THURSDAY, JANUARY 30, 1902.

THE ADVANCEMENT OF NATURAL KNOWLEDGE.

THE *London Gazette* announces that a petition for incorporation has been presented to His Majesty on behalf of a new body, "The British Academy for the Promotion of Historical, Philosophical and Philological Studies." An explanation has been given that the object of this institution is to do for the various departments of "literary science" what the Royal Society has achieved for "natural science." The causes which have led up to this proposal may be stated as follows. At a meeting of the representatives of the chief European and American academies held at Wiesbaden in October 1899, an International Association of the principal Scientific and Literary Academies of the world was decided upon. Most of the academies represented are divided into two sections, a section of natural science and a section of historico-philosophical science. And on this ground the scheme provided for the division of the new association into two sections, "scientific" and "literary," the word "literary" being used only as a short title to embrace the sciences of language, history, philosophy, archæology and other subjects the proper study of which is based on scientific methods. At the conference the representatives of the Royal Society, not feeling themselves competent to represent the United Kingdom in the philosophico-historical section, were unofficially requested to take such steps as might be possible to fill this gap in the future.

The next steps taken may be gathered from the Report of the Royal Society Council presented to the Society on November 30, 1901.

The secretaries, apparently in fulfilment of their undertaking at Wiesbaden, wrote on the subject to the president of the Society of Antiquaries, Viscount Dillon, on November 21, 1899. A meeting was called at which, among others, several fellows of the Royal Society and of the Society of Antiquaries were present. The conclusion arrived at was that the idea of an academy to represent the philosophico-historical subjects formed by the simple federation of existing societies was not one which appeared to meet the views of those present.

At the same time the late Prof. Sidgwick drew up a plan which was approved by several of those attending the meeting and "of which the resolution passed at that meeting might be considered a part." This plan pointed out that the Royal Society might enlarge its scope, and include a section corresponding to the "philosophico-historical" and "philological" division of the German Royal Academies and Societies.

The next step taken was the reference of the matter to a special committee of the Royal Society.

The Committee point out that four possible ways of dealing with the matter were submitted to them :—

"(1) The creation of an organisation independent of the Royal Society, though possibly in some way connected with it, in which case they might both form parts of some larger body, as, for instance, the French Academies form parts of the Institute of France.

"(2) The creation of two 'Academies' within the Royal Society, one of Mathematics and Natural Sciences, the other of Philosophy-History, each Academy having its own Council, Secretaries and President, and the President of each being in turn President of the whole Society.

"(3) The creation of two or of three 'Sections' of the Royal Society, either A and B, corresponding to the Academies just named ; or A, Mathematical and Physical Sciences ; B, Biological Sciences ; C, Philosophico-Historical Sciences.

"(4) The election of some 25 to 50 Fellows representing the Philosophico-Historical subjects, to serve as a nucleus, and the creation of three or four committees, similar to those already existing, viz., one for Ethnography and Archæology, one for Philology, one for Statistics and Political Economy, and one for Psychology, the Officers and Council remaining, so far as statute and enactment are concerned, precisely as they are at present."

After these schemes had been formulated they were discussed at an interview with a number of representatives of the philosophico-historical sciences. Concerning this interview we read :—

"They all expressed themselves in favour of any effort for the corporate representation of those sciences being associated in some way or other with the Royal Society. They seemed unanimous in feeling the great desirability of the organisation and official representation of the Philosophico-Historical subjects, both on the ground of the general encouragement of their pursuit, and also, and more especially, as a means of developing the more scientific methods of treating those subjects.

"The general opinion of these gentlemen upon the practical courses discussed in the Report seemed to be in favour of the plan numbered (3) in the Report, but, recognising the practical difficulties in the way of carrying out any such scheme immediately, they were generally in favour of an effort being made on the lines laid down in plan numbered (4) as a beginning, in the belief that should its adoption lead, as they believe it would, to greater activity in this country in the studies in question, there might ultimately develop out of it some more formal organisation, such as is contemplated in the other plans submitted."

It is frankly stated that the Committee were much impressed by the concurrence of opinion among the gentlemen whom they consulted and by the high value they set on the inclusion within the scope of the Royal Society's action of the subjects they represented.

After the Report of this Committee was sent in to the Council, a special meeting of the Society was called for May 9, 1901. Unfortunately there is no record of what took place at it, but at the Council meeting in June the following resolution was passed :—"That the Council, while sympathising with the desire to secure corporate organisation for the exact literary studies considered in the Report, is of opinion that it is undesirable that the Royal Society should itself initiate the establishment of a British Academy."

The *Times* now tells us that on June 28, 1901, a month after this resolution was arrived at, those interested in the proper representation of the "literary" subjects met at the British Museum and

"after long and careful deliberation resolved to promote the establishment of a British Academy of Historical, Philosophical and Philological Studies on conditions which would satisfy the requirements of the International Association of Academies. It was further decided that the Academy should petition for incorporation by Royal

Charter, and that the nomination of the first Fellows under the proposed charter should be forthwith taken in hand. Before the close of last year, on December 17, the British Academy held its first meeting at the British Museum and petitioned His Majesty for incorporation by Charter."

According to the draft Charter, the petitioners will be the first Fellows of the Academy, and the President and Council will be elected by the Fellows from amongst their own number. New Fellows will be elected at a general meeting of the Fellows.

The announcement in the *London Gazette* states that His Majesty has referred the petition to a committee of the Lords of the Council. Notice is further given that all petitions for or against such grant should be sent to the Privy Council Office on or before February 14 next.

The following letter from Sir Norman Lockyer appears in the *Times* of yesterday (January 29) :—

SIR,—All students of natural knowledge in this country should agree as to the importance of the step recently taken to organise certain branches of it, concerning which you have given your readers much information. There are, however, some points connected with the movement on which you have not yet touched. Will you permit me to refer to them and the conclusion to which they lead?

The petition to His Majesty for a charter to embrace the organisation of historical, philosophical and philological sciences was rendered necessary by the action of the council of the Royal Society, who declined to "initiate the establishment of a British Academy" dealing with these subjects. But, in the first instance, the desire of those interested in the movement was that the Royal Society might include in itself a section corresponding to the philosophico-historical and philological division of the Continental academies ; it was not a question of establishing a British Academy.

To consider the matter in this form a committee of the Royal Society was appointed, and its report has recently been published. In this report we have the following reference to the subjects dealt with by the historical and philological sections of foreign academies :—

These subjects have, in England, hitherto remained unorganised—that is to say, the workers in each one of them have been brought into little or no relation with the workers in each of the others. Societies have been founded for the promotion of some of them, but these societies are not linked together by the membership of their leading members in one body of recognised authority and influence, such as the Royal Society provides for the investigators of various branches of mathematical, observational, and experimental science.

The advantages which the gathering into one body of the men most eminent in the subjects above specified have secured in Germany, France, Italy and Belgium do not exist here, and the absence of any effort to secure them has often excited the surprise of learned men in those countries. Neither is there in England any series of Transactions similar to those of the leading academies of Continental Europe, in which records of the most fruitful inquiries in those subjects, or even systematised references to such inquiries, may be found.

We are next told that the following reasons, among others, have been suggested by eminent men as making it desirable that the Royal Society should take action in the matter :—

Assuming the organisation of the above subjects to be called for in the general interest of the intellectual progress of the country, the Royal Society can promote their organisation more effectively than could be done by the persons who are occupied in the study of them, because these persons have no sort of combined corporate existence, and no voluntary group of them would appear to have a proper *locus standi* for appealing to the public or approaching the Government in order to attain the object sought.

It has been urged on general grounds that the inclusion by the Royal Society of a section corresponding to the philosophico-historical and philological divisions of the German academies would strengthen the society by broadening the range of its scientific activity and increasing its influence ; and would be to its advantage inasmuch as such a course would anticipate and thereby make needless the formation of an association which, by gathering the subjects within its scope, might to that extent be in rivalry with the Royal Society, and tend to narrow the legitimate range of its activity.

And next comes the most important part of the report, indicating that in the past, and by the three charters granted by His Majesty Charles II., the subjects under discussion were, and should now be, held to refer to "natural knowledge," and, therefore, should be dealt with by the Royal Society :—

The society exists for the promotion of natural knowledge. The interpretation of the term "natural knowledge," according to the present practice of the Royal Society, assigns to it a range from mathematics to the various biological sciences, and this secures the inclusion of the scientific study of man in his biological relations. . .

It is evident that the charters have never been interpreted as confining the "studies" of the society to "further promoting by the authority of experiments the science of natural things and of useful arts" in the strict modern meaning of those words. Indeed, the second charter in terms empowers the society to hold meetings "for the examination and investigation of experiments and of natural things," and both charters authorise it to enjoy "mutual intelligence and affairs with all and all manner of foreigners" . . . "in matters or things philosophical, mathematical, or mechanical." The provisions of the first statutes that the business of the society at its meetings shall be "to order, take account, consider, and discourse of philosophical experiments and observations ; to read, hear, and discourse upon letters, reports, and other papers containing philosophical matters ; and also to view and discourse upon rarities of nature and art," and the long and uninterrupted usage to receive papers on observational sciences, such as geology, or on pure mathematics, certainly do establish a *contemporanea expositio* which must be taken into account as *optimus interpres* and *fortissima in lege*.

Even had papers upon philological, psychological, or other subjects been entirely absent, no stress could be laid upon that fact, if in the opinion of the society those subjects have, under modern methods of treatment, become observational sciences, and as fully parts of "natural knowledge" as those subjects which were recognised as such at the epoch of the foundation of the society.

It would clearly be *ultra vires* for the society to resolve to receive a new class of papers, incapable of being regarded either in subject-matter or in scientific treatment as in the same category as those which have hitherto been received. But it would not be unlawful for the society to determine to receive papers on subjects not hitherto regarded as properly within its scope if it came deliberately to the conclusion that, in view of the scientific method in which they were now being treated, those subjects ought not to be excluded from its study.

The committee was not content with expressing its own view on this important matter ; it privately consulted two high legal authorities, whose opinion led the committee to believe, in confirmation of the views above stated, that the inclusion within the scope of the society of such subjects as have been referred to, if treated by scientific methods, is "within the powers of the society."

Two extracts from the first charter granted by Charles II. alone seem to establish this conclusion. The charter begins as follows (I give the English translation as it runs in the "Record of the Royal Society, 1897") :—

Charles II., by the grace of God King of England, Scotland, France, and Ireland, Defender of the Faith, &c., to all to whom these present Letters shall come, greeting.

We have long and fully resolved with Ourself to extend not only the boundaries of the Empire, but also the very arts and sciences. Therefore we look with favour upon all forms of

learning, but with particular grace we encourage philosophical studies, especially those which by actual experiment attempt either to shape out a new philosophy or to perfect the old. In order, therefore, that such studies, which have not hitherto been sufficiently brilliant in any part of the world, may shine conspicuously amongst our people, and that at length the whole world of letters may always recognise us not only as the Defender of the Faith, but also as the universal lover and patron of every kind of truth: Know ye, &c.

Of the "Fellows" we read later on :—

The more eminently they are distinguished for the study of every kind of learning and good letters, the more ardently they desire to promote the honour, studies, and advantage of this Society . . . the more we wish them to be especially deemed fitting and worthy of being admitted into the number of the Fellows of the same Society.

"Every kind of learning and good letters" seems to me pretty general, and it does not seem improper to take the words "philosophical studies," in connection with Bacon's definition of philosophy, as dealing with a threefold division, of matters divine (supernatural), natural, and human, which also, perhaps, explains the subsequent insistence upon natural, as opposed to supernatural, knowledge.

But, without labouring this point further, I suggest that subjects the study of which by scientific methods increases the sum of natural knowledge must all stand on the same footing. I use the word "scientific" in its widest, which I believe to be the truest, sense, as including all additions to natural knowledge got by investigation. Human history and development are as important to mankind as the history and development of fishes. The Royal Society now practically neglects the one and encourages the other.

It is possible, then, to say the least, that the present general action of the society, and I say general, because the action changes from time to time, is really not in accordance with its charters; it certainly is not with its first practice. The charters make the society the head centre of the intellect of the kingdom engaged in making new natural knowledge, and therefore until these charters of King Charles II. are abrogated or revised there is no place logically for a new charter by King Edward VII. giving power to a new body to deal with the subjects the duty of the organisation and encouragement of which was previously committed to the Royal Society.

There can be no question that the gradual departure of the action of the Royal Society from the course laid down in the charters, and actually followed for a time, has been the gradual expansion and increased importance of experimental and observational methods of work, which of themselves are sufficient to employ the existing administrative machinery. But, if the whole work cannot be done inside the society as it exists at present, the question arises, Cannot some be organised side by side with it? Here, again, there may be difficulties; but, as the committee wisely say with regard to the first proposal :—

We are far from intending to express an opinion that any difficulties of detail ought to prevent the important issues involved from being fully considered in their largest bearings, having regard to the great benefits which might be expected to result to the progress of the philosophico-historical studies, and possibly to the Royal Society itself, from the inclusion of those studies within the scope of the society's action.

It is right that I should say that the Royal Society Council, in the resolution from which I have already quoted, expresses sympathy with the desire to secure a proper representation of the subjects now in question, and did not refuse to include them within itself, although its action may give colour to the belief in such an effect.

At present the Royal Society is the unique recognised centre of the general scientific activity in this country.

Will it be conducive to the interests of science, or even of the Royal Society itself, that in future there should be two entirely separate centres?

But will not this state of things be brought about if, without any general consideration, a charter is at once granted to the new body?

The important thing to secure is that the two bodies dealing with the two great groups of scientific subjects shall form part of one organisation—some enlarged Royal Society. What the *nexus* shall be is a matter of such subordinate importance that I do not propose now to refer to it further.

May not this present difficulty, Sir, be really a blessing in disguise? Does it not merely emphasise the activity of the scientific spirit and the employment of the scientific method in new regions, and suggest that the time has arrived, at the beginning of a new century and a new reign, for doing for the science of to-day what Charles II. did for the science of the seventeenth century—that is, organising and coordinating it on a broad basis?

It is clear that the question so wisely referred by His Majesty Edward VII. to the Privy Council is no light one, for the acts of a previous King of England and the future development of British science are involved. The present confusion is great and will become greater if a new charter is granted without a comparison and possible revision of the existing ones; and, short of an inquiry, by a Royal Commission or by some other means, to consider the question, it is difficult to see how the proper organisation of natural knowledge in the future can be secured.

It is fortunate that there is ample time for this important matter to be considered carefully in all its bearings, for not till 1904 can any British representation of the philosophico-historical subjects be considered by the International Association of Academies.

May I finally be permitted to say, Sir, how entirely I agree with the remarks in the leading article in the *Times* of the 16th inst. concerning the importance of organising literature as well as science? Science has undoubtedly gained by the charters of Charles II., and on this ground alone it may be urged that literature will be a gainer if it also is similarly organised. Certainly the most impressive sight I saw in Paris last year, when attending the first meeting of the International Association of Academies as a Royal Society delegate, was the reception of a new literary member of the Académie Française. The combination of troops representing the Government and members of other academies representing the Institute of France formed a picture which is not easily forgotten; it was one also to set one thinking.

I am, Sir, your obedient servant,

NORMAN LOCKYER.

THE EIFFEL TOWER.

La Tour Eiffel en 1900. Par M. G. Eiffel, Officier de la Légion d'Honneur. Pp. 363. (Paris: Masson and Co., 1902.)

IN a handsome volume, profusely illustrated with engravings and photographs, M. Eiffel has given an elaborate account, from its earliest conception, of the lofty structure that will always bear his name, and of the mechanical devices which have secured its success, both as a worthy monument of the art of construction and as a source of delight to the millions who have ascended it. We understand and regret that this monograph in some measure owes its appearance to the attacks of detractors, and it is intended to furnish a complete answer to those who, disapproving of the structure, have commented on its puerility and its uselessness. This ill will, well pronounced in the early days of the structure, and to which

M. Eiffel refers at length, has possibly revived since the falling off of receipts on the occasion of the last exhibition, and the well-earned reputation of the author may have suffered in consequence. Certainly no less than three descriptions of the Tower have emanated from the eminent engineer in a short space of time. The first, entitled "La Tour de trois cents Mètres," was an *ouvrage de luxe*, a massive folio volume with sixty-seven plates, also in folio. This work, intended for experts, has been presented to various public libraries and scientific societies, and will be consulted with interest by those engaged in similar projects of construction. Next appeared, in a more handy form, "Travaux Scientifiques exécutés à la Tour de trois cents Mètres," which, though not generally circulated, was intended to form a complete refutation to those who still urged the plea of inutility against the structure. The present volume appears to follow a middle course between these two, the author giving an account of the history of the construction of the Tower, the modifications that were suggested, after the experience gained in 1889, to make it more accessible to visitors in 1900, together with some account of the scientific investigations which this unique structure rendered possible or facilitated by reason of its height and form.

We have here, therefore, a complete history of the building from the date of its proposal in 1886 up to the present time, and of necessity many of the details have already appeared in the public journals, while the authors of the scientific work that has been carried on in connection with it, having contributed their results to various scientific bodies, have had them published in due course, and these have been commented on in our columns from time to time. As an example, one may refer to M. Janssen's researches on the telluric origin of the lines of oxygen in the solar spectrum, which were carried out in 1889. The value of the book consists in the completeness of the historical details and the ready access it offers to much that has been accomplished in connection with the Tower, particularly in the way of meteorological observations. M. Eiffel naturally thinks it a complete answer to his detractors, but whether this be so or not, it is impossible not to recognise that the management has welcomed with loyalty and assistance every scientific project that has been recommended to its consideration. One gathers that in the view of the promoters, the Tower was never intended to be either a scientific laboratory or a judicious pecuniary investment. We may quote here M. Eiffel himself:—

"Il me semble que, n'eût elle pas d'autre raison d'être que de montrer que nous ne sommes pas simplement le pays des amuseurs, mais aussi celui des ingénieurs et des constructeurs qu'on appelle de toutes les régions du monde pour édifier les ponts, les viaducs, les gares et les grands monuments de l'industrie moderne, la Tour Eiffel mériterait d'être traitée avec consideration."

And again:—

"Étant la plus saisissante manifestation de l'art des constructions métalliques par lesquelles nos ingénieurs se sont illustrés en Europe, elle est une des formes les plus frappantes de notre génie national moderne."

Looked at from this point of view, its existence is its justification. It accomplished what was demandedof it, and its scientific applications, useful as some of them may be, are no more than an ornamental fringe to the main design.

In 1889 nearly two million visitors paid for admission or ascent, and the lifting apparatus had been taxed to the extent of carrying 23,000 persons in a day. With the view of offering greater accommodation on the occasion of the exhibition in 1900, when as great or greater numbers of visitors might be expected, it was determined to increase the accommodation on the various platforms and to rearrange the mechanism of the lifts so that a greater number of ascents could be made per hour. The alterations, necessarily of a costly character, are described in very great detail, and when completed provided for the partial or complete ascent of 3120 passengers per hour, instead of 2680 per hour, as in 1889. Or regarded from another point of view, while the total receipts under the old system could not exceed 5240 francs per hour, under the new arrangement, with a lower tariff, the hourly receipts could amount to 7120 francs per hour. A great deal of work had to be effected, and the manner of its accomplishment, interesting to experts, will be found set out with great clearness and precision. How the sanguine expectations were disappointed is a matter of history, and the falling off in the number of visitors to about one-half is to be regretted; but the efficiency of the arrangements and the success with which they worked should be a matter of congratulation from an engineering point of view.

Having disposed of these mechanical arrangements, to which are added some interesting statistics connected with the financial side of the question, M. Eiffel gives some account of the various scientific purposes to which the Tower has been put during the last eleven years. These, referring to meteorology, to atmospheric electricity, to the construction of a manometer for high pressures, and a variety of other researches, have been mentioned in these columns at the time the different physicists engaged in the work published the results of their investigation. Although mention has already been made of wind observations in connection with the Tower, notably in vol. xlix. p. 596, and li. p. 181, we are tempted to return to this question and give the results of a simple investigation conducted by M. Eiffel to detect the amount of motion that the structure experienced under the influence of a high wind. It will be remembered that the opponents to the scheme of construction in the early days made a strong point of the difficulties that would ensue from excessive wind pressure, and the point is interesting, not only on that account, but because a great deal of loose information is current concerning the motion of tall chimneys and steeples. Anemometry, when applied to considerable areas, is not in a very satisfactory condition, and the necessary strength to be given to buildings is more or less a matter of conjecture and experience. M. Eiffel's method of observation was exceedingly simple. On the third platform, at a height of 309 m., was placed a diagram of concentric circles alternately coloured white and red, each 20 mm. in breadth, and ten in number. The centre of this target, if it may be so described, was made to coincide with the intersection of the cross wires of a solidly mounted theodolite at the base of the eastern pillar. It seems to have been assumed that the telescope

would not move, and the observation was effected by noticing the circle on the diagram which came under the intersection of the cross wires. It is not very clear how the motion in the line of sight was measured, or how the effects of foreshortening were removed. There was no illumination, and the observations were confined to daylight. The general effect of the wind is to make the top of the Tower describe an ellipse, and several diagrams are reproduced showing the effect of the greatest storms. The maximum displacement occurred during the storm of December 20, 1893, when the major axis of the ellipse was 0·10 m., and the minor axis 0·06 m. The time occupied in the description of the ellipse would have been interesting, but is not given. The measured velocity of the wind at the moment of observation is recorded as 31·8 m. per second, or 71 miles per hour. During this storm a velocity of 44 m. per second, or 98 miles per hour, was recorded, but at that moment the major axis of the ellipse was only 0·06 m. This seems to have occasioned M. Eiffel some surprise, but fortunately these excessive gusts are generally operative over a very small area, and the total wind force on the Tower is not to be measured by that experienced at a point very near the anemometer. The same apparatus has served for the measurement of the effects of temperature. The curves traced are generally of a complex character, depending on the position of the sun, and consist mainly of small excursions into the north-west and west quadrants. An example is given of the motion on a very hot day in August, when the centre of the diagram practically traced an elongated ellipse, 24 cm. in length, parallel to the east and west direction.

The researches summarised in the volume appear to be rather unequal in value, and a very small connection with the Tower affords a sufficient warranty for their introduction. Thus we get some account of the recent balloon ascent of M. Santos Dumont, because it was a part of the scheme for testing the capacity of giving definite direction to such an apparatus that the Eiffel Tower should be included in the closed curve to be described by the aëronaut. Perhaps, however, one underestimates the part played by the Tower in this instance, for M. Emmanuel Aimé, slightly changing the well-known aphorism of Voltaire, assures us if the Tower did not exist it would be necessary to invent it for the necessities of aërostation. It seems, however, that M. Dumont prefers to pursue his experiments where he gets no assistance from the lofty structure. This tendency to stray from the subject is still more noticeable in the appendix, where we get a chapter "renfermant une notice sur les travaux exécutées par mes établissements industriels de 1867 à 1890." We have no desire to quarrel with M. Eiffel on this ground. He has carried out many great and difficult works in various parts of the world, and is to be congratulated on the success that has generally attended them. In forming our estimate of what he has accomplished for engineering science he should not be judged simply by the most popular or conspicuous example of his talent, but by the work of his whole career, which he may contemplate with complete satisfaction.

VOIGT'S ELEMENTARY MECHANICS.

Elementare Mechanik als Einleitung in das Studium der theoretischen Physik. Von W. Voigt. Zweite umgearbeitete Auflage. Pp. x + 578. (Leipzig: Veit, 1901.) Price Mk. 14.

THE object of this book is to provide the student of physics with a working knowledge of theoretical mechanics. With this view the reader is introduced successively to dynamics of a particle, dynamics of rigid bodies, attractions, hydrodynamics, elasticity; in each department statics holds a subordinate position, equilibrium being treated as a particular case. The design of presenting, within the compass of a volume of moderate size, an account of the things that are fundamental in the mechanics of bodies, whether solid or fluid, rigid or deformable, is entirely laudable. It brings into prominence the essential unity of subjects which are frequently treated as independent of one another; it imposes a selection of the topics to be discussed, and thus results in the elimination of much that is artificial and conventional though sanctioned by tradition.

A critical discussion of the principles of mechanics would perhaps have been out of place in a work of this character; at any rate it is not attempted by the author. His standpoint, so far as it is indicated, would appear to be nearer to that of Thomson and Tait's "Natural Philosophy" than to that of Kirchhoff's "Vorlesungen über mathematische Physik, Mechanik." As regards methods, it is noteworthy that the author makes comparatively little use of the conception of energy, and that he does not introduce Lagrange's equations. Accordingly, the stability of floating bodies is discussed geometrically after the manner of Dupin, and the small oscillations of a system with a finite number of degrees of freedom are not discussed at all. On the other hand, space is found for an account of "vector fields" and "tensor fields." The distribution of velocity in a fluid affords an example of a vector field, the distribution of strain in a body affords an example of a tensor field; with a vector field there is associated at each point a directed linear segment, with a tensor field there is associated at each point a certain surface of the second degree. Most recent continental writings on physical mathematics treat of vector fields. The chapter devoted to the dynamics of rigid bodies is made unusually interesting by the use of the theories of several pieces of apparatus—the balance, bifilar suspension, Atwood's machine, Foucault's pendulum—as illustrations of the mode of formation and solution of equations of equilibrium or motion the theory of the application of the pendulum to the determination of the acceleration due to gravity is also given. The treatment of rolling friction, of which two accounts, apparently conflicting with each other, are given in two separate articles, leaves something to be desired. An excellent feature of the book is the emphasis laid on the "dimensions" of physical quantities; no quantity is introduced without an explicit statement of its dimensions in terms of the units of mass, length and time.

The plan and purpose of the book require that the reader should not be assumed to possess a knowledge

of the theory of partial differential equations. This restriction renders necessary some originality of method in problems relating to fluid motion and to the equilibrium and motion of elastic solids. The book should prove very useful to teachers, by showing how much of these theories can be treated adequately by the aid of simple analysis. Perhaps the most remarkable piece of work, among those designed to make the theories of mathematical physics accessible to readers whose mathematical equipment is not very large, is the discussion of the equation of transverse vibrations of a stretched string; the writer founds the theory of this equation on a geometrical method, which was initiated by Riemann in his memoir on the propagation of plane sound waves of finite amplitude. The portion of the book dealing with deformable bodies contains, among other things, a very interesting account of *stress*; the notion of stress is introduced by means of a preliminary statement in regard to the observed character of the interactions between the smallest parts of bodies. Observation seems to be credited here with proving things which must, from the nature of the case, be remote inferences from observation. The subsequent deductive investigation is very well done. Viscosity in fluids receives a good deal of attention, and the divergences between the motions and resistances of perfect and of viscous fluids are illustrated by comparing the two solutions of the problem of the steady motion of a sphere through a fluid, regarded first as perfect and then as viscous, and by the contrast between the diffusion of vorticity in a viscous fluid and the permanence of vortex motion in a perfect fluid. Although it might be wished that the treatment of the fundamental theorem of rational hydrodynamics had been less summary, yet it will be felt that the student of theoretical physics owes a debt of gratitude to Dr. Voigt for his clear outline of the theories of fluid motion.

A. E. H. L.

ESSAYS ON BIRD-LIFE.

Birds and Man. By W. H. Hudson. Pp. 317. (London: Longmans, Green and Co., 1901.) Price 6*s.* net.

THE author of "The Naturalist in La Plata" is such a close and accurate observer of nature, and has such a rich store of anecdote upon which to draw, while his style is so fresh and invigorating, that a hearty welcome from the public is well-nigh sure to await all the efforts of his pen. In this little volume he has given us a delightful series of essays dealing with bird-life in England, in the course of which he dwells specially on the relations between bird and man as they exist in nature. Many of these essays have previously appeared in various serials, but a very considerable portion of the book, including the introductory chapter, is new.

Mr. Hudson has such an enthusiastic love for bird-life that, as he tells us in this introductory chapter, the sight of stuffed birds in a museum is positively painful to him. If this be so, an obvious and easy course lies before him, and it is unnecessary on his part to say that collections of this nature "help no one, and their effect is confusing and in many ways injurious to the mind, especially to the young." No one, of course, wishes to argue that stuffed birds are as good as living ones, but since the great majority of us have neither opportunity, time, patience nor money to devote to the observation of birds in their native haunts, we may surely be permitted, if we please, to study and admire their counterfeit presentments in a museum.

Perhaps the most interesting chapter in the book is the second, which bears the same title as the book itself. Here the author tries to imagine what birds think of man. At times, he thinks, they must be considerably puzzled, as when a blackbird is petted while on its nest by the owner of a garden, only to be shot at or stoned when it leaves the protected precincts.

"Birds" (says the author) "are able sometimes to discriminate between protectors and persecutors, but seldom very well, I should imagine; they do not view the face only, but the whole form, and our frequent change of dress must make it difficult for them to distinguish those they know and trust from strangers. Even a dog is occasionally at fault when his master, last seen in black and grey suit, reappears in straw hat and flannels."

Later on it is shown how birds clearly discriminate between dangerous and harmless mammals, the author giving us many interesting anecdotes derived from his Argentine experiences of the relations between birds and mammals in the wild state.

Several of the chapters—notably the one on the Dartford warbler—are devoted entirely to British birds, but in others the author takes a wider field. Among these latter the article on geese, with its description of the vast throngs of the Magellanic and upland species to be seen at certain seasons in Argentina, is of especial interest. It closes with a pathetic anecdote of a pair of these birds, which, on account of the female having a broken wing, started to *walk* the long journey from the pampas of La Plata to distant Patagonia.

In the two concluding chapters the author gives some supplementary notes on the birds of London, and describes his impressions on first visiting Selborne in 1896. In taking leave of this charming book we have two regrets—one that it is not longer, and the other that we have not space for a fuller notice.

R. L.

OUR BOOK SHELF.

The Earth's Beginning. By Sir Robert S. Ball, LL.D., F.R.S. Pp. viii + 384. (London: Cassell and Co., Ltd., 1901.) Price 7*s.* 6*d.*

THIS is a popular account of the nebular hypothesis, based upon a course of lectures adapted to a juvenile audience, and it is, therefore, almost superfluous to remark that the subject is presented in simple language and that no great mental effort on the part of the reader is called for. The theme is one which furnishes splendid opportunities for the display of the powers of graphic description and illustration for which the author is so well known, and the book will doubtless succeed in extending the interest in this fascinating chapter of science.

From the demonstration of the existence of true nebulæ, the reader is gradually led to the evidence that the sun and earth once existed in nebulous form, and thence to see how the present conditions of the solar system accord with the hypothesis. The difficulty presented by the anomalous revolutions of the satellites of Uranus and Neptune is got over ingeniously by supposing that in these cases the concordant stage of the evolutionary pro-

cess has not yet been reached. While the application of the theory to the solar system is kept mainly in view, the evidence of its truth afforded by observations further afield is by no means neglected; but no attempt is made to trace the story of celestial evolution generally, or to state the various stellar stages through which the sun itself must have passed. Thus, for the most part, only familiar ground is traversed, and the chief value of the book as a contribution to the literature of the subject lies in the clearness of exposition and wealth of illustration.

The maintenance of the sun's heat and the principle of the conservation of moment of momentum are treated in a specially lucid manner, and the appendices dealing more fully with these questions greatly enhance the value of the book to students.

Objection might be made to the use of the term "fire mist" as applied to the original nebula, since it was not necessarily an incandescent mass, and consequently also to the extension of the theory which attributes this nebula to the collision of two dark bodies. As a minor objection, the view that the sun's photosphere is composed of particles of carbon cannot yet be regarded as the demonstrated fact which the author seems to suppose. A curious error, occurring on p. 277, may also be mentioned; it is stated that the discovery of helium in the sun in 1868 was made during an eclipse, whereas the main point of the observation to which reference is made was that it was made without an eclipse.

There are numerous excellent illustrations, many of them from photographs; but the descriptions are in some cases quite inadequate. Thus, Figs. 43, 44 and 54 will only be intelligible to those who have a fair acquaintance with astronomical spectroscopy, and the numerous photographs of nebulæ appear to have been distributed almost at random.

Monograph of the Coccidae of the British Isles. By Robert Newstead. Vol. i. Pp. xii + 220. Plates A–E, 1–34. (London: Ray Society.)

THE Coccidæ, or scale-insects, are of great importance horticulturally and economically, for although some species yield important products, such as lac and cochineal, others are among the most destructive pests of our orchards and gardens, being peculiarly injurious to plants grown under glass. Mr. Newstead, himself a practical gardener, has devoted many years to their study, and has given us the results of his painstaking investigations in the present work. He admits about ninety species and varieties of Coccidæ as occurring in the British Islands, belonging to eight of the twelve subfamilies at present recognised, the other four being at present unrepresented in Britain. The systematic part of the first volume deals only with the first subfamily, the Diaspinæ, to which Mr. Newstead refers eleven genera and thirty-seven species. A very full introduction is prefixed to the volume, dealing with the structure and habits, parasites, enemies, &c., of the Coccidæ, and practical observations on the best means of coping with their ravages, and full directions for collecting and preserving. Among the most original of the author's observations are those relating to birds as destroyers of Coccidæ.

Till recently the Coccidæ have been one of the families of insects most neglected by British entomologists, and Mr. Newstead's admirable monograph adds another to the important series of works on neglected groups of insects for which we are indebted to the Ray Society. There is still, however, much work to be done before our knowledge of the insects of the British Islands can be considered to be anything like complete, especially, perhaps, among the parasitic Hymenoptera, which have been strangely neglected by most entomologists, notwithstanding their vast number and variety, their beauty, and their economic importance in keeping down the numbers of all kinds of insect pests. This neglect may perhaps be accounted for, however, by the small size of the great majority of the species, many of which, including some of the most curious and beautiful, are among the smallest insects known. But we hope to see these and other neglected groups of insects gradually worked out, on similar lines to those followed by Mr. Newstead in the present work.

Le Sel, les Salines et les Marais Salants. Par A. Larbalétrier, Professeur a l'Ecole d'Agriculture de Grand-Jouan. Pp. 166. (Paris: Masson et Cie; Gauthier Villars. No date.)

THIS volume is one of the "Encyclopédie Scientifique des Aide-Mémoire," a title which sufficiently expresses its scope. After a brief description of chlorine, sodium and the properties of sodium chloride, the methods of production of salt from sea-water on the coast of France are described, followed by short accounts of the treatment of the mother liquors of crystallisation for bromine, of the principal European salt mines, of the production of salt from saline springs, and of the Stassfurt deposits. The book concludes with a description of the impurities and analysis of salt, statistics of production in various countries, and of the use of salt in food, agriculture and medicine, and, lastly, a bibliography—perhaps the most important part in a work which is chiefly a compilation of facts obtained from other sources.

An encyclopedic article of this description, published in a handy form, will be useful provided the data given can be relied upon. Unfortunately, in this instance this is not always the case; a number of misprints occur in the figures in the tables, misstatements are made in the chemical details, and names of places are misspelt. On the other hand, the methods of mining salt in the principal European mines and the production of salt from sea-water and saline springs in France are adequately described, and the book is written in a readable form, sufficiently illustrated and well printed.

T. S. D.

Elementary Ophthalmic Optics, including Ophthalmoscopy and Retinoscopy. By J. H. Parsons. Pp. 162. (London: J. and A. Churchill, 1901.) Price 6*s.* 6*d.*

A SOUND statement of the optical principles involved in ophthalmology, which nevertheless does not require a knowledge of higher mathematics, and which is confined within reasonable limits, has no doubt been long sought by students of this special branch of surgery, and in "Elementary Ophthalmic Optics," now under notice, they will find a trustworthy exposition of the laws affecting the refraction of the eye. The book is well printed and the diagrams are large and clear; it seems a pity, perhaps, that the author was not bold enough to depart from the conventional letters used in optical formulæ, which, such as f, f_1, f_1', f_2', become liable to confusion, though it is difficult to suggest better symbols offhand.

The student should have been warned that the equation $l_1 l_2 = F^2$ (p. 14), if applied in the case of parallel rays proceeding from infinity, becomes indeterminate. The equations proved in chapters iv. and v. become exceedingly wearisome, important though they are, but a few illustrations of their application at the time would relieve the monotony, which might frighten the more practical man from continuing his reading to the later portions of the book, where their results are made use of and where stress is laid on several most important points not usually explained or mentioned in works on ophthalmology. It is not altogether clear where all the distances given for Listing's schematic eye are measured from; also in an earlier and a later page the foci of the aphakic eye are given differently, leading to confusion in the mind of a careful reader. Chapter vii. brings into prominence some very essential facts in relation to the size of the image formed in the ametropic eye and the effect of spectacles

and their position thereon. The proofs here given should serve to elucidate some of the puzzling cases not infrequently met with in testing errors of refraction. Chapter x., again, gives much valuable information on the use of the ophthalmoscope to the best advantage, and the difficulties of retinoscopy are sufficiently dealt with in the last chapter. There is no mention of accommodation or presbyopia, several points in which might well have been touched upon. An index would have been of assistance in the search for any equation relating to a particular case.

The Process Year Book, 1901–2. Edited by William Gamble. Pp. xvi+152. (London: A. W. Penrose and Co., 1901.)

EVERY year we receive this admirable and beautiful book illustrating the present state of process work, and we cannot do better than again suggest that everyone interested in the art of picture reproduction should be the possessor of this volume. The illustrations and text still maintain their high standard of excellence, and the variety of the subjects and processes dealt with gives the reader a good insight into the manifold methods in photo-mechanical engraving and the allied arts and crafts.

It may, perhaps, be specially mentioned that in consequence of the great advance in the department of process work relating to the three-colour method the editor has introduced a variety of specimens such as perhaps never before has been collected together between the covers of a single book. A glance at these soon suffices to illustrate the high state of efficiency of the methods employed to-day; and one only wonders what the future has in store for us, since it is to this branch of process work that we look for the possibility of the greatest progress.

Nautical Astronomy. By J. H. Colvin, B.A. Pp. 127. (London: E. and F. N. Spon, Ltd., 1901.) Price 2*s.* 6*d.* net.

ONE of the greatest difficulties encountered in the study of spherical and nautical astronomy is to obtain a proper comprehension of the various circles of the celestial sphere, without which the solution of the problems involved can never be anything more than mechanical. The author of this book, however, has not thought it necessary to assist the student greatly in this direction, for fifty very brief definitions can by no means be regarded as an adequate introduction to celestial geometry. Thus, unless the student is endowed with an exceptionally good geometrical imagination, or has the advantage of a good teacher, it does not seem likely that he will be able to use the book with profit. The initial difficulties excepted, however, the book has many good features; the explanatory matter is brief and clear, and there is a useful collection of formulæ, rules, numerical illustrations and exercises to be worked out. Much space is saved by the omission of tables which do not vary, while specimen pages of the "Nautical Almanac," adapted to the exercises, have been introduced.

The book is designed to cover the elementary and advanced stages of the South Kensington syllabus, and also includes the course for "extra master" in the Board of Trade examination.

Elementary Chemical Theory. By G. H. Martin, M.A., F.C.S. Pp. 24. (London: Rivingtons, 1902). Price 9*d.*

THE only use to which this collection of didactic statements can be put is to furnish students of chemistry with material suitable for copying into their notebooks. It was scarcely worth while to attempt to extend the use of the book beyond the author's own pupils.

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.*]

Cherry Disease.

IN NATURE for January 9 (p. 239) there is a report of the meeting of the Royal Microscopical Society on December 18. The president, Mr. William Carruthers, F.R.S., made a communication with respect to the cherry disease which has appeared in Kent, from which I extract the following:—

"The results of experiments in the cultivation of the fungus showed it to be one which belonged to the genus Gnomonia. Many of the fungi in this class passed through various stages in their life-history, for example the mildew on wheat, which was first developed on the berberry and then spread to the wheat, appearing first as rust and afterwards as mildew from the same mycelium. The president referred to the absence in this country of any authority competent to investigate cases such as this; on the continent, however, the Governments had taken up the matter, and the experts who had inquired into it had found that to check the spread of the disease it was necessary to collect all the dead leaves and burn them."

Prof. A. W. Bennett followed in the same strain and "enlarged upon the absence in this country of investigations into such matters by State-paid establishments, and described what was being done in the United States, where every State had its own experimental station."

Now it is not my intention to discuss whether the Government does as much for scientific inquiry in the interests of the community as it might do. But it is clear to me that nothing is gained by overstating the case. There are two "State-paid" establishments devoted to botany in this country, Kew and the Botanical Department of the British Museum. Each happens to have upon its staff an officer trained in mycological investigation. And it may be added that Mr. Carruthers is himself consulting botanist to the Royal Agricultural Society.

So far as Kew is concerned, the matter was promptly dealt with in ordinary routine. Mr. Massee, who has charge of the cryptogamic collections, had given a brief account of the disease in his "Text-book of Plant Diseases," with a figure (pp. 110, 111), although at the time (1899), so far as I am aware, the disease had not been noticed in this country. Mr. A. O. Walker, of Maidstone, sent specimens in November, 1900. I quote the *Gardeners' Chronicle* for May 23, 1901 (p. 191), where he writes:—

"Early in November I sent specimens to Mr. G. Massee, of the Kew Herbarium, who reported to me that the leaves were affected by the fungus *Gnomonia erythrostoma*, and quoted Frank's opinion that the leaves should be gathered and burnt."

The council of the Royal Agricultural Society issued on February 6, 1901, a report by Mr. Carruthers giving the history of the disease and recommending Frank's remedy of burning the leaves. There is nothing very profound in this recommendation, as it is a general method applicable to all plant diseases propagated by spores, and aims at removing the source of infection.

As I recently pointed out in NATURE (vol. lxiv. p. 212), we owe to the late Prof. Cornu "the principle now so familiar as to seem almost obvious, of preventive treatment by the careful destruction by burning of the *débris* of plants which may harbour spores."

I may add that the Gnomonia is well known to mycologists, having, in fact, been first described by Persoon as a Sphæria a century ago, and there are in the Kew Herbarium specimens of it from no less than eight published collections. Mr. Carruthers in his report, which is reproduced in the *Journal* of the Royal Horticultural Society (n.s. xxv. pp. 313–316), does not give an illustration of the Gnomonia, but figures instead a "Fragment of Leaf of Cherry Tree showing groups of Parasitic Fungi." These belong, apparently, to a species of Phoma and, so far as I am aware, there is no evidence that they have anything to do with the Gnomonia.

There the matter stands, and for my part I entirely fail to see how "the authority competent to investigate cases such as this" of whom we are said to be in want, could carry it farther. The

disease has been known on the continent for the last twenty years, and notwithstanding that "Governments had taken up the matter," we are no wiser as to the life-history of the parasite than they were in Germany at starting. Nor if we were should we be probably any better off, however interesting the result might be from a scientific point of view. For each phase of such a fungus has apparently an indefinite capacity for propagating itself independently. The rust of wheat is as destructive in Australia as anywhere else, and is not checked by being unable to complete its life-history on the barberry.

It is not material, but it may be noted that Gnomonia belongs to a group of fungi widely remote from the rust of wheat. I can hardly believe that Mr. Carruthers intended to suggest that they belonged to the same "class."

But my object in drawing attention to the matter is to remonstrate with my scientific friends for the mistaken policy which it seems to me that many of them are too apt to adopt in matters of this kind. It is the fashion now to clamour for "State-paid" assistance for everything, with no sense of the relative importance of the objects aimed at or appreciation of the work which is actually being done. It is most important that Government aid should be obtained for a definite purpose, such as that of the National Physical Laboratory. But if scientific men will not even give the Government credit for the aid it gives, they run the risk of being regarded as impossible to satisfy.

In his report, published by the Royal Agricultural and Horticultural Societies, Mr. Carruthers states:—"The neglect of undertaking this operation (burning of the dead leaves), though costly, means the disappearance of the cherry orchards of Kent in a very few years." In the face of this very serious statement it is remarkable that, so far as I can ascertain, no information on the subject has reached the Board of Agriculture.

Kew, January 22. W. T. THISELTON-DYER.

Variation in Fowls.

EVERYONE who is acquainted with poultry must join Mr. Tegetmeier in deprecating the economic degradation of good old breeds by breeding for fancy points only (p. 152). But it is an ill wind that blows nobody good, and from a scientific point of view a decadent old breed with exaggerated points is more interesting than one of the comparatively useful modern mongrels produced by crossing, since the former shows conclusively what can be done by sheer selection, even though applied for a senseless end.

Fortunately, Mr. Tegetmeier has given excellent comparative views of some breeds before and after "improvement" in his work on "Table and Market Poultry"; but if the old strains are obtainable anywhere in their primitive form it would be, I think, very desirable to get specimens and preserve them, together with some modern highly-bred birds, for the benefit of bionomical students when the declining breeds have become extinct. Meanwhile, I should like to draw the attention of students of variation to the great differences observable in domestic fowls which have not been subjected to any selection, such as the ordinary poultry of India. Among these, although they are allowed to breed anyhow, may be seen all recognised colours of fowls except those of the highly specialised laced, pencilled and spangled breeds, which have needed a long course of selection. Double or "rose" as well as single combs occur, although the latter are a minority, and small crests are common. Five toes and feathered legs are rare; the legs vary much in tint.

Now, in Egypt, I have observed that, while equally variable in coloration, the fowls displayed some structural points peculiarly their own. The combs are very often *really* double; not the coral-like "rose" comb, but a bifid or two-flapped edition of the normal compressed and serrated form. The hind toe also was very often bifid, exhibiting every gradation from the five distinct toes of the Dorking to a distally split hind toe or one in which the normal hallux was represented by a mere terminal joint with a nail, growing from the long upper supernumerary hallux. Indeed, I even got a specimen in which the extra hallux alone remained, the true first digit having disappeared altogether! The consequence was that this bird's foot looked like a curassow's, but I observed that it had very little power of grasping therewith.

In Zanzibar I again found poultry of every colour, but very true to the lanky, close-feathered, small-combed Malay or Chittagong type, which thus seems to maintain itself in spite of neglect by breeders.

What is particularly noticeable in casually-bred poultry is the correctness of some of the types of marking. Thus the silver-grey variation, in the cock, resembles the typical black-breasted red in everything except in that the red parts of the plumage are changed to white. The corresponding hen has the brown and yellow of the upper surface also replaced by white, and hence is grey in tone with a silver-streaked hackle.

When such correlated grey and rufous forms occur in wild gallinaceous birds, they are put down as climatic variations, but it is obvious that climate cannot be the *direct* cause, though it may favour the survival of one type rather than the other, according to constitution or surroundings.

Another common style of marking found in two colours is that in which the base of the neck, the primary quills and the tail are chiefly black in both sexes, the rest of the body being uniform, either white or some rufous shade ranging from bay to buff. This coloration might easily characterise a natural species, although it is not known to do so; in accepted breeds the white form has been adopted as the proper colour for the light brahma, and the cock of the golden-pencilled Hamburg breed closely approximates to the black-tailed rufous form. Hens of the black-tailed red type are, however, not recognised in any breed.

A very common and curious variation in rough-bred fowls is the "wheaten" hen. This bird is of the pale-brown colour of wheat, with a dark-brown neck and black tail; but the correlated cock is a black-breasted red of the jungle-fowl colour. This colour of the hen is recognised in Malays and old English game, and is said to breed the brightest cocks.

It has occurred to me that the occurrence of two such distinct types of hens as the "wheaten" and the "partridge" (the name given to hens of the jungle-fowl brown) in correlation with similarly coloured cocks may, perhaps, help to explain the phenomenon of dimorphism in female butterflies. For if we knew the pedigree of these insects as well as fanciers do that of their fowls we might very possibly find that in dimorphic species two strains with dissimilar females but similar males existed and interbred.

So, also, the great and sudden variations throw light on the origin of mimicry. The form of the fowl with white body and black quills and tail, above alluded to, is similar in plan of coloration to several large and powerful birds. If such a variation occurred where the form and flight were favourable to mimicry, as it might easily do among the multitudes of passerine birds, we should have mimics ready-made.

The problem in the case of butterflies is much easier, owing to their greater general similarity of shape; but in any case it is obvious that variation is more important than selection here.

Indian Museum, Calcutta. F. FINN.

Elementary School Mathematics.

THE appointment of a committee of the British Association on the teaching of elementary mathematics encourages the hope that that body will be able, after collecting the opinions of practical educators, to focus them with due wisdom into a scheme which will be generally acceptable, both to teachers and examiners. For success to be attained it is obviously necessary that those who are in actual touch with the work of teaching should state what, in their judgment, is desirable and practicable. Hoping that others besides myself will follow the example set some time ago by Mr. Hurst of Eton, I venture to write to NATURE a sketch of the conclusions to which an experience of many years at Charterhouse has led me.

I have in mind in what follows the needs of the average boy, not of that comparatively rare individual who has some real mathematical taste; but I am sure that the progress of the latter is at present often sadly retarded by the course of study through which he is put. Our public schools have, unhappily, as I think, no organisation for securing common action except the annual conference of head-masters, which has, so far, done very little for the cause of education, hence methods and ideals vary much; but I shall assume that the average character of what is taught may be gathered from the papers set in the various public examinations for which we all prepare, and from the most popular text-books in use. Taking this ground, I think the broad indictment must be at once admitted that school mathematics are altogether too abstract and

artificial; aiming at training the pure reason they have got out of touch with facts, and for many pupils degenerated into mere jugglery with symbols cast loose from thought; hence they fail to interest and influence all but a very few. Look at the questions set in any of the well-known examinations—and see how many of them consist of stock puzzles of more or less complexity, invented, apparently, solely in order that successive generations of boys may learn how to deal with them, score marks by them, and then lay them aside as useless! And, of course, a large portion of our text-books and our teaching is necessarily devoted to such questions. So long as the chief examinations maintain their present character a general reform of school mathematics is well-nigh impossible, and partial reforms at individual schools (I have Winchester in mind as a pioneer in endeavour) are very difficult. I will, however, briefly and without detail indicate directions in which I think real improvement can be made without introducing revolutionary changes.

The great aim must be to introduce as much as possible the concrete element, for there are few boys who cannot be interested keenly in what they can deal with in practical fashion by drawing or handling in any other way, and fewer still to whom a bare abstract idea is not repellent. Until elementary physical measurements and the mathematics appropriate for dealing with them are taught together, an arrangement much to be wished for both from the points of view of science and mathematics, the best field for the introduction of the concrete is undoubtedly geometry.

In all the earlier stages of geometrical work, theory should always be kept in touch with practice by much drawing and measuring of figures; this, I am convinced, is the best way of building up exact geometrical ideas, and it has besides the great advantage of being intensely interesting to boys. I do not refer to "geometrical drawing" as often taught and usually understood in examinations which aims merely at making certain constructions (though this gives a valuable bit of training to those who have too often no notion of using their hands efficiently for any purpose not connected with a ball), but I would have it used always concurrently with, and in illustration of, demonstrative geometry. This is, I know, quite possible, though I have as yet come across no text-book in which it is done.

In theoretical geometry the only serious divergences from Euclid's methods I would advocate are (1) the introduction from the first of the idea of an angle as generated by a rotation, and (2) the substitution of the arithmetical and algebraical treatment of proportion for Euclid's.

Euclid's test of proportion, which appeals so strongly to the grown mathematician by its elegance and completeness, is for even the very best boys very difficult to grasp, and for the moderate boy a rigid insistence on it (which is practically never made) would involve an absolute bar to the discussion of similar figures and elementary trigonometry, matters which are quite easy if the difficulty of incommensurability be kept in the background. I would, however, while adhering to Euclid as the only possible text-book, omit, on a first reading at least, many of the propositions in order to push on to those which connect with, and can be illustrated by, practical work. For instance, after Book I., I would have read those propositions of Book III., some dozen or so in number, proving the angle properties of circles.

Seeing that demonstrative geometry furnishes by far the most accessible example of pure deductive logic, and for most boys the only one they will ever come in contact with, I would insist most strongly on its never being sacrificed to so-called "proofs" by measurement which are found in some books. The training of the reasoning powers is one of the highest aims of education, and with this end in view constant practice in riders is of the greatest value; the teaching of Euclid's text without this is a most deadly waste of time, and cannot be too strongly condemned.

In arithmetic I think the most important reform would be the general recognition of the fact that decimals are not adapted for exact calculation, but are preeminently valuable in approximation, which is the practically useful form.

From the first, therefore, boys should be taught to work out results correct to a few places only—generally not more than four—and all work with recurring decimals should be omitted.

Many of the puzzling questions set on such subjects as discount, stocks, &c., have very slight relation to practical life, they require much time to learn to deal with them, and should be discarded in favour of work on areas and volumes of simple figures. An equal amount of thought can be elicited, and therefore a not less amount of culture imparted, by good problems on the latter subjects, with the advantage of being more in touch with practical requirements.

In algebra I would, in the earlier stages, insist much more closely than is done at present on the accurate use of symbols as a shorthand language for expressing arithmetical operations, deferring long "sums" of multiplication, division, &c., until much work has been done on simple equations of the first degree as aids to the solution of problems. Later I would omit much of the harder manipulation with fractions and abnormal index expressions which is now taught, and in place of these devote much time to the development of the notion of one quantity as a function of another, illustrated by plotting graphs on squared paper. The theory of fractional and negative indices should be taught as leading up to logarithms to base 10, but I deprecate the too early use of these in calculation.

Arithmetical trigonometry involving functions of acute angles only, and with constant reference to four-figure tables and accurate drawings to scale, should be taught much more generally than it is now. For boys in the higher forms who are but poor mathematicians I have found it an interesting and stimulating change from the weary round of arithmetic and algebra they had trodden *ad nauseam* before. A short course of the same work should, even in the case of good boys, be preliminary to the algebraical treatment of trigonometry.

I have written only of the very lowest rungs of the mathematical ladder; those who from professorial and engineering altitudes lecture us on what we ought to teach have often no notion of the mind stratum in which the greater part of our life's labour is spent; hence their advice, and their books when they condescend to write for us, are too often hopelessly above the mark. That by cooperation of all interested some real improvements in the curriculum may enable us to get a rung or two higher all round is the earnest wish of myself and many other teachers.

J. W. MARSHALL.

Charterhouse.

The Distance of Nova Persei.

SINCE publishing, in NATURE of January 2, the suggestion that the cause of the apparent expansion of the nebula surrounding Nova Persei might be explained by the illumination of meteoric matter by the light sent out on the occasion of the outburst of the Nova, I have seen a paper published by Prof. Kapteyn in the *Astr. Nach.* (No. 3756), in which he suggests the same idea. His claim to priority in the matter is therefore clear. In my note, referred to, I give the distance of the Nova as 313 light years. In calculating this distance I made the mistake of taking the date of the outburst as February 12 instead of the 22nd. This made the distance of the Nova considerably too great.

Let D denote the distance of the Nova, and r the radius of the nebula, in *miles*; and let ρ be its radius in seconds of arc. Then we have

$$\frac{r}{D} = \frac{\rho}{206265}, \quad \therefore D = 206265 \times \frac{r}{\rho} \quad . \quad . \quad . \quad . \quad . \quad (1)$$

But if V is the velocity of light in miles per second, and if T be the time in *days* elapsed from the outbreak of the star to the date of the photograph, then

$$r = 24 \times 60 \times 60 \, . \, V \, . \, T \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Substituting this in (1) we find

$$D = 24 \times 60 \times 60 \times V \times 206265 \times \frac{T}{\rho} \quad . \quad . \quad . \quad . \quad (3)$$

Also if L be the distance travelled over by light in a year of $365\frac{1}{4}$ days, *i.e.* a light year, then

$$L = 24 \times 60 \times 60 \times V \times 365\tfrac{1}{4} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Dividing (3) by (4) we find

$$\frac{D}{L} = \frac{206265}{365{\cdot}25} \frac{T}{\rho}$$

or

$$D = \left[2{\cdot}75184 \right] \times \frac{T}{\rho} \times L, \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

the figures in brackets being the logarithm of $\frac{206265}{365{\cdot}25}$.

Taking T = 211 days from the outburst to the date of the photograph taken on September 20 and the angular distance ρ of the point (*a*) on Ritchey's photograph as equal to 480″, the distance D is equal to 248 light years. The same point on the photograph of November 13 leads to D = 265. The difference between these two values of D is, I believe, as Prof. Kapteyn also points out, due to the fact that the plane of the nebula is not normal to the line of sight. Ritchey also points out that, besides the radial expansion, there has been an apparent motion of the nebula round the Nova in position angle. From an examination of the photographs, the nebula seems to be evidently a spiral, and the observed shift in position angle would be caused by the gradual illumination of these spiral wreaths by the advancing spherical wave of light.

It can be shown that, if the sun were removed to the distance of the Nova, it would only be of the 10·24 magnitude, so that, even at the present moment, the Nova is more brilliant than the sun. When the Nova was at its greatest brilliancy it was about 0·2 magnitude. It must then have been 10,380 times brighter than the sun. If we take the light of the Nova at the earth as equal to a first-magnitude star and take Zöllner's estimate of this compared to the sun as $\frac{1}{5\times10^{10}}$, then the outer margin of the nebula with a radius of 8′ would be 430 times nearer the Nova than the earth, and would receive per unit area 430^2 times the amount of light, or $\frac{430^2}{5\times10^{10}}$, which is equal to $\frac{1}{270500}$, of sunlight. This is about equal to 2·2 times the light of full moon. Of course, these figures are of very uncertain value and we must not place too much reliance on them, but if we take the above value of 2·2 times moonlight as that received by the nebula, it at first seems too faint to be visible as reflected light. We must, however, recollect that the light reflected from the nebula at its brightest points cannot have an intrinsic brilliancy of more than an eighteenth-magnitude star, whereas the Nova was of the first magnitude. Hence it is only necessary for the nebula to reflect light of an intrinsic brilliancy equal to $\frac{1}{6,310,000}$th that of the Nova to seem as bright as it actually is, even assuming that the nebula has no inherent light of its own. The above figures will evidently require some alterations when the photographs available are carefully measured. W. E. WILSON.

Daramona, co. Westmeath, Ireland.

A Luminous Centipede.

IN your issue of January 9 (p. 223), an account of some observations of the Geophilus is given, from which it would appear that it used its power of emitting light as a means of protection. It might be well to point out that irritation or excitation of many luminous organisms has this result. Even in such low forms as the light-producing bacteria the same effect can be seen. In a paper on the "Physical Basis of Animal Phosphorescence," by S. Watasé, of the University of Chicago, published with the biological lectures delivered at Woods Holl, 1895, a very full account is given of the phenomenon as seen in the ordinary fire-fly, and the process is essentially the same in all light-producing organisms. In some the luminous product of cell metabolism is oxidised *in situ*, while in others it is thrown out in response to a stimulus as a liquid secretion.

J. E. BARNARD.

Birds Capturing Butterflies in Flight.

MR. LATTER still believes the capture of butterflies in flight by birds to be "exceptional so far as this country is concerned" (p. 273). Closer observation would assure him of the contrary, I think. Why is the case he mentions "probably to be regarded as a mistake on the part of the bird," when it is admitted that the captor "only relinquished its hold in consequence of a luckily-aimed stick"? Why assume that the thrower of the stick knew better what the house-martin ought to eat than the bird itself? In July 1900 I saw a house-sparrow in my garden attack a common brown butterfly on the wing (species unidentified). The chase lasted three minutes, by my watch, *in the air* the whole time, the butterfly doubling and turning again and again, and the sparrow after it, in a manner most remarkable for a bird without much hovering-power. Eventually both butterfly and sparrow went into a box hedge, and the sparrow came out immediately afterwards, eating the butterfly; he finished it with much apparent satisfaction on a branch of an apple-tree, and cleaned the scales off his beak on the twig. Sparrows are not, as a rule, insect-eaters, but J. H. Gurney gives, as a result of 694 dissections, under the heading "occasional food," these entries:—

"August.—Moth of *Crambus culmellus*."

"June.—Large brown cabbage-moth (W. Johns),"

and adds: "I have notes of sparrows occasionally feeding on the yellow Underwing, Ermine moth, and a few other insects in the perfect state. . . . Everybody must, at some time or another, have observed their clumsy efforts to catch some common butterfly" ("The House-sparrow," Gurney, Russell and Coues, pp. 11–18). These notes have the greater value because they occur in a book written with the avowed object of convicting the sparrows of a diet injurious to the agriculturist!

If, therefore, attacks by "occasional" enemies are not infrequent, why imply that the toll taken by the vast crowd of insectivorous birds "*must be* very slight?" The question is, is it? Only specially directed observations can answer this.

LILIAN J. VELEY.

20 Bradmore Road, Oxford, January 26.

Extremes of Climate in the British Empire.

I HAVE just read the note on p. 87 of your issue of November 28 last giving an abstract of the "Summary of the Climate of the British Empire" in *Symons' Meteorological Magazine*; and I think that even though it is expressly said to be only "so far as it can be represented by reports for eighteen stations," such a summary is misleading. Thus, Adelaide is given as having the highest shade temperature, absolutely ignoring the fact that Lahore, with a population 50 per cent. more than Adelaide, has a maximum shade temperature for a month or more at a time rarely falling below 116°, and often well over 120°; while in Jacobabad, a much less important place, it is true, but still a garrison town, the maximum shade temperature in June and July is more often over 120° than under it.

Again, for maximum rainfall, not to mention Cherra Punji, with an average of more than 400 inches, or many places on the west coast of India and Burmah with averages of 100 to 200 inches, the large town of Rangoon is far wetter than Calcutta. Being far from records here I can only give averages; but I do not think I am wrong when I say that the places mentioned in your paragraph are hardly typical of the extremes of climate exhibited by even the *larger* places in the British Empire, which, I take it, should be the object of such a summary.

Lalitpur, India, January 2. CHAS. A. SILBERRAD.

A GALLERY OF ANIMAL ENGRAVINGS OF THE STONE AGE.

THE clever etchings on bone and ivory of the cave-dwellers of western Europe who lived towards the close of the Palæolithic period are well known to all who interest themselves in the pre-history of man. In 1895 M. E. Rivière published the first discovery of engravings and pictographs on the sides of a cavern. The second and quite recent similar record is published in the *Comptes rendus* of the Paris Academy of Sciences (December 9, 1901, p. 1038) by MM. Capitan and Breuil. These archæologists had the good fortune to discover on the walls of the cave of Combarelles, in the neighbourhood of Eyzies (Dordogne), 109 engraved figures which date from the Magdalenian epoch. All the figures are engraved upon the vertical walls of the cave for a distance of 100 metres on each side of the passage. They reach to an average height of 1·50 metres, commencing at about 15 or 20 centimetres above the ground and often extending to the roof—which, in truth, is mostly low, being only one to two metres in height, but this has been curtailed by stalagmites.

The figures are mostly deeply graven in the rock, but some designs are merely scratched. Very often they have been coated by a layer of stalagmite which is

sufficiently thick in some places to more or less completely obliterate the figures. In some figures the incisions have been reinforced by black pigment, which occasionally replaces the cuts. Sometimes, more especially about the head of certain animals, the surface of the rock is scraped away around the contour of the figure so as to throw it into a slight relief.

The style of the engravings is in complete accord with those etchings on bone and antler which occur in the Magdalenian stations, and their character proves that

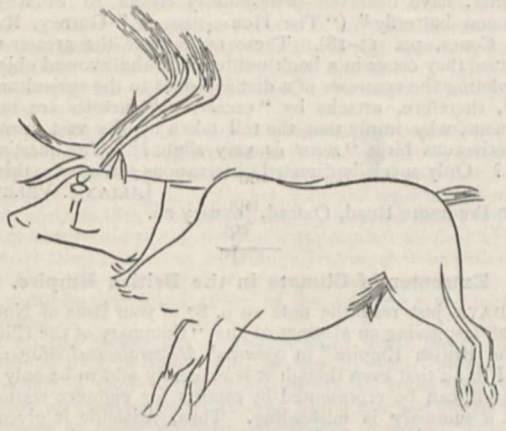

FIG. 1.—Running Reindeer, Cave of Combarelles.

they were drawn by artists who were perfectly familiar with the living animals. As in the earlier finds, the animals may be represented separately, or intermingled, or in definite groups.

Among the forty representatives of horse-like animals, at least two distinct types are recognisable. One has a massive head with a convex nose, the mane is short and stiff or long and flowing, and the tail is similar to that of our own horses. Some of these horses were domesticated ; several very clearly show a halter and others a cord round the

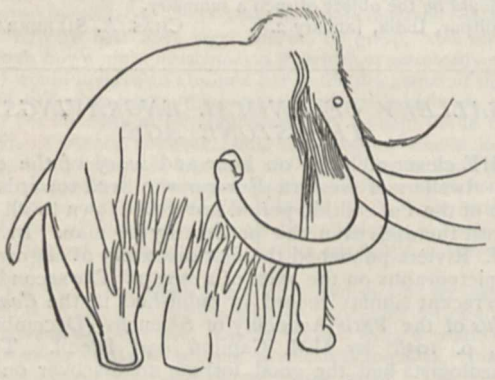

FIG. 2.—Mammoth, Cave of Combarelles.

muzzle ; a covering of some sort appears to be thrown over the back of two of the horses. This new evidence, in addition to the several representations of haltered horses from the cave of Mas d'Azil, seems to prove beyond question that the horse was domesticated at this early period. Certain Equidæ are represented of a more elegant shape, with a small head, slender legs, short and always erect mane, and with a tail that arises low down and is bare save for a terminal tuft of long hair.

The representations of the Bovidæ are less frequent. Three appear to represent bisons ; one is not unlike the domestic cattle of to-day ; a third, with erect mane, slightly incurved horns and a dewlap provided with long and abundant hair, recalls certain African antelopes. Two heads may be attributed to the saiga antelope, and one large head suggests that of an eland, but it is without horns. There are only two entire figures of reindeer ; the one which is represented as running is here reproduced. The artists have clearly indicated the differences between the reindeer and the wild deer of Europe, of which there are three examples.

The drawings of the mammoth are of interest second only to that of the horses. Of the fourteen examples, some are represented as entirely covered with hair and look like fluffy balls ; others have less hair, but are provided with a fleece on the under side of the body, on the head and occasionally around the mouth, as shown in our illustration. The trunk, the tusks, which are always strongly recurved, and the great characteristic feet are very distinctly drawn ; only in two figures are indicated the details of the form of the ears.

The only approach to a representation of a human face is a kind of irregular circle with an indication of two eyes and some marks for the nose and mouth. Among other simple signs were three roof-like fairly complicated designs, a double-contoured lozenge in the middle of the body of a horse, several M-like marks, semicircles, &c., which may be related to the script-like paintings found in the Mas d'Azil cave, and, finally, a group of very distinct small cups.

As only a preliminary paper has been published by the French savants, we are unable to give any further particulars of this most interesting and important find. The publication of all the particulars will be eagerly awaited by archæologists, as doubtless fresh light will be thrown upon these very remarkable troglodyte artists, who

"Pictured the mountainous mammoth, hairy, abhorrent, alone—
Out of the love that he bore them, scribing them clearly on bone."

A. C. H.

THE UNIVERSITY OF LONDON.

THE Drapers' Company has come forward with a generous offer in order to secure the incorporation of University College with the University of London. The offer is contained in the following resolution, which was brought before the Senate of the University on January 22 :—"That the Drapers' Company, believing that it is for the good of the higher education in London that University College should be incorporated in the University of London, and that for this purpose it is desirable to place the site, land, buildings and endowments of the college at the complete disposal of the University, are willing to facilitate this object by making themselves responsible for the debt on University College to the extent of 30,000*l*., provided that the Senate of the University and the corporation of University College can, before February 28, 1903, agree upon a scheme for the incorporation of the college in the University, and such scheme be approved by the company."

At first sight it seems difficult to imagine how such an incorporation can be effected. Committees appointed by the University and University College will consider the matter, and it is to be hoped that the bearings of the proposal will soon be published. An additional inducement for the realisation of this scheme lies in the announcement made by Sir Michael Foster that a gentleman is prepared to give to University College 1000*l*. a year, redeemable either by himself or his executors by payment

of 30,000*l.* free (in the latter case) of legacy duty, on condition that the college becomes incorporated in the University on terms similar to those on which the gift of the Drapers' Company has been made, and satisfactory to Sir Michael Foster and two other persons to be named hereafter.

The Senate of the University has decided to devote the grant of 10,000*l.* by the London Technical Education Board to the following objects, subject to the approval of the Board and to the result of negotiations with the various institutions interested :—

(1) To found two professorships and two assistantships in chemistry ; (2) to organise the teaching of German in London by appointing two professors and three readers. The classes will be held at the colleges and polytechnics, but the fees will be paid into a central fund, and the whole staff will be under the direction of the University ; (3) to make grants of 1425*l.* and 1000*l.* a year respectively to two institutions in aid of the faculty of engineering ; (4) to appoint and pay the regular staff of teachers in the London School of Economics ; (5) to reserve 800*l.* a year pending negotiations with the London County Council as to the establishment of a day training college.

A scheme for establishing advanced courses of study on physiology in the University buildings has been approved by the Senate, and 400*l.* has been voted to meet the donation of 2000*l.* by Mr. Walter Palmer.

From the *British Medical Journal* we learn that each course will consist of not less than eight lectures, or will extend over at least eight weeks, and attendance will be open without fee to students of the University and to other persons approved by the principal. It is recognised to be essential to the success of such lectures that they should immediately proceed from laboratory work, and be in a large measure demonstrative of current research. It is, therefore, necessary that the University lecture-room should be supplied by preparations and work-rooms in which current research will be actually prosecuted. It is hoped that from the outset the University lecturers and other physiologists may be able to prosecute research in these accessory rooms, and it is strongly felt that official recognition and provision for research is in several ways essential to success, first, as a corrective of a purely verbal and didactic type of lecture, and secondly, as being calculated to stimulate the intellectual interest of University lecturers and other students. Further, the working of the scheme will afford at a relatively small cost evidence on the point whether a larger scheme for the establishment of a central institute of physiology and experimental psychology will be practicable in the future.

It is proposed that the list of annual courses of lectures shall be prepared and advertised during the preceding year, and candidates for the honours school in physiology will be permitted to nominate any two subjects on the published list for the special practical examination. The provisional arrangements are as follows :—

The first course, to begin in May, will be given by Dr. Leonard Hill, F.R.S., on the circulation. Dr. A. D. Waller, F.R.S., will give a double course, on (*a*) signs of life, (*b*) animal electricity. Prof. E. H. Starling, F.R.S., will begin a course, on the sources of animal energies, in October, and Dr. M. S. Pembrey a double course on (*a*) heat, (*b*) respiration.

The arrangements for 1903 are provisionally as follows :—January, Prof. W. D. Halliburton, F.R.S., on proteids, and Prof. W. M. MacDougall, on sense organs ; May, Dr. G. A. Buckmaster, on the blood ; and Prof. J. Bretland Farmer, F.R.S., on vegetable cytology ; in October, Dr. F. W. Mott, F.R.S., on the central nervous system, and Prof. W. R. Dunstan, F.R.S., on a subject not yet announced.

NOTES.

THE determination of the fundamental unit of electrical resistance by the late Principal Viriamu Jones ranks among the most important of such determinations, and justly acquired for him a foremost position among physicists. This determination was carried out by means of a modification of the Lorenz method, and a machine for the purpose, on which he spent 400*l.*, was erected by Principal Jones at the University College at Cardiff. He was, however, of opinion that improvement was possible, and accordingly the Drapers' Company, in 1898, in recognition of his signal services both to science and to education, voted to him the sum of 700*l.* for the construction of more perfect apparatus. This apparatus he proposed ultimately to set up at the National Physical Laboratory, where preparation had been made to receive it. His illness and death prevented the realisation of these hopes, but the Drapers' Company have, with great generosity, and with a view of showing their appreciation of his merits, confirmed their vote and announced their intention of putting the sum of 700*l.* at the disposal of the committee of the Laboratory for the complete equipment of a Lorenz apparatus as a memorial to Principal Jones. The apparatus is to be erected under the supervision of Prof. Ayrton, F.R.S., and the director. This valuable gift has been accepted by the committee of the Laboratory ; a tablet will be affixed to the apparatus stating that it was presented by the Drapers' Company in memory of Principal Viriamu Jones and in recognition of his great scientific attainments.

THE annual meeting of the Institution of Naval Architects will be held on Wednesday, March 19, and the two following days. The Earl of Glasgow, president, will occupy the chair. On behalf of the members of the Institution, the council has accepted an invitation to take part in the summer meeting of the Schiffbau Technische Gesellschaft, which is to be held in Düsseldorf on June 2. There will be no regular summer meeting of the Institution this year.

WE much regret to see the announcement of the death of Mr. A. W. Bennett, lecturer on botany at St. Thomas's Hospital, and the author of a number of books and papers on botanical subjects. Mr. Bennett was for several years the sub-editor of NATURE, and was an occasional contributor to these columns up to the time of his death, on January 23. He was sixty-eight years of age.

A MEMORIAL tablet is about to be placed in Harpenden Parish Church bearing the following inscription :—"In affectionate memory of Sir John Bennet Lawes, Bart., F.R.S., born at Rothamsted, December 28, 1814, died at Rothamsted, August 31, 1900. He used his long life and his great knowledge and experience as an agricultural chemist, and as a practical and scientific farmer, in the pursuit of truth, and for the benefit of his fellow men in his own country and in all parts of the world. This tablet is erected by the parishioners of Harpenden and others who deeply feel his loss as an example and friend."

THE Wellington correspondent of the *Times* states that at a public dinner given to the officers and men of the *Discovery* by the Philosophical Institute of Canterbury and the citizens of Christchurch, a number of interesting speeches were made. Captain Scott, who was loudly cheered, replying to the toast of "The *Discovery* Antarctic Expedition," said it was their intention to pass down the 175th meridian a little to the eastward of New Zealand. Then they hoped to pass down the east coast of Victoria Land, leaving records of what they had done. These records could be picked up by any relief expedition that might follow them. Next they would go to the south of

Victoria Land through those regions which Sir Thomas Ross discovered in 1840, and which they hoped to explore. They also hoped to pass along the ice barrier that stretched for 300 or 400 miles to the eastward. Then they would pass into the region of the unknown. When they returned to New Zealand, probably in two years' time, they might come back as beggars, for, though they had provisions and outfit for a three-years' cruise, wages and other things had been arranged for two years only.

THE following official statement of the plans of the Carnegie Institution (see p 278) is given in *Science*:—"It is proposed to found in the city of Washington, in the spirit of Washington, an institution which, with the cooperation of institutions now or hereafter established, there or elsewhere, shall, in the broadest and most liberal manner, encourage investigation, research and discovery, encourage the application of knowledge to the improvement of mankind; provide such buildings, laboratories, books and apparatus as may be needed, and afford instruction of an advanced character to students whenever and wherever found, inside or outside of schools, properly qualified to profit thereby. Among its aims are these: (1) To increase the efficiency of the universities and other institutions of learning throughout the country, by utilising and adding to their existing facilities, and by aiding teachers in the various institutions for experimental and other work, in these institutions as far as may be advisable. (2) To discover the exceptional man in every department of study, whenever and wherever found, and enable him by financial aid to make the work for which he seems specially designed, his life work. (3) To promote original research, paying great attention thereto, as being one of the chief purposes of this institution. (4) To increase facilities for higher education. (5) To enable such students as may find Washington the best point for their special studies to avail themselves of such advantages as may be open to them in the museums, libraries, laboratories, observatory, meteorological, piscicultural and forestry schools and kindred institutions of the several departments of the Government. (6) To ensure the prompt publication and distribution of the results of scientific investigation, a field considered to be highly important. These and kindred objects may be attained by providing the necessary apparatus, by employing able teachers from various institutions in Washington and elsewhere, and by enabling men fitted for special work to devote themselves to it, through salaried fellowships or scholarships, or through salaries, with or without pensions in old age, or through aid in other forms to such men as continue their special work at seats of learning throughout the world."

ALL the international balloon ascents which took place in Europe on the morning of December 5, 1901, were made in an extensive area of high barometric pressure, the centre of which lay over Germany. Two recording balloons were sent up from Trappes (near Paris); one reached 14,380 m., lowest temperature − 72°·9 C. (on ground − 1°); the other reached 14,900 m., lowest temperature − 75°·8 (on ground − 3°). The Strassburg balloon rose to 6580 m., minimum temperature − 30°·5 (on ground − 2°). From Berlin two recording balloons were sent up; at 7634 m. − 38°·7 was registered (on ground − 5°·4); at 9606 m. − 52°·8 was recorded (on ground − 4°). Two manned balloons also ascended. From Vienna − 40° was recorded at 6920 m. (on ground 1°). A manned balloon was also sent up. From Pavlovsk (near St. Petersburg) the greatest height attained was 3120 m., minimum temperature − 14°·7 (on ground − 11°). Mr. Rotch also sent up kites from Blue Hill Observatory in the afternoon. Temperatures of − 9°·9 at 1343 m. and − 9° at 800 m. were recorded. The kites remained up for two hours.

THE current number of the *Nineteenth Century* contains an instructive article on "The Reduction of Town Fogs," by the Hon. Rollo Russell. The author, who has for many years made a special study of the subject, divides fogs, so far as London is concerned, into four classes:—(1) Damp fog or mist with much cloud, from the ground up to about 1000 feet. Dust particles not numerous, and town clearer than country. (2) Damp fog or mist, dense in country. This type may be slight in London, especially if the fall of temperature has not been great. In mid-winter the fog tends to increase during the daytime in town, while in the country it rapidly dissolves. (3) Dense dry fog, with low temperature following a very cold night. It is anticyclonic in character, and the lowest strata of air are much colder than the strata at 500 to 1000 feet. Fogs of this kind are the most serious and most frequent in London; their approach can usually be foretold. (4) Occasionally a fog occurs after a severe frost, when a warm southerly wind displaces the cold air near the surface. This fog is most dangerous to traffic, being the densest. It is the least damaging to health, and may not reach more than 50 feet above the ground. The author considers that the need of the day is not so much scientific inquiry as administrative regulation, by which dark fogs might be reduced to almost harmless proportions. The preparation of forecasts is useful, as in the case of storms. Observations of the upper clouds are especially valuable in the prediction of fogs, but in London these clouds cannot always be seen; in such cases valuable data could be obtained by sending up a small balloon, with recording thermometer and hygrometer.

THE Meteorological Office pilot chart of the North Atlantic and Mediterranean for the month of February shows that very little ice was reported in the neighbourhood of Newfoundland during December, the latest date being the 11th, when a berg was seen not far from Cape Race. The Belle Isle route being closed for the winter, there were no reports from that region. Northward of Iceland unusually heavy ice has been seen. With regard to the paths of cyclonic disturbances, it is pointed out that on the eastern side of the Atlantic storm centres may be fallen in with, not only near the Azores, but even southward of the latitude of the Canaries. These, however, are much more erratic in their movements than those of the more northern ones, so that at times the changes of wind and barometer seem to be subject to no rule. On the western side of the ocean there are areas where the gale frequency this month is from 25 to nearly 40 per cent. of the wind records, the February storms being amongst the most violent and disastrous experienced in the course of the year, the exceptionally severe weather of February, 1899, being referred to as an illustration. This is the period of least fog about the banks of Newfoundland, the area of slightly more than 10 per cent. frequency being limited to a narrow strip across the southern extremity. The "smokes" of the Bight of Benin are mentioned, and it is stated as an unusual occurrence that a very dense fog visited Abaco Island, Bahamas, in February, 1901, dwellings being invisible at a distance of 100 feet. The remarks on currents deal with Rennel's Bay of Biscay current and the variations in the velocity of the Gulf Stream according to the time of day and of the lunar month, the daily maximum variation of strength being nearly 2 knots an hour and the mean daily variation about 1½ knots. In heavy gales on the coast of North Carolina strong local currents are set up which completely mask the tidal streams. Two inset charts illustrate the easterly and northerly types of weather over western Europe at this season, and the paths of Mediterranean disturbances are dealt with.

SOME years ago Prof. J. W. Moll made experiments on the effect of forcing water into cut stems; this was managed by tying the shoot into the short arm of a U tube, containing water, and

pouring mercury into the long arm. The method is still used for demonstration purposes, but it has certain disadvantages. One of these—namely, the fact that the pressure diminishes as the water passes into the plant—the author now proposes to remove by the use of the apparatus described in a paper on the hydrosimeter (Amsterdam Academy of Sciences, vol. iv., November 1901). The arrangement by which this is effected is simple and practical, and may no doubt be useful in other cases where it is desired to subject a plant to prolonged and constant pressure. The paper is illustrated by a drawing of the apparatus, and has the merit of being written in English.

LIGHT electric motor carriages, or "runabouts" as the Americans have termed this type of vehicle, were a feature of the recent exhibition of automobiles held in New York. According to the *Electrical World and Engineer*, the Electrical Vehicle Co. of New York was represented by a light car of this type weighing only 394 kg. and provided with a battery of the new Exide cell, capable of driving the carriage 64 km. at a speed of 22 km. per hour. The American Bicycle Co. exhibited an electrical carriage weighing 450 kg. The battery in this case was composed of thirty cells, and was of sufficient power to drive the vehicle for four hours at the rate of 27 km. per hour. The Baker Motor Vehicle Co. showed a light "Stanhope" weighing 405 kg., provided with a battery of ten Planté cells, capable of driving the carriage 64 km. on one charge. The battery weighed 140 kg. It would have been interesting to know the average life of the plates in these batteries under normal road and running conditions, but upon this crucial point nothing is said in the report before us. In large towns, where several generating stations exist, and where the recharging of exhausted batteries is a comparatively simple affair, we believe there is a useful future before this type of motor-vehicle.

PROF. P. ZEEMAN, in a paper recently read before the Amsterdam Academy of Sciences, (November 30, 1901), stated that he had been investigating the limits of resolving power attainable by means of the Michelson Echelon grating spectroscope, with an instrument consisting of thirty plates, each 7·8 mm. thick, set at steps of 1 mm. Testing by means of light sources in magnetic fields of gradually increasing intensities, he found that the resolving power was almost equal to its theoretical value.

IN a paper on the energy of the universe in the *Revue scientifique*, M. I. Skvortzow discusses the influence of electrical phenomena in cosmogony. He considers that in the past history of the earth, and of other celestial bodies, electrical and chemical energy have originally played the most important part, and that heat energy has become more and more important in proportion as the earth has assumed a more material form, so that the more its energy has passed from the dynamic to the static form the greater has been the absorption of dynamical energy in overcoming resistances. The heat of the earth M. Skvortzow attributes to electric currents circulating mostly near the surface; the interior of the earth, on the other hand, he thinks may be as cold as the greatest depths of the ocean. Changes in the aspect of the earth, as well as meteorological phenomena, are attributed to electric currents induced by solar influence. The temperatures of different planets are considered to depend less on their distance from the sun than on their reserve of energy and on the currents which the sun induces in them in virtue of their axial and orbital motions. Will this theory of the electromagnetic origin of the earth's heat reconcile the two opposing views on the age of the earth?

THE somewhat heated controversy which ensued at the beginning of last year on the occasion of the starting of the London United Tramway's electrical system has borne after-fruit in the paper on earth currents derived from distributing systems which was read last Thursday before the Institution of Electrical Engineers by Mr. E. B. Wedmore. The author treated the subject of the magnetic disturbance caused by the currents leaking from the rails of a rail-return tramway system from a mathematical and practical point of view, and also discussed briefly the electrolytic troubles that may arise. To judge by the paper itself and the discussion, which was of a very quiet nature, the whole subject is in need of further investigation. This applies, perhaps, more particularly to the question of the electrolysis of gas and water pipes. With most of the speakers it seemed to be an article of faith that the leakage currents under Board of Trade rules will not do any damage worth considering, but experimental evidence, which is doubtless very difficult to procure, is wanting. There still remains to be explained the presence of the fifteen amperes which were found flowing in the London United Tramways' rails before the system had started electrical working, and it is not to be wondered at if facts such as these make gas and water engineers feel uncomfortable. Another point brought out by two speakers is worthy of notice; the term earth currents has for long definitely meant the cosmic phenomena, and should not be applied to the leakage currents from tramways, or else confusion is sure to result.

THE Dumoulin process for the electro-deposition of copper in the form of tubes does not appear to have been very successful at Widnes, where a works for operation of this process was built in 1896–1897. According to the fifth annual report of the Electrical Copper Co., it has been decided to close the works permanently and to sell the plant, since at no period of its operation has a profit been earned. This failure to earn profits is ascribed, to the small output—only thirty tons per month, to the high price of fuel, and to the heavy interest charged on the loans raised by the company. The directors in their last report, however, still speak confidently of the value of their patents (which stand in their balance-sheet at 405,000*l.*), and negotiations are to be opened for the sale of these to refiners able to work the process on a larger scale of operations. We may remind our readers that the Dumoulin process depends upon the electro-deposition of copper upon revolving mandrils; specially treated strips of skin being used to supply the friction necessary for obtaining smooth and dense deposits. The process differs from the well-known Elmore process chiefly in this substitution of skin for agate burnishers; and it is noteworthy that in neither case has the financial success realised the early expectations of the promoters of the companies operating these processes.

A REPORT on the Rampur coal-field, which lies in the Central Provinces of India, north-west of Sambalpur, has been prepared by Mr. G. F. Reader (*Mem.* Geol. Survey, India, vol. xxxii. part ii.). A good steam coal, 7 feet 10 inches thick, and two other seams of workable coal, have been proved to exist. Their extension has, however, to be determined.

WE have received from Mr. A. Gibb Maitland, Government Geologist, the annual progress report for 1900 of the Geological Survey of Western Australia. A detailed geological map of Kalgoorlie has been prepared and will be published together with a full report on the geology of this important mining centre. The lodes are for the most part bands of basic rocks, which are characterised by strong foliation, by the alteration of amphibole into chlorite and carbonates of iron, lime, manganese and magnesia, and, finally, by the development of secondary silica, mica, pyrites, gold, tellurides of gold, &c. There are no grounds for believing that the mines of Kalgoorlie have reached the limit of ore deposition, or that the lodes will not prove productive in depth. Reports on other

metal-mining districts have been made; attention has been given to the possible extension of artesian water-bearing strata, and also to borings in search of coal near Albany, where in all cases the floor of older crystalline rocks was reached without evidence of coal-bearing strata.

FROM the Iowa Geological Survey, which is under the direction of Dr. Samuel Calvin, State Geologist, we have received the eleventh volume, comprising the annual report and accompanying papers for 1900. The papers are brief memoirs on seven counties, in which the geology is described, typical sections are noted in detail, fossils are recorded, particulars are given of economic deposits and soils, and the papers are admirably illustrated. The Survey is carried on with evident vigour and ability. Special reports on coal, artesian wells, lead and zinc ores have already appeared. Dr. S. W. Beyer, one of the special assistants, has now in preparation a monograph on Iowa clays, and others are working at the materials suitable for the manufacture of Portland cement. We are informed by Dr. Calvin that the demand for the publications of the Survey has, so far as the earlier volumes are concerned, exceeded the supply. Yet much ignorance prevails, and samples of yellow mica or iron pyrites are received almost weekly from persons who imagine they have discovered gold in Iowa; and an important part of the survey work is to prevent useless explorations for geological products.

THE *American Naturalist* commences the year well, some of the articles in the January number being of more than usual interest. Among them is one by Dr. R. W. Shufeldt, on the habits of kangaroo-rats in captivity, illustrated by a couple of excellent photographs of these curious little American rodents, taken by the author from life. The specimens, three in number, which Dr. Shufeldt had under observation belonged to the species known as *Perodipus richardsoni*, and became quite tame after a few days in confinement. "They hopped about," he writes, "with great agility on their hind pair of kangaroo-like legs, while the little short pair of anterior limbs were curled inwards on the chest. . . . They are able climbers, and the rapidity with which they can dig a burrow in ordinary ground is astonishing. They use the fore-feet to perform the digging part and the long and strong hind-legs to kick the loosened soil out of their way behind, as it accumulates every moment or so. In soft soil one of these little mammals can put itself out of sight in less than a minute by digging." It is added that kangaroo-rats are in the habit of turning their cheek-pouches inside out in order to clean them. In another article in the same journal, on the best method of mounting fishes for museum-exhibition, Mr. S. E. Meek pronounces in favour of quadrangular glass-vessels, in which the specimens, after being painted on the side to be shown with water-colours, are placed in alcohol as if swimming. It is added, however, that this method, although the best yet devised, is by no means perfect, and discussion is invited from experts in the hope that a more satisfactory way of exhibiting these animals may be devised.

A POPULAR account of the principles and performances of telegraphy without intervening wires is given by Mr. S. R. Bottone in his little book on "Wireless Telegraphy and Hertzian Waves," the second edition of which has been published by Messrs. Whittaker and Co. The first edition was noticed in NATURE of September 27, 1900 (vol. lxii. p. 522).

IN the letter on the influence of temperature on the action of nitric acid on metals, which appeared in NATURE of December 12, 1901, the words "the temperature abruptly rising from 80° C. to as much as 104° C." were printed as received from Dr. A. J. Ewart, who, however, now informs us that they should read "the temperature abruptly rising *to* from 80° C. to as much as 104° C."

A SECOND edition, revised and extended, of Dr. S. Rideal's work on "Water and its Purification" has been published by Messrs. Crosby Lockwood and Son. The original edition was reviewed in these pages on April 29, 1897 (vol. lv. p. 602), and the book remains substantially the same, though changes have been made in the chapter on the characters of natural waters, and there are several additions dealing with recent water epidemics and with sand filtration. It is a little surprising to find in a scientific book that the employment of a dowser or "water-finder" is suggested, and the cautious remark is made with reference to water-finding that "if further research should discover a physical law underlying the process, its utility would become more certain and extended." The same remark could just as reasonably be made of astrology, chiromancy, or any other process of divination.

A CATALOGUE of protected rheostats, measuring instruments and electrical apparatus relating to them has been issued by Messrs. Isenthal and Co. The rheostats have been devised to economise space on switchboards and elsewhere and to minimise the chances of short circuit. In the Electra Rheostats (Schindler-Jenny's patents) the resistance wires are embedded in a highly refractory, insulating material, and a protecting sheet of metal is cast around the latter. Instruments constructed upon this plan do not possess the defects commonly found in other embedded rheostats, and they are particularly suitable as motor-starting rheostats for continuous and rotary current. The Dimmer switches, also included in Messrs. Isenthal's list, provide a means of moderating the light of electric incandescent lamps. By means of a reducing rheostat in the switch the light of an electric lamp connected with it may be given four degrees of brightness, from the dimness of a night light to full luminosity. The measuring instruments include several types of voltmeters, ampèremeters, and cell testers, for workshop and laboratory use.

THE twenty-third communication from the laboratory of van 't Hoff to the Prussian Academy of Sciences, on the conditions of formation of the oceanic salt deposits, contains a summary of the results obtained from the investigation of solutions saturated at 25° C. with sodium chloride and containing the chlorides and sulphates of magnesium and potassium. As the result of this series of researches, the conditions of existence of a large number of the Stassfurt salts in contact with aqueous solutions, and inversely the conditions necessary for the separation of these salts from the mother liquors, have been accurately established. The salts or minerals for which these valuable data have been obtained are—bischofite, sylvine, thenardite, carnallite, glaserite, astrakanite, reichardtite, kieserite, schönite, leonite and kainite, all of which may separate from solutions at 25° C. The two salts langbeinite and löweite are apparently not capable of existence in contact with solutions at this temperature, and their occurrence in the Stassfurt layers points to the prevalence of a higher temperature than 25° C. in the formation of these natural deposits.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. C. Hunterbrocken; a Patas Monkey (*Cercopithecus patas*) from West Africa, presented by Mr. A. Richmond; two Sharpe's Wood Owl (*Syrnium nuchale*), a White-throated Monitor (*Varanus albigularis*) from West Africa, presented by Mr. William Cross; a Bengalese cat (*Felis bengalensis*) from the East Indies, two Egyptian Geese (*Chenalopex aegyptiacus*) from Africa, an Anaconda (*Eunectes murinus*) from South America, a Black Sternothere (*Sternothaerus niger*) from West Africa, deposited; a Barasingha Deer (*Cervus duvaucelli*) from the Himalayas, received in exchange.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY.

Feb. 1. 19h. 10m. to 20h. 29m. Moon occults β^2 Scorpii (mag. 5·2).
1. 19h. 10m. to 20h. 28m. Moon occults β^1 Scorpii (mag. 3·0).
3. oh. Mercury at greatest elongation (18° 17′ E.).
6. 17h. Jupiter in conjunction with moon. Jupiter 5° 26′ S.
8. 17h. Venus in conjunction with moon. Venus 3° 9′ N.
9. 9h. Mercury in conjunction with moon. Mercury 2° 23′ S.
12. 7h. 40m. to 8h. 18m. Moon occults ϵ Piscium (mag. 4·5).
14. 5h. 53m. to 6h. 45m. Moon occults σ Arietis (mag. 5·5).
14. 11h. Venus in inferior conjunction with the sun.
16. 6h. 24m. to 7h. 18m. Moon occults *i* Tauri (mag. 5·1).
17. 11h. 41m. Minimum of Algol (β Persei).
20. 8h. 30m. Minimum of Algol (β Persei).

VARIABILITY OF THE SATELLITES OF SATURN.—In the *Bulletin de la Société Astronomique de France* (January 1902), M. L. Rudaux directs attention to the probable variation in the brightness of the satellites Titan and Japetus, from evidence furnished by observations since 1892. He concludes that in the case of Titan the change is about half a magnitude, from 8·0 to 8·5, and, moreover, the variation appears to occur regularly at the same parts of the satellite's orbit. Maxima occur near and just after west elongation, and minima when the satellite is between superior conjunction and east elongation. A suggested explanation supposes the existence of fixed regions of different brightness and the rotation period equal to the time of revolution, as in the case of our own moon. There is a rapid passage from maximum to minimum.

The satellite Japetus is also thought to have equal periods for rotation and revolution, and the observation of Cassini is confirmed that the body almost becomes invisible in the eastern portion of its orbit. The variation is from the ninth to twelfth magnitude.

Prof. T. J. J. See refers to the variable visibility of Japetus in an article giving measures of the diameters of the satellites of Jupiter and Saturn in *Astronomische Nachrichten* (Bd. 157, No. 3764). He says, "The disc of Titan is rather obscure, but that of Japetus is even more so; in fact, only one side gives sufficient light to enable the observer to recognise a disc. This is visible when the satellite precedes the planet."

MAGNETIC OBSERVATIONS DURING TOTAL SOLAR ECLIPSE, MAY 18, 1901.—In a pamphlet reprinted from the *Overgedrukt uit het Natuurkundig Tijdschrift voor Ned-Indië* (vol. lxi., part iii. pp. 173–193), Dr. W. van Bemmelen presents the observations undertaken at Batavia and Karang Sago (Sumatra) during the last total eclipse of the sun on May 18, 1901. The determinations were made on behalf of the Batavia Observatory in response to the appeal of Dr. L. A. Bauer for accurate measures. The observations were made both visually and by means of self-recording photographic apparatus, reproductions from these latter being given. Although complicated by the presence of various common disturbances, the curves show decided irregularities about the time of eclipse which are thought to be due to the occurrence of that phenomenon. The observations at Batavia were only rendered possible by the courtesy of the Electric Car Company in stopping traffic over their lines from 11.30 a.m. to 2.30 p.m. on the day of eclipse.

SIMULTANEOUS VISIBILITY OF SUN AND TOTAL LUNAR ECLIPSE.—In the *Transactions* of the Vienna Academy of Sciences (Section of Mathematics and Natural Scienccs) No. xxiv. pp. 263–271, Herr Dr. C. Hillebrand directs attention to the possible observation of both sun and total lunar eclipse at such times when the phenomenon occurs as the moon is rising or setting. As the refraction at the horizon is greater than the diameter of the lunar or solar disc, the sun will be visible after true sunset or before true sunrise; the conditions for the eclipsed moon to be thus seen may be fulfilled at certain localities during the lunar eclipses of April 22 and October 16 of the present year.

THE VALIDITY OF THE IONISATION THEORY.[1]

Introduction.—The theory of electrolytic dissociation as advanced by Arrhenius in 1887 is based primarily upon the facts that the molecular conductivity of solutions increases with the dilution, that substances which, when dissolved, conduct electricity also have abnormally low molecular weights in such solutions when tested by osmotic or freezing- or boiling-point methods, and that the so-called degree of dissociation may be calculated from the electrical conductivity or the results of the molecular weight determinations. In his original article, Arrhenius states that the phenomena of electrolysis, when viewed from the standpoint of thermodynamics, require the assumption of free ions, as was pointed out by Clausius, and that the well-known additive properties of solutions support this hypothesis. Arrhenius sought to save van 't Hoff's theory of solutions from having but a limited application, and to extend it.

Van 't Hoff found it necessary to introduce the factor *i* in the case of electrolytic aqueous solutions in order to make them conform to the gas equation. This factor Arrhenius calculated from the electrical conductivity on the one hand and from molecular weight determinations on the other, the resulting figures showing an agreement to within 5 to 15 per cent. The agreement was not good, and the results were obtained exclusively from aqueous solutions. The non-aqueous solutions then known were practically non-conductors, and appeared to be fairly normal as regards van 't Hoff's theory, so that non-aqueous solutions in general came to be regarded as having normal molecular weights and as being non-conductors.

Behaviour of Non-aqueous Electrolytic Solutions.—Previous work has already shown that non-aqueous electrolytic solutions are frequently abnormal in the light of the ionisation theory. Thus in many cases the molecular conductivity decreases with increased dilution, *e.g.* NaI and NaBr in benzonitrile, $AgNO_3$ in piperidine, $FeCl_3$ in pyridine and in benzaldehyde, and CoI_2 in $POCl_3$. In other cases the molecular conductivity at first increases and then decreases with dilution, *e.g.* $FeCl_3$ in paraldehyde, CBr_3COOH in $POCl_3$. Many solutions which, according to molecular weight determinations, are undissociated, conduct well. Thus $AgNO_3$ has a normal molecular weight in pyridine and benzonitrile, yet it conducts fairly well. According to Dutoit and Friderich, CdI_2, LiCl, NaI, $HgCl_2$ and NH_4CNS have normal molecular weights in acetone, and yet these solutions are conductors. Walden has found that KI, NaI, RbI, NH_4I and KCNS conduct well in liquid SO_2, and yet have abnormally large molecular weights in this solvent. Franklin and Kraus have found that while NH_4NO_3, $NaNO_3$ and KI dissolved in liquid ammonia are excellent conductors, the boiling points of the solutions are not nearly so high as they ought to be according to the ionisation theory. Nicolo Castoro found by means of the freezing-point method that $AgNO_3$, $CdCl_2$, $HgCl_2$ and $ZnCl_2$ have normal molecular weights in urethane; yet the author has found that the first three of these solutions are conductors. Recently, Innes found the molecular weights of succinic, salicylic and tartaric acids to be normal in pyridine according to the boiling-point method; preliminary tests by the author have shown that all three of these solutions are fairly good conductors.

In the case of non-aqueous solutions the various methods of observing ionisation do not always give the same indication with increasing dilution; it is sometimes in one direction and sometimes in the other. Occasionally simple substances in solution show abnormally low molecular weights, and yet are non-conductors. The author has found this to be so in the case of solutions of diphenylamine in methyl cyanide.

The abnormal behaviour, according to the theory, of non-aqueous solutions led the author to investigate aqueous solutions somewhat further.

Experimental Part.—The investigation consisted of four parts:—(1) Determination of boiling points of aqueous solutions of typical, common, chemical compounds from low to very high concentrations, to see how the molecular weight changes with the concentration. (2) Measurement of the conductivity of these solutions at or near their boiling points. These two parts of the work were carried out by Mr. A. A. Koch. (3) Measurement

[1] Abstract of a paper by Mr. Louis Kahlenberg in the *Journal of Physical Chemistry* (vol. v. pp. 339–392, June, 1901).

of conductivity at 0°. These determinations were made by Mr. R. D. Hall. (4) Cryoscopic determination of the molecular weights. The results of (1) and (2), and also of (3) and (4), were comparable, being under similar conditions.

The conductivity determinations were made by means of the usual Kohlrausch method with a telephone. The measurements at 0° were made in baths of melting ice. Those near the boiling point were not carried out at the boiling point, but at 95°, as small gas bubbles were apt to form at the electrodes at 100°. The freezing-point determinations were made with a regular Beckmann's apparatus of large size, about 40 grammes of water being used in each case. The solutions were cooled only from two to three tenths of a degree below their freezing points, and the crystallisation was inaugurated by means of a point of ice. The boiling-point determinations were made with a Beckmann's apparatus of about double the ordinary size, and thermometers graduated to 0°·01. It was at first thought best to surround the thermometer with a platinum cylinder in the boiling tube, as recommended by Jones, but fluctuations in the boiling point were found to result, apparently due to the solution within the cylinder being more concentrated than that without.

The water used was distilled in a block-tin condenser and had its conductivity reduced to 2×10^{-6} by drawing air through it free from carbon dioxide. In the results given, the conductivity of the water at the proper temperature has been deducted. Water of crystallisation was determined and allowed for in making up solutions, these being based on the amount of anhydrous salt present.

Conductivity measurements at 0° and at 95° are given for NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $AgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$. The volume in litres containing a gramme equivalent was varied from ¼ to 8192 in the case of the determinations at 0°, and from ½ to 2048 in the case of those at 95°. The results show an increase of the equivalent conductivity with dilution and the same trend in the curves at the two temperatures, but they are not parallel. For example, the curve between equivalent conductivity and the cube root of the volume is nearly a straight line for $MgSO_4$ at 95°, but much more curved at 0°. Curves of salts belonging to any one group all have the same trend.

The freezing-point determinations include NaCl, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$. The results are summarised below :—

Sodium Chloride.—For about 0·2 normal solution the molecular weight was found to be 32·6, equivalent to 79·4 per cent. ionisation; for an approximately normal solution (the strongest used) the molecular weight was 31·7, equivalent to 84 per cent. ionisation. According to the conductivity tests the ionisation is about 79 per cent. for a 0·2 normal solution and 70 per cent. for the normal solution. The results are, therefore, about the same by both methods for the dilute solution, but whereas the ionisation increases rapidly with dilution according to the conductivity, it remains constant or diminishes according to the cryoscopic method. This result is confirmed by the work of C. Dieterici and of R. W. Wood.

Magnesium Sulphate.—The limits were about 0·1 and 1·5 normal. The degree of ionisation for the first was 40 per cent. and for the second only 5 per cent. According to the conductivity measurements the ionisation should be 44 and 22 per cent. respectively, showing an increasing discrepancy with concentration.

Zinc Sulphate shows no ionisation in a normal solution, yet the conductivity is nearly the same as that of $MgSO_4$, and indicates 24 per cent. ionisation. The molecular weight in the strong solutions was above the normal.

Manganous Sulphate shows at first an increase of molecular weight with concentration and then a decrease. The same is true of $ZnSO_4$ and $CdSO_4$, and to a slight extent of $NiSO_4$, $CoSO_4$ and $CuSO_4$. According to the conductivity of these solutions, the ionisation increases constantly with the dilution, but according to the cryoscopic measurements there is first a decrease and then an increase with increasing concentration. An approximately N/4 solution of $MnSO_4$ gave a molecular weight of 125·2, or 21 per cent. ionisation, the conductivity method giving 35 per cent. In a solution giving a molecular weight of 146·5 the ionisation is 3 per cent., whereas conductivity indicates 20 per cent.

Cadmium Sulphate, though a good conductor, shows no ionisation except in the most dilute solution (3·071 gm. $CdSO_4$ in 100 gm. of water), which gave 12 per cent. ionisation, the conductivity indicating 30 per cent.

Nickel Sulphate appears to be un-ionised when the strength is 10 per cent., but the conductivity shows 22 per cent. ionisation. In the most dilute solution the two methods gave about the same result.

Cobalt Sulphate.—The freezing point shows no ionisation when the solution is 5 per cent. or stronger, whereas the conductivity indicates 26 per cent. when the observed molecular weight is 155·2. In the most dilute solution the molecular weight was 131·8, corresponding to 18 per cent. ionisation, the conductivity indicating 34 per cent.

Ferrous Sulphate also is un-ionised in 6 per cent. solutions or above, according to cryoscopic determinations, yet the conductivity indicates 24 per cent. ionisation when the observed molecular weight is 154·8 (*i.e.* above the normal), and ionisation should be absent. The most dilute solution showed a molecular weight of 135·8, or 12 per cent. ionisation, the conductivity indicating 30 per cent.

Copper Sulphate is like the last two salts. When the observed molecular weight is 163·9, corresponding to no ionisation, the conductivity indicates about 22 per cent. In the most dilute solutions tested the molecular weight corresponds to 38 per cent. ionisation and the conductivity to 32 per cent.

The results obtained with copper sulphate are as follows, similar results for the other salts being given in the original paper :—

Copper Sulphate ($CuSO_4$). *Molecular Weight*, 159·7.

Amount of $CuSO_4$ in 100 gm. water.	Lowering of freezing point.	Molecular Weight.
1·835	0·300	115·6
3·312	0·405	154·6
6·443	0·743	163·9
9·242	0·996	175·4
14·210	1·569	171·2

The agreement, therefore, of the methods, viz. conductivity and freezing points, is poor, even in the dilute solutions. Arrhenius originally gave figures from cryoscopic measurements indicating no ionisation for $MgSO_4$, $FeSO_4$, $CuSO_4$, $ZnSO_4$, $CdSO_4$ and CdI_2, whereas ionisation was indicated by conductivity. He sought to explain this, in the case of the sulphates, by polymerisation of the un-ionised molecules, basing this assumption on the fact that Hittorf found the migration numbers of $MgSO_4$ and $ZnSO_4$ to show a considerable variation with concentration. This was also true of CdI_2, for which Hittorf consequently assumed double molecules, and applied the same explanation to other salts of the magnesia series. This at first seems to justify the position taken up by Arrhenius. However, the latter has not applied the explanation to all salts of the magnesia series, but has assumed polymerisation simply for those salts that did not behave according to his theory. $MgCl_2$ is a case in point. Similarly, Hittorf found the migration numbers of $CaCl_2$, $BaCl_2$, $Ca(NO_3)_2$ and $Ba(NO_3)_2$ strongly dependent on concentration, but Arrhenius did not assume polymerisation, for these salts agree better with his theory. To assume polymerisation in the case of $MgCl_2$, $CaCl_2$ and $BaCl_2$ would render it difficult to explain the results of Jones and Chambers, who found a minimum for the molecular lowering between 0·1 and 0·2 normal, and that the lowering in concentrated solutions was as great as, or greater than, that corresponding to complete ionisation. These authors attempt to explain this by assuming that the salts form hydrates. Thus another theory is brought in to account for abnormally low freezing points, to explain which the ionisation theory was itself originally introduced. Results of a similar kind have been observed by C. Dieterici.

The boiling-point determinations given by the author refer to NaCl, KCl, KBr, KI, $MgCl_2$, $BaCl_2$, $HgCl_2$, $KClO_3$, KNO_3, $AgNO_3$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, $CdSO_4$, $NiSO_4$, $CoSO_4$, $FeSO_4$ and $CuSO_4$.

In the case of NaCl, KCl, KBr and KI the molecular weights continually diminish with increase of concentration, finally becoming less than half the theoretical values, whereas the molecular conductivity increases regularly with the dilution.

The molecular weight of $MgCl_2$ and of $BaCl_2$ decreases with increasing concentration until it becomes less than one-third the theoretical value, but the conductivity in both cases increases with the dilution.

$HgCl_2$ shows no ionisation by the boiling-point method. The molecular weight increases with concentration. It might be assumed that polymerisation takes place and, further, that some of the molecules which are not yet polymerised are ionised and thus account for the conductivity, which, though low, increases with the dilution.

In the case of $KClO_3$, KNO_3 and $AgNO_3$ the molecular weight increases with concentration, and there is good agreement with the conductivity measurements. Thus $AgNO_3$ in the most dilute solution tested appeared to be ionised to the extent of 65 per cent., while the conductivity method showed 67 per cent. For a normal solution the boiling-point method indicated 54 per cent. and the conductivity 52 per cent. The agreement is closer at the boiling point than at the freezing point.

In the case of $MgSO_4$ the molecular weight begins, in the dilute solution (2·733 gm. in 100 gm. of water), with a value above the theoretical, indicating no ionisation ; then it increases with the concentration, and finally decreases after passing through a maximum, the values in the concentrated solutions becoming less than the theoretical. But there is no irregularity in the conductivity values. What has been said of $MgSO_4$ applies also to $ZnSO_4$, $NiSO_4$ and $CuSO_4$. The same general behaviour is also exhibited by $MnSO_4$, $CdSO_4$, $CoSO_4$ and $FeSO_4$, except that the molecular weights of these salts, while first increasing and then decreasing with increase of concentration, always remain above the theoretical values. The molecular weight of the sulphates is less by the freezing-point results than by the boiling-point method. So that if it be assumed that the molecules are polymerised, this polymerisation is greater at the higher temperature.

A series of boiling-point determinations was made on a solution of cane sugar, as an example of a non-electrolyte. It was found that the molecular weight diminished appreciably as the concentration increased, becoming less than the normal (212 in a solution of 289·4 gm. in 100 gm. of water, as compared with the normal 342). But, as is well known, the solution does not conduct. A test with Fehling's solution showed that no invert sugar had been formed by the boiling. Solutions of H_3BO_3, on the other hand, show practically constant molecular weight with varying concentration.

Discussion of Results.—From the above results it appears that there are solutions which are excellent conductors and which, nevertheless, show a normal molecular weight of the solute. While in some cases the molecular weight increases with the concentration, thus agreeing qualitatively at least with the ionisation theory, in other cases the molecular weight decreases with increase of concentration, finally becoming less than what it ought to be even for complete ionisation. In other cases the molecular weight at first increases with concentration and then diminishes. But the conductivity of these solutions continually increases with dilution. There are cases, however, in which the conductivity at first increases with the dilution and then decreases, *e.g.* aqueous solutions of the alkaline hydroxides.

It follows, therefore, that there is no such connection between freezing points and boiling points of solutions on the one hand and their conductivity on the other as is claimed by the ionisation theory. Often there is not even a qualitative agreement. Want of agreement is to be found in the original table of Arrhenius, but this was ascribed to experimental errors.

Various properties of electrolytes have been explained by the ionisation theory. Thus the various additive properties of salt solutions are presented as supporting the theory. But the theory cannot be based on additive properties of this kind, for such are known to exist in the case of true chemical compounds, where, since there are no solutions under consideration and since there is no electric conductivity observable, the possibility of ionisation is out of the question. In the realm of physiology, also, the theory cannot cope with the facts.

The heats of neutralisation of acids and bases have been used as an argument in favour of ionisation ; Crompton, however, has shown that the theory is not only unnecessary, but that it is inadequate. Again, the theory cannot be brought into harmony with the law of mass action, which is one of the strongest arguments against it.

The chemical reactiveness of electrolytes has been explained by attempting to ascribe to the ions a peculiarly strong chemical activity on account of the electrical charges that are supposed to reside upon them. In this connection attention is drawn to the action of water in frequently facilitating chemical action. While this fact may be in agreement with the ionisation theory, it cannot be used to support it ; for there are many pure substances and mixtures that are very active, although there is no ground for assuming the presence of ions ; *e.g.* many explosives. It is well recognised that many bodies unite with the solvent, and interaction then takes place between the new products, reactions taking place which might easily not occur between the original anhydrous bodies.

It has been supposed by Nernst and by J. J. Thomson that the higher the dielectric constant of a solvent the greater its ionising power. But many exceptions are now known, *e.g.* liquid NH_3, butyronitrile and pyridine (H. Schlundt), liquid SO_2 (Walden), liquid HCN, and amylamine.

That the ionising power of solvents is dependent upon the polymerisation of their molecules, as claimed by Dutoit and Aston, has been shown to be incorrect in many cases by Kahlenberg and Lincoln.

The ionisation theory is at its best in explaining electrolysis, but there are many phenomena which the theory does not explain. For example, why are the deposits of silver from some solutions poorly adherent and from others dense and well adhering, the potential difference and current density being the same ?

As to the ionisation theory being required by thermodynamics, Clausius, who showed the discrepancy in the Grotthus theory, did not find it necessary to put forth such a radical hypothesis as that of Arrhenius. Nor did Hittorf find it necessary to frame such a theory. Finally, no marked improvements or discoveries in electrolysis are due to the theory. It has led to Nernst's theory of the E.M.F. of galvanic cells and a formula which really involves the assumption that the law of mass action is applicable to electrolytes in the sense required by the ionisation theory. That this law does not hold has already been mentioned. By maintaining the correctness of this formula and thus assuming that the law of mass action holds for electrolytes, Jahn has arrived at the conclusion (as clearly he must) that the ratio of the equivalent conductivity at a given concentration to that at infinite dilution does not correctly represent the degree of ionisation, and that the ionic velocities vary in dilute solutions. This has given rise to a discussion in the *Zeits. Phys. Chem.*

If the ionisation theory is not true, then the original difficulty with the van't Hoff theory of solutions recurs, viz. the theoretical interpretation of the factor i in the gas equation. Of course this equation is supposed to hold strictly only for ideal gases. A normal solution, however, is rather dilute for many of the practical purposes of life. Not that one expects the gas equation to hold strictly for a normal solution, but what one has a right to expect from the modern theory of solutions is that, with increasing concentration, a solution should behave at least qualitatively as a gas does with increase of pressure. The ionisation theory does not satisfactorily explain the significance of the factor i. In any case this factor should never be placed equal to unity without experimental evidence, whether in connection with electrolytes or non-electrolytes.

Substances of similar chemical composition, when dissolved in the same solvents, behave similarly so far as boiling points or freezing points are concerned ; this shows that the influence of the chemical nature of the solute affects these variations.

The analogy between gases and solutions has been pressed too far, so that it has been forgotten that we are dealing only with an analogy. The solution of a substance and the expansion of a gas are really very different. A gas will expand in vacuo or mix with any other gas, but a substance will not dissolve in every liquid. And here lies the difficulty of the theory. It neglects the all-important *rôle* of the solvent. It fails to emphasise the fact that the process of solution takes place because of a mutual attraction between solute and solvent, and this attraction is the essence of the so-called osmotic pressure, which is closely related to, if not essentially identical with, chemical affinity. The attraction between solvent and solute should be recognised. Each solution should be examined separately, beginning with the most concentrated, the behaviour of the most dilute solutions appearing as a limiting case ; then we shall see the present theory of solutions in its true relation to the facts.

W. R. C.

AN ITALIAN ELECTRIC RAILWAY.

THE motive power on our great railways forms such an important question that any enterprise made with a new motive power, electricity or otherwise, adapted so as to utilise the existing rolling-stock, not only may at some future time greatly accelerate the present speed, but also introduce great economies, especially if the new power can be derived from a natural source. In Italy the railway authorities have been thoroughly alive to this fact; a portion of the railway of northern Italy has been electrically equipped for running by means of electric motors, as a pioneer installation, and if successful the remainder will be similarly equipped. The Valtellina electric railway (says *Feilden's Magazine* for January), which is sixty-two miles long, runs from Lecco along the shores of Lake Como to Colico, where it divides, one branch going to Sondrio and the other to Chiavenna. The power of the line is furnished by falling water from the river Edda, which operates four turbines (2000 h.p. each) and which, coupled direct with four Schubert three-phase generators, give a current at 20,000 volts and 15 cycles. This current is led to ten substations (placed about six miles apart) along the route, where it is transformed to 3000 volts, at which voltage the various sections of the line are fed. The two overhead trolley wires which supply the motors (the railway track forming the third) are hung from steel wires supported on each side by posts spread with crossbeams; these also carry the main supply wires (20,000 volts). The traffic of the line comprises both goods and passenger, and it is worthy of note that for the former electric locomotives are used for the haulage of the wagons (which are of the standard Italian type), and for the passenger traffic bogie motor-cars act in place of locomotives and pull four coaches as trailers (these latter also of the ordinary Italian type). A train of this description is run at thirty-nine miles per hour on all gradients less than 10 per cent.; for anything steeper than this "the Cascade" arrangement of motors is used, then the speed is halved. The speed of the goods traffic is twenty miles per hour with a load of 250 tons. The line is equipped with every facility for safe working, everything being made as automatic as possible. For instance, "when a train receives a block signal it also has its current cut off so that it cannot proceed." Again, "where a train is coming up at full speed, and it is necessary to order it to stop owing to sudden occurrence of something in front, the signalman not only makes the signal to stop, but he also cuts off the current and applies the full brake power available to the advancing train." Lightning has been fully guarded against. The power house is supplied with a group of conductors of the "Horn" type outside the building, and lightning arresters of a similar type are fitted in the substations, and, lastly, the electric locomotives and motor-cars have also similar apparatus fitted. The working of the line will not only be watched with interest, but also forms an important example of electric traction on account of its newness in design (especially in detail), and the thorough way in which the system is made automatic and interlocking and also safely guarded against accidents.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. E. Johnson, of King's College, has been appointed the first Sidgwick lecturer in moral science.

The Balfour studentship in animal morphology will be vacant at Lady Day next. Applicants are requested to send their names, with such information as to their qualifications and proposed researches as they may think desirable, to Mr. J. W. Clark, Scroope House, Cambridge, by February 28.

The complete degree of M.A. *honoris causa* is to be conferred on Dr. W. E. Dixon, London, assistant to the Downing professor of medicine.

THE proposal to establish a University of Liverpool was warmly supported at a meeting held at the Liverpool Town Hall on Monday, the Lord Mayor of the city being in the chair. At the close of the meeting it was announced that the sum of 80,0000*l.* has been promised in support of the scheme.

THE Lord Lieutenant of Berks (Mr. J. Herbert Benyon) has been elected president of Reading College, in succession to the late Lord Wantage. A fund of 1000*l.* a year for five years has been raised to augment the existing income. Lady Wantage, Mr. Benyon and Mr. Alfred Palmer have each contributed 250*l.* a year to this fund.

IT is proposed to erect a bronze tablet in the museum at Marischal College, Aberdeen University, in honour of the late Prof. H. Alleyne Nicholson. Prof. J. Arthur Thomson and Mr. J. E. Marr, F.R.S., have undertaken the preliminary steps and are prepared to receive subscriptions from "those who were friends, colleagues, collaborateurs or old students" of Prof. Nicholson.

MR. T. J. I'A BROMWICH, Fellow of St. John's College, Cambridge, has just been appointed professor of mathematics in Queen's College, Galway, in succession to Prof. A. C. Dixon, lately appointed professor of mathematics in Queen's College, Belfast. Mr. Bromwich graduated as senior wrangler in 1895, and subsequently obtained a first class (first division) in the second part of the mathematical tripos. Since taking his degree he has made a number of original contributions to various branches of mathematics.

ANNOUNCEMENT is made in the *Times* that Lord Curzon, the Viceroy of India, has appointed a commission to visit the University centres and colleges of India to inquire into their prospects, report on their working, and recommend measures for the improvement of the teaching and the standard of learning. The commission is composed as follows:—Mr. T. Raleigh, president; Syad Hossain Bilgrami Nawab; Mr. J. P. Hewett, Secretary to the Home Department; Mr. A. Pedler, Director of Public Instruction in Bengal; Prof. A. Bourne, Principal of Madras College; and the Rev. Mr. Mackichan, Principal of Wilson College, Bombay. Mr. R. Nathan will act as secretary.

PROTESTS are being made against the dissolution of Victoria University. It is suggested that there might be one great University for the north and not several connected with single cities. At a meeting of graduates of Victoria University held at Leeds on January 24, a resolution was unanimously adopted expressing the conviction that to abolish the Victoria University would be detrimental to the interests of higher education in the north of England. A committee was appointed to attend an approaching meeting at Manchester in connection with the Victoria University and protest against its disruption. The board of governors of the Yorkshire College, Leeds, has adopted a resolution expressing the view that though the dissolution of the Victoria University in favour of separate universities would be detrimental to the interests of education in the north of England, still, having regard to the resolutions passed by Owens College, Manchester, and University College, Liverpool, preparations should be made for the establishment of a University for Yorkshire based upon the existing Yorkshire College, with provision for the admission of other constituent colleges and for the affiliation of other suitable institutions.

THE annual meeting of the Association of Directors and Organising Secretaries for Technical Education was held on Friday last. Mr. A. Keen, the president, delivered an address dealing with the question of rural education. He urged that what are wanted are:—(1) A system of suitable elementary instruction which should include practical work in every standard; (2) a good supply of secondary schools at low fees of the rural grammar school or modern school type, taking, say, the Rural School of Science course in the Government Directory, and such other studies as the circumstances of different districts might direct; (3) a more limited supply of higher secondary schools of the high-grade grammar school type for boys and girls who were intended to continue their education beyond the usual age, and probably go to a university or some other place of advanced education; and (4) for the benefit of boys intended to be farm bailiffs, agents, stewards, farmers, or market gardeners, and especially those who had no suitable means of acquiring at home an intimate knowledge of farm and garden work and general practical experience, there should be in every large county, and in every group of smaller ones, a farm school, or an agricultural school or college, for boys of fifteen to sixteen years of age and upwards, providing a course of instruction for two or three years of a thoroughly practical character.

AN interesting introductory address delivered by Prof. Wilson, professor in anatomy at Sydney University, has been sent to us. The address is entitled "Ideals in Medical Education"; it is

well worthy of careful perusal, and in a short paragraph only the very salient points can be touched upon. The author begins with a plea for centralisation and a note of warning against the multiplication of universities, when ample means are not to hand for their equipment. Local convenience is undoubtedly an important consideration, as is also emulation between districts for the possession of intellectual centres, but both of these should be subordinate to the true interests of education. The equipment of the modern university is necessarily a very costly matter. The next point we can consider is the length of the medical curriculum. Prof. Wilson directs attention to the value of general education to the medical student, and views with regret the abolition by many universities of the obligatory preliminary degree in "Arts." In this connection he refers to the new regulations at Harvard, in which it has been enacted that the medical student shall undergo a preliminary four years' course in arts before entering upon his four years' medical curriculum. In view of the present controversy concerning elementary medical education, it is of interest to note that the author appears to accept the general educational value of special medical studies, but is apparently not in favour of the relegation of physics, chemistry and biology to the schools. The chief reason against this is the assumption that it would still add another year to the curriculum, and "this might be as well done frankly under university guidance." It may be objected, however, that the boy could perfectly well begin these studies at sixteen, and it is certainly a very open question whether at such an age he is better at the school or university. With regard to pharmacology, Prof. Wilson would relegate the experimental part entirely to the physiologist and the therapeutical part entirely to the physician. He apparently does not see in pharmacology as at present taught what he describes so accurately in the case of general pathology, namely, a "bridge-like" position in the medical curriculum, fitting the student, when essentially pursuing the intermediary subjects, for the problems awaiting him in the wards, and enabling him to utilise to the full the relatively small clinical experience which he will obtain. In conclusion, Prof. Wilson admits that the medical curriculum is at present full to overflowing, and recommends a somewhat novel plan to relieve it. He suggests, and instances certain American universities as precedents, a more universal use of the honours system. He would establish a system of "elective studies," would allow the student to specialise earlier in his career, and while demanding certain evidence of all-round knowledge, would very considerably reduce the standard in it, according to the depth and thoroughness of the work done by the student in certain directions. It must be admitted, however, that the magnitude of the irreducible minimum would be difficult to decide, as would also the thoroughness of "work done by the student in certain directions."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 23, 1901.—"On the Intimate Structure of Crystals. Part v.—Cubic Crystals with Octahedral Cleavage." By Prof. W. J. Sollas, F.R.S.

November 21, 1901.—"On Skin Currents, Part ii. Observations on Cats." By Augustus D. Waller, M.D., F.R.S.

In part i. it was stated that the normal electrical response of frog's skin to excitation is outgoing, from internal to external surface. In the skin of the pad of the cat's foot the electrical effect of excitation of the sciatic nerve proved to be ingoing, as stated by Luchsinger and Hermann. Dr. Waller determined this fact by decapitating cats and immediately testing the effect of excitation of the sciatic nerve on the pad of the foot; the effect gradually declines and disappears an hour after decapitation. It is pointed out that this experiment on a freshly killed animal is a convenient class demonstration of a fundamental fact which it has hitherto been thought necessary to demonstrate on living animals. The effect is elicited after the sciatic has ceased to provoke muscular contraction; the largest response observed and photographed was ·0100 volt, the lost time was three seconds.

In order to observe the response to direct excitation, the pad of a cat's foot was cut off and set up between unpolarisable electrodes; during the first forty-eight hours there is a normal ingoing current of ·0100 volt. If after exact compensation of this current a single induction current is sent in in either direction, the after-effect is nearly always outgoing, as in frog's skin; an ingoing effect is observed with a fresh skin and weak excitation.

Dr. Waller thinks it probable that both ingoing and outgoing forces may co-exist in the excited skin, the galvanometer expressing the resultant. In order to investigate the causes of the variability of the direction of response, the A B C method is devised:—Three electrodes are applied to the external surface of the skin, the third electrode C being used to examine separately the effects at A and B. By means of an especially designed switch called the M-shaped switch, an excitation can be applied at A and B, and the response led off through C and A, or C and B. The response is found to be always an outgoing current at A or B for both directions of excitation.

Physical Society, January 24.—Prof. S. P. Thompson, president, in the chair.—A paper on the factors of heat was read by Mr. James Swinburne. In all branches of physics, except heat, energy is divided into pairs of factors. Heat is generally thought of as a sort of indivisible energy and is not split into factors, but is treated as a whole, so that we have conductivity for heat, capacity for heat, specific heat, &c. Capacity for heat and specific heat are also taken when they include external work, at constant pressure for instance; so that the capacity is reckoned as capacity for energy which is only partly in the body or substance. So little is heat realised as energy that it has its own unit, so that equations involving other forms of energy with it need to be complicated with a coefficient. Temperature might be a factor of heat, but there is no corresponding quantity factor. There is no unit of temperature, it is measured in degrees which have no proper connection with anything. Temperature is sometimes treated as a tension factor with heat as the quantity factor, as when heat is said to run down temperature. Heat is thus regarded as its own quantity factor. Entropy is sometimes incorrectly used as the quantity factor corresponding to temperature. Entropy is at present indispensable as a function involving information as to whether heat has been or might have been converted into work. The author discusses "chy" as a possible factor for use with absolute temperature where "chy" is a quantity factor such that when multiplied by the temperature at which it is added or withdrawn gives the energy added or withdrawn. In the θ, χ system capacity, specific capacity and conductivity vary inversely as the temperature. These factors are not analogous with the factors of other forms of energy and are not convenient. The energy of heat is therefore split into $\tau\,\pi$, where τ is proportional to the square root of the temperature and is called by the author "tasis." The other factor, π, is called "posot." In any gas, tasis is proportional to the effective velocity and posot to the momentum. Tasis and posot are analogous to the tension and quantity factors already in successful use and indispensable in the treatment of other forms of energy. Conductivity of posot follows Ohm's law and the capacity of a body for posot is constant.

Chemical Society, January 16.—Prof. J. Emerson Reynolds, V.P.R.S., president, in the chair.—An investigation of the radio-active emanation produced by thorium compounds, by Prof. Rutherford and Mr. Soddy. The authors have previously shown that whilst thoria gives rise to a Becquerel radiation, it also communicates to gases passed over it a radio-active substance referred to subsequently as the emanation. They find that the emanating power of the oxide is destroyed by heating and can be restored by reprecipitation, and, further, that probably the emanating power is not a specific property of thoria, but is due to the presence of some foreign substance. As regards the nature of the emanation itself, it appears to be a gas of the argon type, since it is not destroyed by such powerful agents as red-hot lead chromate, white-hot platinum black, red-hot magnesium, &c.—The constitution of hydrocyanic, cyanic and cyanuric acids, by Dr. F. D. Chattaway and Mr. Wadmore. It is generally assumed by chemists at the present time that in these substances the hydrogen is joined to carbon and that they must be represented by such formulæ as H.C⁞N, HO.C⁞N, &c. The view that they are really the *iso*-compounds of the formulæ C:N.H, O:C:N.H, &c., is again brought forward by the authors, and the evidence afforded by the behaviour of the haloid cyanogen compounds—which is that of substances containing the haloid joined to nitrogen—is shown to necessitate their representation by such *imino*-formulæ.—A modification of Zeisel's method for the estimation of methoxyl groups, by Dr. J. T. Hewitt and Mr. T. S. Moore. The

complicated apparatus designed by Zeisel is greatly simplified by the substitution of a fractionating column consisting of nine aludels, alternately closed and open, arranged in series in a glass tube, for the sloping condenser with water at 40° C. and the washing bulbs containing amorphoric phosphorus. Results obtained with codeine and quinine proved that this rearrangement is effective in retaining iodine and hydriodic acid.—A new colour reaction of hydroxylamine, by Mr. W. C. Ball. When a solution of hydroxylamine or its salts is boiled with a solution of ammonium-sulphite until sulphur begins to form and to the liquid a strong solution of ammonia is added, together with a few c.c. of alcohol, a fine purple colour is produced which is visible when only one part of hydroxylamine in 500,000 of water is used.—On the sensitiveness of a thermoregulator, by Mr. A. W. C. Menzies. A description of an apparatus whereby a definite temperature may be maintained over considerable periods with a maximum variation of ·0025 of a degree.—Myricetin, Part ii., by Mr. A. G. Perkin. An account is given of the methyl and ethyl ethers of this colouring matter, extracted from the bark of the Indian tree *Myrica nagi*, and which has already been shown by the author to be a hydroxyquercetin. Myricetin appears not to occur free in the plant, but in the form of a rhamnose ether (glucoside), which has been named *myricetrin* ($C_{21}H_{22}O_{13}$).—The colouring matters of green ebony, by Messrs. A. G. Perkin and S. H. C. Briggs. This dyewood contains (*a*) *excoecarin*, $C_{13}H_{12}O_5$, easily oxidised by bromine to *excoecarone*, $C_{13}H_{10}O_5$, and hydrolysed by potash fusion to hydroquinone carboxylic acid. (*b*) Jacarandin, $C_{14}H_{10}O_3(OH)_2$, which appears from its reactions to belong to the quercetin series of dyes.—The action of methylene iodide on aryl- and naphthylamines; diaryl methylene diamines, acridines and naphthacridines, by Dr. Senier and Mr. Goodwin. With anilines, toluidines and xylidines, diamines are formed, but with amine of condensed substances such as naphthalene, bodies of the acridine type are produced.—The polymerisation of cyanic acid, by Dr. Senier and Mr. T. Walsh. In this reaction cyamelide is not, as is generally supposed, the only product, a quantity of cyanuric acid being also formed.

Mathematical Society, January 9.—Dr. Hobson, F.R.S., president, in the chair.—The president (Major MacMahon, F.R.S., vice-president, in the chair, *pro tem.*) communicated a paper on non-uniform convergence and the integration of series. Messrs. Larmor, Love, Whittaker and the chairman spoke on the subject of the paper, which followed out the work of Prof. Osgood.—Mr. S. Roberts, F.R.S., read a paper on networks. This paper treats of certain networks (1) with triangular meshes, (2) with polygonal meshes. They are intimately connected with the problem of colouring maps with four colours only. The doubts and difficulties which have arisen with regard to the demonstration of the general theorems involving the solution of the problem in question show the expediency of discussing limited and defined cases and passing to more general results step by step. The subject, the author says, is, in fact, larger and more intricate than the simplicity of the empirical solution would lead one to expect. The late Prof. Tait's theorem is animadverted upon and is considered to have been enunciated in too general a form. In connection herewith reference is made to Prof. Petersen's communication (*cf.* "L'Intermédiaire des Mathématiciens," vol. v., p. 226). But it is not certain that Prof. Tait was responsible for the unguarded statement (*cf. Phil. Mag.*, vol. xvii. pp. 30, &c.). In any case Prof. Petersen's example shows that the theorem is not absolutely general.—The president communicated a paper by Mr. W. H. Young, on the fundamental theorem of differential equations. The fundamental theorem of the modern theory is Cauchy's existence theorem, dealing with the existence and uniqueness of a set of integrals satisfying given initial conditions and the holomorphic character of the solution. Some doubt has been expressed as to whether the proofs furnished by Picard and Painlevé are rigorous. It has been suggested that it has not been conclusively demonstrated that the holomorphic solution is unique even in the simplest case which can arise. The paper gives a brief account of the theorem in question, and examines an example which has been put forward as typical of a large class of cases where the theorem fails.—A paper by Prof. W. Snow Burnside, on the integrals of the differential equation

$$\frac{du}{\sqrt{f(u)}}+\frac{dv}{\sqrt{f(v)}}=0, \text{ where } f(x)\equiv aax^4+4bx^3+6cx^2+4dx+e,$$

considered geometrically, was communicated by title.

Geological Society, January 8.—Mr. J. J. H. Teall, V.P.R.S., president, in the chair.—A system of glacier-lakes in the Cleveland Hills, by Mr. P. F. Kendall. After referring to existing "extra-morainic" lakes, such as the Märjelen See and those of the Chaix Hills, the author proceeds to deal with the criteria for the recognition of such lakes. These include beaches, deltas, floor-deposits and overflow-channels. Shore-scarps are common in Cleveland, but beaches are rare or absent, the reason being in part that stability was rarely secured owing to the overflows being over soft Jurassic strata. Deltas also are not common. The floor-deposit of lakes may be distinguished from river-alluvia by the fact that the lamination is close and regular, but, being parallel to the subjacent surface, it may be highly inclined. On the other hand, alluvia are laid down on horizontal surfaces, but rarely show good lamination. Evidence from borings and drift-filled channels is given to show that during or before the Glacial period the land was considerably above its present level. The Glacial deposits are described in detail from sections and borings, some of them carried out by the author, and the assemblages of boulders are identified and classified into three chief groups—a western group, from the Solway, Vale of Eden, Stainmoor Pass and the Tees; a northern group, from the Tweed and Cheviots and from eastern Durham; and an eastern group, from the Christiania region, the Gulf of Bothnia and Denmark or the North Sea. The author has been unable to detect any signs of the presence of the sea in this area at any time during the Glacial period. Three main ice-masses appear to have been concerned in producing the deposits—one from the southern Uplands and the Solway, joined by the local ice of the Tees; a second originating in the Tweed Valley, and driven southward round the Chevoits by the pressure of the third, or Scandinavian, ice-mass. The general order of events is supposed to have been: (1) the unobstructed passage of the Teesdale glacier to the coast, (2) the arrival of the Scandinavian ice, and (3) the invasion of the Scottish ice. The first of the extra-morainic lakes described is that of the Vale of Pickering, the lowest of the sequence, which for a long period received all the drainage of the district except that of the western margin, and the outflow from which into Lake Humber was that now occupied by the River Derwent. Newton Dale was the outflow of the lake-series of the Eskdale country. The Eskdale system comprises a series of lakes connected by an "aligned sequence" of overflows; and here it is possible to trace the consequences of the shrinkage of the ice-masses and to follow out the low-level phases of the lake. The ice pressing upon the northern face of the Cleveland Hills gave rise to a series of lakelets, connected with which are the following set of overflows:—Scugdale and Scarth Nick, Bilsdale, Kildale, Ewe Crag Beck, Tranmire, and Egton Moor. Iburndale contained a lakelet overflowing eastward. Behind a narrow coast-strip of country, extending from Robin Hood's Bay to Hunmanby, there runs a gorge which receives all the drainage of the "hinterland" and carries it into the Vale of Pickering. In the production of this arrangement the effects of an ice-sheet shutting the seaward ends of the valleys are traceable; the position of the main overflows was stable, and the drainage was permanently deflected.—The glaciation of Teesdale, Weardale and the Tyne Valley, and their tributary valleys, by A. R. Dwerryhouse. After an account of the topographical solid geology of Teesdale, the author describes four distinct types of drift in the area. A detailed description of the Glacial deposits, boulders and striæ is given, and from this the following conclusions are deduced:—Upper Teesdale was heavily glaciated by local ice from the eastern slope of the Cross Fell Range; this part of the Dale was not invaded by any other ice, and the higher peaks stood out as nunataks. At the period of maximum glaciation a number of lakes were formed, owing to the obstruction of the drainage of lateral tributary-valleys by the ice of the main glaciers. Lunedale was occupied by ice (the Stainmoor glacier) which came from the drainage-basin of the Irish Sea, joined the Teesdale glacier about Middleton-in-Teesdale, and by its thrust deflected the Teesdale ice into the valley of the Wear. During the retreat of the ice there was a lengthened period of "constant level," when well-marked drainage-channels were formed, and after this the ice was removed with great rapidity. A tongue of ice flowed from Upper Teesdale by Yad Moss to the Valley of the South Tyne.

Zoological Society, January 14.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—Dr. A. S. Woodward, F.R.S., exhibited a newly-discovered upper molar tooth of Onohippidium from the cavern near Consuelo Cove, in Last

Hope Inlet, Patagonia. This new specimen was fixed in the bone and bore trace of the soft parts.—Mr. Oldfield Thomas, F.R.S., exhibited and made remarks upon the skin of a female yellow-backed duiker (*Cephalophus sylvicultrix*) which had been obtained in the Awemba district of north-eastern Rhodesia, and presented to the British Museum by Mr. Robert Codrington. This species had previously been known only from West Africa. —Mr. Tegetmeier exhibited the skin of an animal which it had been suggested was a hybrid between a hare and a rabbit, but which proved to be merely a variety of a hare.—Prof. E. B. Poulton, F.R.S., read a paper (illustrated with lantern-slides) by Mr. R. Shelford, curator of the Sarawak Museum, on cases of mimicry amongst Bornean insects and spiders. The author, who had carefully studied this subject in the Malay Archipelago, had made some striking discoveries, and among them were: (1) the well-marked mimetic resemblance of the Mantispidæ to the Hymenoptera; (2) the wonderfully large and complex group of insects of all kinds which mimicked the common dammar bee (*Trigona apicalis*); (3) the large amount of mimicry in longicorn beetles, some resembling Hymenoptera, others Phytophaga, others Lycidæ and others Rhynchophora; (4) the fact that longicorns of the genus Chloridolum and also of some genera of Clytinæ were mimicked by other longicorns; and (5) the re-discovery of the locustid *Condylodera tricondyloides*, formerly described by Westwood from Java, being a splendid mimic of the cicindelid Tricondyla.—A communication was read from Mr. F. H. A. Marshall, describing the variation in the number and arrangement of the male genital apertures in the Norway lobster (*Nephrops norvegicus*), as observed on an examination of a series of 1080 specimens of this crustacean.—A paper was read by Dr. Einar Lönnberg chiefly dealing with the alimentary canal of Trichosurus, Pseudochirus, Phalanger and Petaurus. The varying length of the different sections of the gut and their structure were correlated with the varied food of these marsupials.—A communication from Dr. L. von Lorenz gave an account of the mounted specimen of the quagga (*Equus quagga*) in the Imperial Museum of Natural History at Vienna, and pointed out its differences from other known specimens of this animal.—Mr. J. Lewis Bonhote contributed a paper on a small collection of mammals made by Mr. Th. H. Lyle in Siam. Of the eight species enumerated in the paper, a hare was described as new under the name of *Lepus siamensis*.—A communication from Dr. A. G. Butler contained an account of two collections of Lepidoptera made by Sir H. H. Johnston, K.C.B., in the Uganda Protectorate during the year 1900. The species, of which specimens were contained in the collection, were enumerated, and three of them, viz. *Harma johnstoni*, *Pseudathyma plutonica* and *Aphnaeus hollandi*, were described as new.—Mr. W. L. Distant communicated a paper on the insects of the order Rhynchota collected by Sir H. H. Johnston, K.C.B., in the Uganda Protectorate, in which it was pointed out that the species, of which specimens were contained in the collection, showed marked affinities with the West African forms of these insects.

Entomological Society, January 15.—The sixty-ninth annual meeting, the Rev. Canon Fowler, president, in the chair. —It was announced that the following had been elected officers and council for the session 1902-1903:—President, the Rev. Canon Fowler; treasurer, Mr. Robert McLachlan, F.R.S.; secretaries, Mr. Herbert Goss and Mr. Henry Rowland-Brown; librarian, Mr. George C. Champion; and as other members of council, Mr. R. Adkin, Prof. T. H. Beare, Mr. Arthur J. Chitty, Mr. W. L. Distant, Dr. F. D. Godman, F.R.S., the Rev. Francis D. Morice, Prof. E. B. Poulton, F.R.S., Mr. Edward Saunders, Dr. David Sharp, F.R.S., and Colonel Swinhoe. The president announced that he should appoint Dr. F. DuCane Godman, F.R.S., Prof. E. B. Poulton, F.R.S., and Dr. D. Sharp, F.R.S., as vice-presidents for the session 1902-1903. He then delivered an address in which he dealt chiefly with the question of protective resemblance and mimicry in the case of the Coleoptera, a branch of the subject concerning which but little has been recorded, although mimicry in this order is quite as important as in the case of the Lepidoptera; as a matter of fact, beetles are protected in many ways: by a hard integument, by the assimilation of colour or form to environment, by adopting colours in strong contrast to environment (warning colours), by protective attitudes, by warning attitudes, by warning sounds, by the secretion of distasteful juices or odorous substances, by resemblance to unpleasant substances such as the droppings of birds, by resemblance to well-protected insects other than Coleoptera such as ants, bees and wasps, by imitating other genera and species of the same order which are plainly distasteful. In the course of the address it was pointed out how easily it can be proved that beetles form a large part of the food of birds, as their hard elytra or wing-cases remain for some time entire in their stomachs; in this way it can be proved which species are most liked, and which are disliked or rejected. It is an interesting fact that many of the rapacious birds devour large numbers of beetles, and that a systematic examination of the stomachs of birds proves that the damage done to game is much less than is usually believed, for many of the most persecuted species are mainly or to a very great extent insectivorous; it would be well, therefore, on all grounds, that the indiscriminate slaughter of our few remaining birds of prey should be rigorously discountenanced.

PARIS.

Academy of Sciences, January 20.—M. Bouquet de la Grye in the chair.—On the use of lunar distances at sea, by M. E. Guyou. The method for the determination of the longitude by lunar distances has fallen into disrepute during the last century, and the Bureau des Longitudes has decided that the amount of work required each year for the prediction of lunar distances is out of all proportion to the benefit derived from them by mariners; in the next volume of the *Connaissance des temps*, for 1905, these calculations will accordingly be discontinued. In the present paper a simplified formula is worked out for the case of those navigators who still wish to use this method.—On some properties of fused lime, by M. Henri Moissan. Quicklime, if pure and free from silicate, is melted only in small quantity and with great difficulty at the highest temperature obtainable with the oxy-hydrogen blowpipe; it is, however, melted with great ease in the electric furnace, and with an arc of 1000 amperes first melts and then boils. On cooling, the crystals were found to belong to the cubical system, although after keeping for some months the crystals broke up into others which acted upon polarised light. The density of the lime was raised from 3·3 to 3·4 by fusion. Since lime forms the basis of the electric furnace, it was of importance to study the effect of heating it to high temperatures with various substances. The results of the reactions with carbon, silicon, boron, titanium, chromium, manganese, iron, nickel, cobalt and platinum are given.—The analysis of some antique metallic objects, by M. Berthelot.—On the passage from hermaphrodism to the separation of the sexes by unilateral parasitic castration, by M. Alfred Giard. It appears probable that there exists in the Compositæ parasitic fungi of several kinds. The morphogenic action of these upon their host varies, and the influence of these parasites upon the condition of sexuality of their hosts is equally variable, and furnishes natural experiments of great interest for general biology.—On the conditions to the limits in hydrodynamics, by M. P. Duhem.—On the growth of entire functions, by M. Pierre Boutroux.—Remarks on the preceding communication, by M. Paul Painlevé.—On factorial series, by M. Niels Nielsen.—Coincidences between the elements of the planets, by M. Jean Mascart.—On the application of the Lagrangian equations to electrodynamic and electromagnetic phenomena, by M. Lienard. M. Carvallo, starting with the example of Barlow's wheel, comes to the conclusion that the equations of Lagrange are not always applicable to electrodynamic phenomena, especially in the case of conductors of two or three dimensions. In the present paper it is shown that this restriction is unnecessary and that a rigorous application of the Lagrangian equations gives perfectly exact results in the case of the motion of Barlow's wheel.—Electrodynamics of bodies in motion, by M. E. Carvallo.—Critical constants and molecular complexity of some organic compounds, by MM. Ph. A. Guye and Ed. Mallet. The conclusion is drawn that all the aliphatic nitriles are clearly polymerised, their coefficients of polymerisation being larger than have been hitherto observed.—On some physical properties of hydrogen selenide, by MM. de Forcrand and Fonzes-Diacon. The gas was obtained in a pure state by the action of a little water upon pure aluminium selenide over mercury. Its boiling point under ordiaary pressure was found to be $-42°$ C., its melting point $-64°$ C., and its density in the liquid state 2·12 at $-42°$ C. Its solubility in water was found to be less than has usually been supposed.—Remarks on the oxides of molybdenum, by M. Marcel Guichard.—On the decomposition of acetylene during its combustion, by M. Fernand Gaud. An experimental study into the causes of the choking

up of acetylene burners.—On the tribromo- and triiodo dinaphthoxanthonium and on the hydrobromic, dibromo-, and hydriodic diiodo-ethers of the supposed binaphthylene glycol, by M. R. Fosse.—On the action of the mono-halogen propionic esters upon the sodium derivative of acetyl-acetone, by M. Fr. March.—Contributions to the study of the chemical modifications in plants submitted to the influence of sodium chloride, by MM. E. Charabot and A. Hébert. The addition of common salt to the soil has the following effects: it increases the percentage of organic matter in the plant, and also increases the relative loss of water. At the same time that this double influence is exerted on the plant, the sodium chloride favours esterification and reduces the transformation of menthol into menthane.—The biological theory of vision, by M. Georges Bohn. A criticism of the theory of vision put forward by M. Pizon. Of the three essential ideas of this theory, M. Bohn regards the first as not new and the two latter as not true.—The elementary forms of phosphorus in the invertebrates, by M. Jean Gautrelet. In the blood, carapace and shells of crustacea and molluscs, phosphorus exists in two elementary forms, mineral and organic.—The utilisation of sugars by the organism, by MM. Charrin and Brocard.—On the assimilation of sugar and of alcohol by *Eurotyopsis Gayoni*, by M. P. Mazé. The analytical results quoted would tend to show that the mycelium of this fungus is capable of utilising both alcohol and ammonia without loss of material.—The indications of the prophylaxy and treatment of pulmonary tuberculosis, by MM. Albert Robin and Maurice Binet.—On the origin of certain diseases of chrysanthemums, by M. Chifflot. Two diseases of the chrysanthemum described by M. Joffrin as new have been well known for some time both to botanists and horticulturists.—The siliceous tufa of Côte-aux-Buis, at Grignon, by M. Stanislas Meunier.—On the appearance of lesions in a foal analogous to those produced in its mother by an accident, by M. Le Hello.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 30.

ROYAL SOCIETY, at 4.30.—The Chemical Origins of the Lines in Nova Persei: Sir Norman Lockyer, K.C.B., F.R.S.—The Specific Volumes of Oxygen and Nitrogen Vapour at the Boiling Point of Oxygen: Prof. J. Dewar, F.R.S.—The Distribution of Magnetism as affected by Induced Currents in an Iron Cylinder when rotated in a Magnetic Field: Prof. E. Wilson.

ROYAL INSTITUTION, at 3.—Recent Excavations at Delphi and in the Greek Islands: Dr. A. S. Murray.

FRIDAY, JANUARY 31.

ROYAL INSTITUTION, at 9.—The Ions of Electrolysis: Prof. A. Crum Brown, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Quay-Walls of Keysham Harbour: J. C. Collett and W. H. C. Clay.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Discussion of the Paper by Mr. H. F. L. Orcutt, on Modern Workshop Methods.

MONDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—The Purification and Sterilisation of Water: Dr. Samuel Rideal.

IMPERIAL INSTITUTE, at 8.30.—The Native Races of Nigeria: Dr. C. F. Harford-Battersby.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Explosion of Potassium Chlorate by Heat: Dr. A. Dupré, F.R.S.—The New Table Photometer and Standard Pentane Burner prescribed by the Gas Referees for use in the London Gas-testing Stations: Dr. F. Clowes.

TUESDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 3.—The Cell: its Means of Offence and Defence: Dr. A. Macfadyen.

SOCIETY OF ARTS, at 4.30.—The History of the Rosary in all Countries: Rev. Herbert Thurstan, S.J.

ZOOLOGICAL SOCIETY, at 8.30.—Ecdysis, as Morphological Evidence of the Original Tetradactyle Feathering of the Bird's Fore-limb: Edward Degen.—A Revision of the Amblypodia-Group of the Lycænidæ: G. T. Bethune-Baker.—Notes on the Osteology of *Cegia breviceps*: Prof. W. Blaxland Benham.

INSTITUTION OF CIVIL ENGINEERS, at 8.—*Papers to be further discussed*: The Sewerage Systems of Sydney, N.S.W., and its Suburbs: J. Davis.—The Bacterial Treatment of Trades Waste: W. Naylor.

MINERALOGICAL SOCIETY, at 8.—On the Hornsilvers: G. T. Prior and L. J. Spencer.—The Identity of Kilbrickenite with Geocronite: Analyses of Miersite, Marshite and Copper-Pyrites: G. T. Prior.—A New Sapphirine-like Mineral from Ceylon: G. T. Prior and A. K. Coomara-Swamy.—Attempts to reproduce Interference-Effects by Three-Colour-Printing: Prof. Miers.

WEDNESDAY, FEBRUARY 5.

SOCIETY OF ARTS, at 8.—Jamaica: Herbert T. Thomas.

GEOLOGICAL SOCIETY, at 8.—On the Matrix of the Suffolk Chalky Boulder-Clay: Rev. Edwin Hill.—On the Relation of certain Breccias to the Physical Geography of their Age: Prof. T. G. Bonney, F.R.S.—On some Gaps in the Lias: E. A. Walford.

ENTOMOLOGICAL SOCIETY, at 8.

SOCIETY OF PUBLIC ANALYSTS, at 8.

THURSDAY, FEBRUARY 6.

ROYAL SOCIETY, at 4.30.

SOCIETY OF ARTS, at 4.30.—The Coal Resources of India: Prof. W. R. Dunstan, F.R.S.

LINNEAN SOCIETY, at 8.—On a Method of Investigating the Gravitational Sensitiveness of the Root-tip: F. Darwin, F.R.S.—An Extinct Family of Ferns: Dr. D. H. Scott, F.R.S.

CHEMICAL SOCIETY, at 8.—An Investigation into the Composition of Brittle Platinum: W. N. Hartley.—Conversion of *l*-Hydroxycamphene into β-Halogen Derivatives of Camphor: M. O. Forster.—Tetrazoline, Part II.: S. Ruhemann and H. E. Stapleton.—(1) The Solubilities of the Calcium Salts of the Acids of the Acetic Acid Series; (2) The Equilibrium between a Solid and its Saturated Solution at various Temperatures: J. S. Lumsden.—The Influence of Temperature on Association in Benzene Solution, and the Value of the Molecular Rise of Boiling Point for Benzene at Different Temperatures: W. R. Innes.—The Magnetic Rotation of Ring Compounds; Camphor, Limonene, Carvene, Pinene, and some of their Derivatives: W. H. Perkin, sen., F.R.S.—Polymerisation Products from Diazoacetic Ester: O. Silberrad.

RÖNTGEN SOCIETY, at 8.30.—A System of Radiography: E. W. H. Shenton.

FRIDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 9.—The New Mammal from Central Africa and other Giraffe-like Animals: Prof. E. Ray Lankester, F.R.S.

GEOLOGISTS' ASSOCIATION, at 7.30.—Annual General Meeting.—Address on a Dozen Years of London Geology (Eocene, Chalk, and Underground): W. Whitaker, F.R.S., President.

CONTENTS.