazy effect, but a very definite one. This certainly would not be the case if all molecules did not behave in the same manner, and if certain conditions of isotropy of the molecules were not fulfilled.[3]

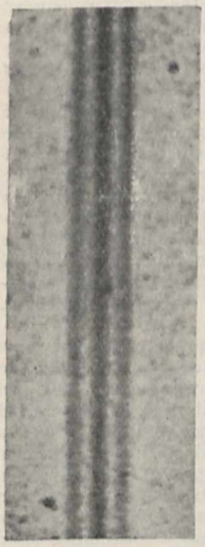

FIG. 2.

The consideration of the model may illustrate some other points which were foreseen by Lorentz's theory. Consider the light emitted at a right angle to the lines of force. The three kinds of light seen in this direction are each due to vibrations of one kind, and therefore polarised. We can, therefore, extinguish the light of the central component, or of the two external components, of the triplet by a Nicol. In one half of the slide shown the external components are extinguished; in the other half the central one. So, for the first time, we were now able to get polarised radiations from the molecules of a gas. All attempts to produce such simple vibrations from gaseous molecules had hitherto failed.

With some lines the central component and the outer ones differ much in intensity. If this be the case the spectroscope can be dispensed with entirely, and we may observe a partial polarisation of the light emitted by the vapour in the field as found by Egoroff and Georgiewsky. We shall now consider the light emitted in the direction of the lines of force (Fig. 4).

It is seen at once that each line must split up into two components. Moreover, both lines must be circularly polarised, but in opposite directions. With suitable arrangements, in one half of the field of view the one, in the other the second, component can now be extinguished. I observed this circular polarisation for the first time in the case of the sodium lines now shown. You see how complete the circular polarisation is. There is no trace of rectilinear or of elliptic polarisation.[4]

When I first looked for this circular polarisation, I did not have the field of view divided into two parts, but the position of the line was determined by means of a spider's thread. On the reversal of the magnetising current the luminous line moved. I do not wish to disguise the fact that no observation has ever afforded me so much pleasure as this one.

It has already been remarked that we can also study the absorption lines which become visible when white

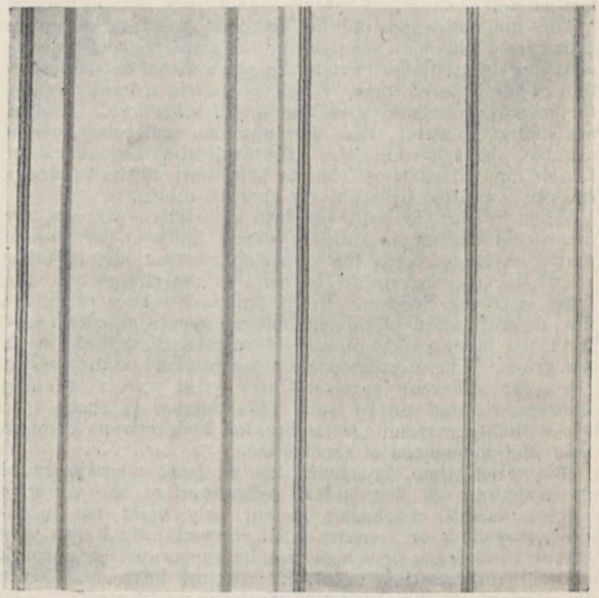

FIG. 3.

light is transmitted through the vapour. We then study the inverse effect. I shall use it to show you at least something directly depending upon the effect, because the effect itself is too young to appear before so large an audience. The inverse effect for light parallel to the lines of force plays a part in an experiment due to Righi.[1] Consider a horizontal ray parallel to the axis of an electromagnet with pierced poles, and let crossed Nicols be placed

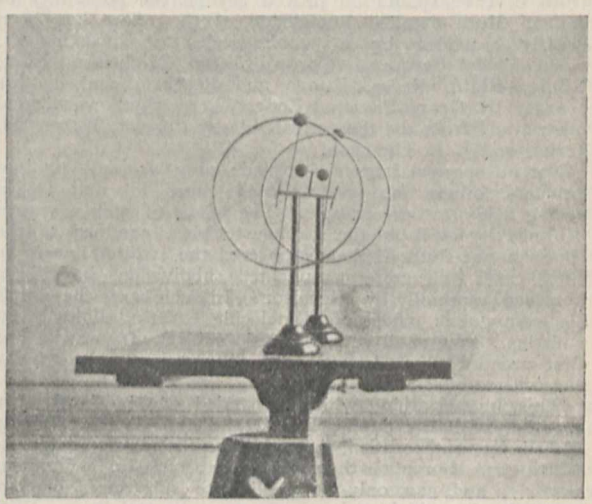

FIG. 4.

before and behind the instrument, as in Faraday's experiment. A sodium flame in the field emitting two kinds of circularly polarised rays absorbs these same radiations, but does not stop the radiations polarised in the opposite

1 Zeeman, Verslagen Kon Akademie v. Wetenschappen, Amsterdam Mei, Juni, October, 1897. *Phil. Mag.*, July and September, 1897.

2 The photographs illustrating this lecture are, excepting the diagrams, enlarged copies from negatives. The scale is different in the various cases. The separation of the outer components is of the order of one-sixth of the distance of the sodium lines (the vertical lines in Fig. 5). No. 2 is a copy of one of the first photographs I obtained. The author is indebted to Prof. Runge for No. 11. The nonet is not distinctly shown in the latter reproduction. In the Proceedings of the Royal Institution some additional Figs. will be reproduced.

3 Lorentz, *Annalen der Physik*, Bd. 63, p. 278, 1897.

4 *Cf.* Larmor, "Aether and Matter," p. 345, 1900.

1 Righi., *C.R.*, cxxvii., p. 216, 1898. *C.R.*, cxxviii., p. 45, 1899. *Nuovo Cim.* (9), 8, p. 102, 1898.

direction. These remaining circularly polarised rays cannot be extinguished by a Nicol.

The brilliant yellow spot which appears on the screen as soon as the current is put on is due to such rays. The explanation of this experiment is not complete, however, at least not for denser vapours. The Faraday rotation of the plane of polarisation then plays a part, as we shall see further on.

The magnetisation of the spectral lines allows us to determine whether positive or negative electrons are vibrating in a flame. From the phenomena in the direction of the lines of force, it follows that in a luminous gas *the negative* electrons give rise to all vibrations. It does not follow, however, that the luminous molecules have a negative charge. On the contrary, the researches of Lenard and Stark show that at least part of the luminous spectra is emitted by positively charged atoms.

When a line is split up into a triplet, we can, by measuring the amount of the effect, find out how much matter is loaded with the revolving electron, or, in other words, we can determine the ratio of the charge e to the mass m of the electron. In this manner I have made the first determination of this notable number e/m, and found it of the order of magnitude of 10^7 electromagnetic units per gram.[1] The most accurate measurements of the present time for different spectral lines yield values ranging between 1·4 and 1·8 by 10^7. This number is about 1500 times the corresponding number for hydrogen as deduced from the phenomena of electrolysis.

We must, then, conclude that at least a majority of spectral lines is due to the vibrations of the negative electron. This conclusion is not only valid for incandescent sodium or mercury. All elements which can give colour to a flame or which can be evaporated in a spark show the magnetisation of the spectral lines, and hence in all elements these negative electrons are present

Independent experimental evidence for the existence of electrons has been derived from the study of the kathode rays in a vacuum tube. The discontinuous structure of electricity was also proved by other phenomena, and in this way physicists were led by purely experimental methods to the negatively charged corpuscle of J. J. Thomson, 1500 times smaller than the hydrogen atom, in full accordance with the electron necessitated for the explanation of the magnetisation of the spectral lines.

All fundamental characteristics of the magnetic resolution of the spectral lines were then explained, and the truth of the explanation proved beyond the possibility of doubt. More detailed knowledge of the effect has been greatly extended by a whole series of investigators, especially by Becquerel, Cornu, Cotton, Michelson, Kent, König, Righi, Reese, Runge and Paschen, and in this country by Gray, Preston, Lodge, Lord Blythswood, and others, and from the theoretical side by Larmor, Fitzgerald, Jeans, and J. J. Thomson.

Not all spectral lines are tripled; some are split up into quartets, others into sextets. The lines D_1 and D_2 in strong fields are an example. The whole of such a system of lines is, even in the strongest fields, confined to the space of one-sixth of the distance of the sodium lines. In some cases still more complicated subdivisions have been observed, especially by Michelson. In such cases the simple electromagnetic model of a molecule emitting light is insufficient. We shall return to this subject afterwards, and first proceed to a discussion of *phenomena accompanying the inverse effect.*

This investigation, which I carried out in Amsterdam together with my pupils, Drs. Hallo and Geest, was suggested by a theoretical investigation by Prof. Voigt, of Göttingen. Lorentz's theory relates to one single vibrating particle, and can only be applied to substances of very small density which emit very narrow spectral lines. With greater density, and therefore broader spectral lines, the mutual influence of the molecules must be taken into account. It seems, however, that a theory of emission of a system of reciprocally reacting molecules is rather difficult. In the case of absorption the problem is easier, and is considered by Prof. Voigt in his theory of magneto-optical phenomena.[1] He does not deal with the electrons directly, but adds suitable new terms to the equations of motion in an absorbing medium. His method establishes a connection between the rotation of the plane of polarisation and the resolution of the spectral lines, a connection almost simultaneously pointed out by Fitzgerald. This also led to an interesting result, until then missed by the electronic theory, namely, rotation of the plane of polarisation close to an absorption band.

(To be continued.)

[1] Zeeman, Verslagen Kon. Akademie, Amsterdam, November, 1896, § 23.

[1] Voigt, *Annalen der Physik*, Bd. 67, S. 345, 1899.

MINERAL RESOURCES OF THE UNITED STATES.

FROM time to time we have directed attention to the variety and magnitude of the work being carried on by the United States Geological Survey. Of all the work undertaken, none is of greater value to the general public than that of the division of mining and mineral statistics under the able direction of Dr. David T. Day, whose masterly report (Washington, 1905) on the mineral resources of the United States for 1904 has recently been issued. The volume covers 1264 closely printed pages, and in arrangement and scope is similar to the twenty preceding annual reports of the series. Each chapter is a census of the productive features of the industry under discussion from the pens of statistical experts. The figures dealt with are stupendous. In 1904, for the fifth time, the total value of the mineral production of the United States exceeded the sum of 200,000,000*l.*, and it is curious to note that the value of non-metallic minerals exceeded that of metallic minerals by 41,000,000*l.* Iron ore and coal are the most important of the mineral products. Statistics of the production of moulding sand were collected for the first time in 1904. Another novelty is a report, written by Mr. H. H. Hindshaw, directing attention to the occurrence of peat in the United States and to its possibilities as a source of fuel. Appended to the report is a useful bibliography of the subject. Tin ore was produced commercially, though in small quantities, in South Carolina, South Dakota, and Alaska.

There is a constant increase in the demand for such abrasives as corundum and emery, and consequently the publication of Bulletin No. 269 (Washington, 1906), on corundum and its occurrence and distribution in the United States, by Mr. J. H. Pratt, is a welcome addition to technical literature. It is an enlarged edition of Bulletin No. 180, published in 1901, and has grown from 98 pages to 175 pages. It is admirably illustrated with eighteen plates, and constitutes a complete monograph on the three varieties, sapphire or gem corundum, corundum, and emery. All the occurrences in the United States are described, and particulars are added regarding the distribution of corundum in other countries, the methods of mining and cleaning, and the uses of corundum. In conclusion, some useful suggestions to prospectors for chromium are given.

The most remarkable outcome of the recent work of the mining division is the extensive series of tests of the various coals found in the United States. These are recorded in three bulky quarto volumes forming Professional Paper No. 48 (Washington, 1906), and covering 1492 pages. The work was carried out at the coal-testing plant of the United States Geological Survey at the St. Louis Exhibition under the direction of a committee consisting of Messrs. Edward W. Parker, Joseph A. Holmes, and Marius R. Campbell. The first volume describes the field work, classification of coals, and chemical work; the second deals with boiler tests; and the third with producer-gas, coking, briquetting, and washing tests. The results are of far-reaching importance in the solution of the fuel and power problems upon which the varied industries of the United States depend. Most of the American bituminous coals and lignites can, it was found, be used as a source of power in a gas-producing plant, the power efficiency of bituminous coals when thus used being two and a half times greater than

their efficiency when used in a steam-boiler plant. Some of the lignites from undeveloped, but extensive, deposits in North Dakota and Texas showed unexpectedly high power-producing qualities, and it is shown that certain of the dry, non-coking, bituminous coals and semi-anthracites, which are now almost wasted, can be converted into useful fuel by briquetting. The work of the chemical laboratory in connection with the sampling of the coal has undoubtedly set a standard for similar work in the future. The total sum appropriated for the work by the United States Government was 12,000*l*.

The United States Geological Survey has undertaken a far-reaching investigation of all the lead and zinc deposits in the Mississippi valley. A large part of this field has been investigated by the Wisconsin Geological Survey, and an interesting report on the ore deposits, with an atlas of eighteen detailed maps, has been published by Mr. U. S. Grant (Bulletin No. xiv., Madison, Wisconsin, 1906). The results brought out by these maps in regard to the relations and origin of the ore are extremely satisfactory, in that they show that a large portion of the ore deposits are confined to the structural basins.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The voting on the proposed new regulations for the mathematical tripos will take place at a Congregation to be held on Friday and Saturday, February 1 and 2, 1907.

The general board of studies has recommended (1) that a university lecturer in hygiene be appointed, in connection with the special board for medicine, with an annual stipend of 100*l*. payable out of the funds in the hands of the State Medicine Syndicate; (2) that a university lecturer in pathology be appointed, in connection with the special board for medicine, with an annual stipend of 100*l*. payable out of the common university fund.

The general board of studies has approved Mr. E. W. Barnes, Trinity College, for the degree of Doctor in Science.

PROF. M. E. SADLER will distribute the prizes at the Merchant Venturers' Technical College, Bristol, on Thursday, December 20.

LORD MONKSWELL will distribute the prizes and certificates to students at the Borough Polytechnic Institute on Tuesday, December 11, at 8 p.m.

A GIFT having the annual value of 500*l*. a year has been made to the University of Paris by Mr. Andrew Carnegie for scholarships to be awarded for the purpose of carrying on research in the laboratory of Mme. Curie.

A STATUE of the late Principal Viriamu Jones, F.R.S., first principal of the University College of South Wales and Monmouthshire, and the first senior Vice-Chancellor of the University of Wales, was unveiled at Cardiff, on December 1, by Viscount Tredegar.

A DEPUTATION from the executive of the Association of Education Committees was received by Mr. Birrell at the Board of Education on November 29. The deputation sought to obtain more elasticity in the local development of higher education, greater freedom for local education authorities in the training of teachers, and increased Imperial aid for the relief of education rates. Mr. Birrell, in reply, expressed his sympathy with the ideals and most of the objects of the association, and his regret that the Treasury could not authorise him to promise at present any further grant of public funds in relief of local education rates.

AN unusually interesting and important Blue-book (Cd. 3255) has just been issued by the Board of Education. It deals with statistics of public education in England and Wales for the years 1904–5–6. Every grade of school is dealt with, and it is now easy to trace the growth of educational enterprise in recent years. One of the numerous sections is devoted to technical institutions, that is, as defined by the regulations of the Board, to institutions giving organised courses of instruction in day classes. In 1904–5 twenty-three such institutions only were recognised; 2509 students attended them at some time during the year, grants amounting to 8542*l*. were paid on 1295 students attending a full course of instruction, and 1507*l*. on 489 students attending part only of a course. Small as these numbers are, it is satisfactory to find they are larger than the corresponding figures for 1903–4. These students were taught by 416 teachers, of whom nine were women, numbers representing an increase of 108 in the teaching staff in the year. The average age of the students attending these classes was rather low. Of the total number of students, under 300 were women and girls; 1136 were between fifteen and eighteen years of age, 879 between eighteen and twenty-one, and 494 were more than twenty-one years of age. Courses of work in engineering and in applied chemistry were most numerous. During 1904–5 the number of evening schools recognised reached 5706, and the number of students who attended at any time during the year 718,562; a grant was paid on 487,699 of the total number of students. The amount of the grant reached 320,762*l*. Of this total number of students as many as 155,938 were under fifteen years of age, and 202,707 were more than twenty-one years. Two-thirds of the students were men or boys. This Blue-book will prove indispensable to educational administrators everywhere.

THE scholarships, medals, and prizes gained by candidates at the examinations of the London Chamber of Commerce were distributed on November 30 by Mr. Asquith, Chancellor of the Exchequer, who subsequently delivered an address. After referring to the growth of the educational work of the Chamber of Commerce, Mr. Asquith said that men and women of all classes and schools of opinion must agree in feeling gratification that during the last twenty or thirty years we have by our continuation classes, by our technical classes, by our polytechnics, been endeavouring, at any rate, to superadd to the common basis of education which was the possession, or ought to be the possession, of all classes of the community, some means of equipping men and women for the special exigencies of the particular branches of their profession in life. The English people, who have some very excellent qualities, have some ingrained and almost ineradicable superstitions. All agree that in the case of what are called the learned professions some kind of special training and knowledge is needed before a man takes upon himself the pursuit of his calling in them, but every Englishman thinks he is perfectly qualified to take up without any preliminary training the work of business. But, Mr. Asquith continued, we cannot now take things in the easy-going and the happy-go-lucky fashion that we used to do. The strain of foreign competition presses upon us in every walk of business and every market in the world, and, whatever are the contributory causes of the pressure which we all in a greater or less degree experience, there is not a man acquainted with the facts who will not agree that in the case, at any rate, of some of our most formidable competitors—for instance, Germany and the United States—one of the great sources from which they have derived exceptional strength in their commercial and industrial struggle with us has been the superior development of their technical and educational system.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 21.—"The Action of Radium and Certain other Salts on Gelatin." By W. A. Douglas **Rudge**. Communicated by Prof. J. J. Thomson, F.R.S.

The author has completed his experiments on the above subject, following the method first described in NATURE (vol. lxxii., p. 631). A "growth" which appears cellular in structure is seen to occur when a radium salt is put in contact with gelatin. This growth is traced to the formation of an insoluble precipitate of barium sulphate, owing to the barium always associated with radium salts and the sulphuric acid usually present in commercial samples of gelatin. Specially prepared gelatin containing no sulphuric acid gives no growth.

A sample of gelatin from which the sulphuric acid had

been removed was sealed up with some radium salt in September last, and at the present time no signs of growth have made their appearance, but if to a portion of the gelatin a soluble sulphate is added, a growth at once appears.

A series of photographs has been taken by means of the large photomicrographic apparatus of Zeiss, using magnifying powers of from 400 to 4000 diameters.

It thus seems to be quite clear that the cellular growth cannot be produced by radium or barium unless a sulphate is present, and other metals, save Sr and Pb, fail to produce any result, because they do not form insoluble sulphates.

The cellular form of these precipitates is probably due to the circumstance that the gelatin is liquefied by the actions of the salt, and each particle of precipitate is formed about a core of gelatin, so that the layer of barium sulphate forms a kind of sac or cell which is surrounded by the solutions of the salt in the liquefied gelatin. This *cell* may be permeable to the liquefied gelatin containing a salt in solution, which, passing through the cell wall, causes an expansion to take place, the limit of growth being controlled by some surface-tension effect.

The conclusions which are drawn from a study of the photographs and direct examination under the microscope with high powers are that:—

(1) The cells form round a precipitate of an insoluble sulphate, and the energy of the growth of the cell depends upon the amount of sulphate present.

(2) *Radium has no specific action in forming cells*, any effect produced being due to the barium associated with it, and the purer specimens of radium salts are less satisfactory as cell-formers than the impurer ones. Probably pure radium salt would have no action except that of causing an evolution of gas.

(3) The cells do not divide or bud, or show anything resembling "karyokinesis," their growth very quickly reaches a maximum, and they do not decay or split up, save as a consequence of the drying of the gelatin. If the cover glass is sealed down with cement, the cells have been observed to suffer no alteration in the course of four months.

(4) Radio-active substances, unless they contain barium, do not give rise to the formation of cells.

November 1.—"The Anæsthetic and Lethal Quantity of Chloroform in the Blood." By Dr. George A. **Buckmaster** and J. A. **Gardner.** Communicated by Dr. A. D. Waller, F.R.S.

The amount of chloroform present in the arterial blood of animals at various stages of anæsthesia has been accurately determined by the authors for the first time in this country. All observers who have worked at the question of chloroform-anæsthesia, including those members of the Special Chloroform Committee of the British Medical Association who have specially investigated this point, are agreed that chloroform is tenaciously held by blood, and that the transport of the drug from alveolar air to the cells of the body and the nervous system is probably effected by the red corpuscles.

The authors have given in some detail an account of the researches recently undertaken by French observers, J. Tissot and Mansion, and M. Nicloux, who have improved on the original methods employed by Gréhant and Pohl by using the reaction described by Dumas in 1821. To ascertain the amount of chloroform in blood, this is distilled off from the liquid, boiled with alcoholic potash, and the potassium chlorate thus obtained is titrated with silver nitrate.

In the experiments now described, the amount of chloroform in arterial blood at the moment when both the conjunctival and tail reflexes have disappeared, when the respiratory movements cease, and when the reflexes reappear, has been calculated from the difference in the chlorine-content of the blood before and after the administration of the anæsthesia. The method of estimation was the well-known one introduced by Carius for determining the amount of halogen in organic compounds, and by the adoption of Gooch's method of filtration and J. P. Cooke's suggestion of washing the silver chloride precipitate with water containing a little silver nitrate, a very high degree of accuracy was obtained. For the validity of this method the natural chlorine-content of the blood must be shown to remain constant during the course of any single set of experiments. Several tables show that this is the case during prolonged anæsthetisation with ether, the actual deviations from the mean being only 0·00123 and 0·00165.

The majority of the observations have been made on cats, since the phenomena of anæsthesia in these animals closely resemble those observed in man. In order to afford a means of comparison with the results obtained by the French observers on dogs, a few experiments were carried out on these animals.

Since it is difficult in any given case to ascertain the exact moment when an animal is actually anæsthetised, the authors have been obliged to take the disappearance of both conjunctival reflexes as a fixed point, and the occurrence of the first asphyxial convulsion of the respiratory muscles as indicative of the lethal stage, and in order to obtain comparable results they have found that the experiments must be made on healthy, well-nourished adults, and that the animals must not be in full digestion.

From the results of all the experiments it has been found that the amount of chloroform in arterial blood at the moment when the conjunctival reflexes disappear varies between 14 and 27·6 milligrams in 100 grams of blood. As others have noticed, the rate of induction of anæsthesia varies slightly in different animals, though the actual body-weight is a negligible factor. The curves given in the paper, which have been constructed from the varying chloroform-content of the blood during anæsthesia, show that the rate of induction is a feature peculiar to each individual animal. The average lethal dose of chloroform in 100 grams of blood is 40 milligrams.

After anæsthesia the chloroform is eliminated with extreme rapidity, and though the rate of elimination varies in different animals, the rate of disappearance of chloroform is far more constant than the rate of assumption.

A considerable number of experiments devised to ascertain how chloroform when inhaled is distributed in the red corpuscles and plasma, show that the drug is primarily associated with the corpuscles, and only gets into the plasma when the anæsthesia is pushed to an extreme point or a high percentage of the vapour is rapidly administered. From the results given in Table xvii. it appears that no less than 98·5 of the total chloroform in the blood was held by the corpuscles at the moment when the respiration ceased.

The view of Desgrez and Nicloux that carbon monoxide is formed in the blood during intense chloroform-narcosis has not been verified by the few observations which were made to determine this particular point.

November 8.—"Experimental Investigation as to Dependence of Gravity on Temperature." By L. **Southerns.** Communicated by Prof. W. M. Hicks, F.R.S.

The object of this investigation is to determine whether the action of gravity on a given mass varies to any measurable extent when the temperature of the mass is altered. Experiments having the same object, but differently carried out, were described by Poynting and Phillips in the Proceedings of the Royal Society, September, 1905, about a year after the commencement of the present work. These led to a null result, which receives confirmation from the experiments here noticed.

The apparatus in its original form was constructed several years ago by Dr. Hicks. After some modification it was set up in the new university buildings at Sheffield. A mass of paraffin oil was used in the experiments. This was contained in an air-tight, jacketed calorimeter, and suspended from one end of the beam of a balance, the other end carrying a suitable counterpoise. A coil of fine platinum wire was immersed in the oil, and by passing through this an alternating current, the temperature of the oil could be raised to the required degree. In order that this might be accomplished while the balance was freely suspended on its knife-edges, the current was conveyed to the coil by means of two wires rigidly fixed to the beam, their ends being pointed and made just to dip into mercury cups which were placed in line with the central knife-edges, and were joined up to the external circuit. The connections between the wires and

the coil leads consisted of thin strips of tinfoil. The error caused by the expansion of these wires due to the passage of the current was negligibly small. The balance was enclosed in a partially exhausted box, the weighings being carried out under a pressure of from 1·6 cm. to 5 cm. of mercury.

The experiment consisted in observing (by means of telescope and scale, and a mirror attached to the beam) the equilibrium position of the beam before heating the mass of oil, and noting any deflection of the same which might occur during and after the passage of the heating current. Only very minute, transient deflections were obtained, and as these did not persist it was evident that they could not be due to actual alterations of weight due to rise of temperature. The results seem to show that no variation of weight greater than 1 in 10^8 occurs during an increase of temperature of 1° C. for the substance used in the experiments.

Geological Society, November 7.—Sir Archibald Geikie, Sec.R.S., president, in the chair.—The Upper Carboniferous rocks of west Devon and north Cornwall: E. A. Newell **Arber.** After a reference to the previous work in the area, the author gives a description of the coast-sections, which display a highly-disturbed sequence of Upper Carboniferous rocks. Special attention is paid to two lithological types: the Carbonaceous rocks, which contain inconstant and impersistent beds of the impure, smutty coal, known locally as "culm"; these beds have yielded plant-remains; and the Calcareous rocks, partly of marine and partly of fresh-water origin, consisting of well-marked, impersistent bands of impure limestone, and conglomeratic beds of calcareous nodules embedded in shales. One of the limestone-bands, the Mouthmill Limestone, is marine, and contains an abundant fauna, while in others the only fossils are *Calamites suckowi* and *Alethopteris lonchitica*. Two distinct and unmingled faunas are present in the rocks: one consists of fresh-water lamellibranchs, and the other of marine fishes, cephalopods, and lamellibranchs, and the evidence as to horizon obtained from them agrees with that yielded by the plant-remains.—The titaniferous basalts of the western Mediterranean: Dr. H. S. **Washington.** In 1905 the author visited the volcanic districts of Catalonia, Sardinia, Pantelleria, and Linosa. He recognises the existence in this region of a hitherto unrecognised petrographic province, in which the basalts contain a remarkably high percentage of titanium. The rocks are of Tertiary age. Labradorite, augite, and olivine are the essential minerals, with titaniferous magnetite and apatite, and in some cases subordinate nepheline. The extent of the region is as yet problematical, and the author points out that along the southern coast of France there are several "basaltic" volcanoes, and it is possible that these may eventually turn out to be connecting links between the rocks of Sardinia and those of Catalonia, or possibly extrusion southward is indicated by the occurrence of phonolite at Maid Gharian, near Tripoli.

Royal Astronomical Society, November 9.—Mr. W. H Maw, president, in the chair.—Account of recent work at the Royal Observatory, Cape of Good Hope, Sir D. **Gill.**—The systematic motions of the stars: A. S. **Eddington.** The author's conclusions supported Kapteyn's hypothesis that there exist two drifts of stars; one drift moves relatively to the sun with a speed between three and four times that of the other, and the numbers of the stars in each drift are nearly equal.—The irregular movement of the earth's axis of rotation: a contribution towards the analysis of its causes: Prof. J. **Larmor** and Major E. H. **Hills.** The movement of the earth's axis of rotation is compounded of a "free precessional" period of 428 days, with irregular disturbances superimposed. The authors give a graphical method of setting out the direction and magnitude of the forces giving rise to the irregular disturbance, and hence arriving at its cause. The curve representing the movement of the pole about its mean position is first referred to an axis revolving in a period of 428 days. The hodograph of the derived curve is constructed, and this is transferred into the corresponding hodograph referred to axes fixed in the earth. The last curve then becomes a "torque diagram," showing in direction and relative magnitude the couple or torque acting upon the earth's axis at any date which would account for the observed motion of the pole. The forces to which these torques are due may be either internal or external transfer of material on the earth, the latter being in the form of change of ocean level, melting of polar ice, earthquake disturbances, or changes of barometric pressure. A numerical estimate of the possible amount of shift due to these various causes was given.—The distribution of energy in the continuous spectrum. The resolving power of spectroscopes: E. T. **Whittaker.**

Physical Society, November 9.—Prof. J. Perry, F.R.S., president, in the chair.—Exhibition and description of apparatus for students' practical work in physics: G. F. C. **Searle.**

PARIS.

Academy of Sciences, November 26.—M. H. Poincaré in the chair.—The determination of the integrals of certain partial differential equations by the values of the normal differential coefficients along a contour: Emile **Picard.**—The alcoholysis of cocoa butter: A. **Haller** and M. **Youssoufian.** Three kilograms of cocoa butter were submitted to the action of methyl alcohol in the presence of either hydrochloric or phenylsulphonic acid, and the methyl esters separated by fractional distillation under reduced pressure. The methyl esters of caproic, caprylic, capric, lauric, myristic, palmitic, stearic, and oleic acids were separated and identified. Butyric acid was carefully searched for, but not found.—Some remarks on the observations of contacts in total eclipses of the sun: Ch. **André.** It is shown that the perfect concordance between the times observed at the same place for the same contact by two different observers does not prove that this result is the real time of contact. A correction is necessary, depending on the observer and the aperture employed.—The history of the principle employed in statics by Torricelli: P. **Duhem.**—An improvement in the eudiometer: its transformation into a grisoumeter. Detection and estimation of methane and carbon monoxide: Nestor **Gréhant.** The fine platinum wire, first introduced by Coquillion as a means of combustion of gases, is fitted to the graduated tube by means of a rubber cork. The wire is heated to redness from two to six hundred times. In a 1 per cent. mixture of methane and air, 0·92 per cent. was found by this improved method, or an accuracy of 92 per cent. of the amount present.—The determination of the geographical coordinates of Tortosa and of the new Ebro Observatory: R. **Cirera.**—Partial differential equations of the second order with two independent variables admitting a group of even order of transformations of contact: J. **Clairin.**—The integration of differential equations: J. **Le Roux.**—The electrical conductivity of selenium: Maurice **Coste.** From the point of view of electrical conductivity, light produces the same effect on selenium as a rise of temperature. A specimen of selenium possessing a large residual conductivity is insensible to the action of light.—A mode of preparation of hydrated hypovanadic acid: Gustave **Gain.** Ammonium metavanadate is gently ignited at a low temperature, and the resulting mixture of V_2O_3 and V_2O_4 placed in a stoppered flask with an excess of saturated sulphurous acid solution. The blue solution thus obtained is submitted to prolonged ebullition, when the acid H_2VO_3 is deposited.—The elements producing phosphorescence in minerals. The case of chlorophane, a variety of fluorspar: G. **Urbain.** By converting the fluoride into oxide, and examining the kathode spectrum of the phosphorescent line thus obtained, traces of the rare earths, including samarium, terbium, dysprosium, and gadolinium, have been detected.—The oxide-ethers of glycollic nitrile: Marcel **Sommelet.**—The transformation of cinnamic alcohol into phenylpropylene and phenylpropyl alcohol by the metal-ammoniums: E. **Chablay.** The metal-ammoniums reduce cinnamic alcohol in a similar manner to the unsaturated fatty alcohols, giving the corresponding hydrocarbon, and according to the same mechanism; but the yield is very poor, the principal reaction being the production of phenylpropiolic alcohol.—A method of preparing the oxynitriles $ROCH_2CN$: D. **Gauthier.** The monochlor-ethers, $R.O.CH_2Cl$, are readily prepared by Henry's method, the reaction of hydrochloric acid upon a mixture of the alcohol, ROH, and formaldehyde

in aqueous solution. The chlorine atom in these compounds is readily exchanged for the cyanogen group by treating with mercury, or, better, cuprous cyanide. An account is given of the preparation and properties of several nitriles by this method.—Vicianine, a new cyanogenetic glucoside contained in vetch seeds: Gabriel **Bertrand.** Full details are given of the method adopted for extracting the glucoside from the seed. Vicianine contains 3·2 per cent. of nitrogen, the whole of which is set free as hydrocyanic acid by the action of emulsin.—Cytological observations on the germination of the seeds of Gramineaceæ: A. **Guilliermond.**—The concentration of chlorophyll and assimilating energy: W. **Lubimenko.**—A disease of *Abies pectinata*, accompanied by a reddening of the leaves: L. **Mangin** and P. **Hariot.** Several species of fungi were found on the infected leaves, and it is not yet clear to which of these the disease is due. To settle this point, inoculation tests with the various spores isolated will be carried out in the Cryptogam garden.—The culture of the artificial cell: Stéphane **Leduc.** Experiments on the structures formed by a grain of copper sulphate placed in an aqueous solution containing from 2 per cent. to 4 per cent. of potassium ferrocyanide, 1 per cent. to 18 per cent. of sodium chloride or other salts, and from 1 per cent. to 4 per cent. of gelatin. The granule becomes surrounded by a membrane of copper ferrocyanide, permeable to water and certain ions, but impermeable to sugar. It is shown that the products of growth of these artificial seeds are sensitive to all chemical and physical actions. The growth is arrested by numerous poisons, and the direction of growth is determined by differences of temperature and osmotic pressure.—The action of *Eriophyes passerinae* on the leaves of *Giardia hirsuta*: C. **Gerber.**—The *rôle* of olefaction in the recognition of ants: H. **Piéron.**—Experimental researches on thermal troubles in cases of absolute privation of sleep: N. **Vaschide.** The privation of sleep induces a constant and sensible lowering of the body temperature. The first physiological effect of sleep is to restore the thermal equilibrium of the organism.—The physiological *rôle* of the yellow pigment of the macula: A. **Polack.**—Contribution to the study of the hearing of fishes: M. **Marage.** Fishes do not hear vowel sounds transmitted in the interior of the liquid, even although the energy of the sound is sufficiently great to be remarked by persons regarded as completely deaf.—Experimental researches on the lesions of the nervous centres following on insolation: G. **Marinesco.**

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 6.

ROYAL SOCIETY, at 4.30.—A Comparison of Values of the Magnetic Elements deduced from the British Magnetic Survey of 1891 with Recent Observation: W. Ellis, F.R.S.—The Theory of the Compositions of Numbers, Part ii.: Major P. A. MacMahon, F.R.S.—On the Transpiration Current in Plants: Prof. H. H. Dixon.—The Theory of Photographic Processes, Part iii., The Latent Image and its Destruction: S. E. Sheppard and C. E. K. Mees.—The Chemistry of Globulin: W. Sutherland.

CHEMICAL SOCIETY, at 8.30.—The Liquid Volume of a Dissolved Substance: J. S. Lumsden.—Some Derivatives of Benzophenone; Synthesis of Substances occurring in Coco-bark (preliminary notice): W. H. Perkin, jun., and R. Robinson.—A Synthesis of Terebic, Terpenylic and Homoterpenylic Acids: J. L. Simonsen.

LINNEAN SOCIETY, at 8.—*Papers:* A Contribution to the Physiology of the Museum Beetle, *Anthrenus museorum* (Linn.): Prof. A. Ewart.—Note on the Origin of the Name *Chermes* or *Kermes*: E. R. Burdon.—*Exhibitions:* An Abnormal Specimen of a Dab with Three Eyes: Dr. A. T. Masterman.—A Note on *Siegesbeckia orientalis*, Linn.: Rev. H. Purefoy FitzGerald.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Selection and Testing of Materials for Construction of Electric Machinery: Prof. J. Epstein.

FRIDAY, DECEMBER 7.

GEOLOGISTS' ASSOCIATION, at 8.—The Zones of the White Chalk of the English Coast, Part v.: Isle of Wight: Dr. A. W. Rowe.

AËRONAUTICAL SOCIETY, at 8.—The Use of the Kite in Meteorological Research: Dr. W. N. Shaw, F.R.S.—The Gordon Bennett International Balloon Race: Colonel J. E. Capper.—The Aëroplane Experiments of M. Santos Dumont: E. S. Bruce.—The Stability of the Conic Shape in Kites and Flying Machines: R. M. Balston.—*Exhibit*: A Model of the Santos Dumont Aëroplane, made by the President.

MONDAY, DECEMBER 10.

VICTORIA INSTITUTE, at 4.30.—Review of Prof. Flinders Petrie's "Sinai": The Secretary.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Irrigation in the United States; its Geographical and Economical Results: Major John H. Beacom.

SOCIETY OF ARTS, at 8.—Artificial Fertilisers: Phosphatic Fertilisers A. D. Hall.

TUESDAY, DECEMBER 11.

ZOOLOGICAL SOCIETY, at 8.30.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Discussion:* The Talla Water-supply of the Edinburgh and District Waterworks; Repairing a Lime-stone-concrete Aqueduct: and The Yield of Catchment Areas.—*Probable Paper:* Mechanical Considerations in the Design of High-tension Switch-gear: H. W. E. Le Fanu.

FARADAY SOCIETY, at 8.—(1) On the Electrochemistry of Lead; (2) Contributions to the Study of Strong Electrolytes: Dr. A. C. C. Cumming.—Storage Batteries and their Electrolytes, Part ii.: R. W. Vicarey.

WEDNESDAY, DECEMBER 12.

SOCIETY OF ARTS, at 8.—Fruit Growing and Protection of Birds: Cecil H. Hooper.

THURSDAY, DECEMBER 13.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Intensity of Light Reflected from Transparent Substances: Prof. R. C. Maclaurin.—Contributions to our Knowledge of the Poison Plants of Western Australia, Part ii., *Oxylobium parviflorum*, Lobine: E. A. Mann and Dr. W. H. Ince.—Experiments on the Length of the Kathode Dark Space with Varying Current Densities and Pressures in Different Gases: F. W Aston.—An Examination of the Lighter Constituents of Air: J. E. Coates.—Further Observations on the Effects produced on Rats by the Trypanosomata of Gambia Fever and of Sleeping Sickness: H. G. Plimmer.

SOCIETY OF ARTS, at 4.30.—The Indian Mohammedans: their Past, Present, and Future: A. Yusuf Ali.

LONDON INSTITUTION, at 6.—Tadpoles—a Study in Embryology: Dr. J. W. Jenkinson.

MATHEMATICAL SOCIETY, at 5.30.—On the Form of the Surface of a Search-light Reflector: C. S. Jackson.—The Potential Equation and Others with Function given on the Boundary: L. F. Richardson.—On the Limits of Real Variants: J. Mercer.—The Asymptotic Expansion of Integral Functions defined by Generalised Hypergeometric Series: Rev E. W. Barnes.—The Diophantine Equation $x^n - Ny^n = z$: Major P. A. MacMahon.

FRIDAY, DECEMBER 14.

PHYSICAL SOCIETY, 7 p.m. to 10 p.m.—Second Annual Exhibition of Electrical, Optical, and other Physical Apparatus.

ROYAL ASTRONOMICAL SOCIETY, at 5.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Mechanical Improvements in the Drainage of the Bedford Level: A. Carmichael.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.

MALACOLOGICAL SOCIETY, at 8.—Description of *Latirus* (*Peristernia*) *Sowerbyi*, sp.n.: J. Cosmo Melvill.—On the Anatomy of *Tagelus gibbus* and *T. divisus*: H. H. Bloomer.—Descriptions of two New Helicoid Forms from German New Guinea: J. H. Ponsonby.

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