THURSDAY, FEBRUARY 3, 1910.

THE DEVELOPMENT OF GLASS-MAKING IN JENA.

Die Glasindustrie in Jena. Ein Werk von Schott und Abbe. Geschildert von Eberhard Zschimmer. Mit Zeichnungen von Erich Kuithan. Pp. 160. (Jena: Eugen Diederichs, 1909.)

THE history of the firm of "Otto Schott und Genossen" may be said to commence from the date of May 27, 1879, when Otto Schott first addressed from Witten, in Westphalia, to Ernst Abbe, professor and director of the observatory in Jena, a letter relating to some experiments he had recently been making in the production of lithium glass. He wrote:—

"Recently I produced a glass into which was introduced a considerable amount of lithium, and of which the specific gravity was relatively low. I anticipate that this glass will show, in some direction or other, exceptional optical properties, and would ask you whether you are prepared to examine it as regards its refractive and dispersive qualities to determine whether my anticipation is correct."

The glass had been made in a small experimental furnace of Schott's design. The mixing was imperfect, and Abbe's report was to the effect that the glass contained too many striæ for optical determinations to be made. It was not long before this difficulty was surmounted, and with stirrers made from the stems of Dutch clay pipes, Schott succeeded in producing in small quantities in the laboratory experimental meltings homogeneous enough to allow of a complete determination of their optical properties. This determination, however, brought a new disappointment; for the secondary spectrum of an objective in which the crown glass of Fraunhofer was replaced by the new lithium-crown was more pronounced than before. The lithium glass, indeed, showed exceptional properties, but they were not in the direction desired.

The work was not immediately continued. A year elapsed before Abbe urged that it should be resumed. Schott thought of State aid, but Abbe, more experienced, represented the uselessness of applying for help from public funds until laboratory results of promise had been reached. In a letter of December, 1880, he suggested the main products to be desired from the point of view of technical optics.

(1) Crown glass of appreciably lower mean dispersion than that yet known, or of higher refractive index with the same dispersion.

(2) Flint glass the relative dispersion of which in passing from red to blue agrees more closely throughout the spectrum with that of crown (thus giving smaller secondary colour aberrations).

(3) Flint glass of very high dispersion, but of smaller mean refractive index.

The work was re-commenced on a more comprehensive scale. A systematic examination of glasses of varying composition was planned. To Schott, however, the procedure seemed to promise to be too protracted, and here his general chemical knowledge, and especially his acquaintance with mineralogy, served to shorten the path. Almost instinctively he fixed on the addition of phosphates and borates as the substances most likely to give glasses of novel character. As is well known, his intuition proved correct, and resulted in the foundation of a new industry. On October 7, 1881, Abbe, in sending greetings on the one-hundredth melting, writes:—"The problem of the complete achromatisation of the telescope objective I regard as solved by the two meltings 78 and 93"—two borate glasses.

The next step was the industrial realisation of the results proved possible in the laboratory. For this capital was needed, but in January, 1882, a "Glastechnisches Laboratorium" was founded in Jena by Abbe and Schott, in conjunction with Carl Zeiss and Dr. Roderich Zeiss. It was just at this time that Dr. Wilhelm Förster, director of the observatory and of the Normalaichungskommission in Berlin, was pressing that the Ministry of Finance should give State aid to an industrial research to determine satisfactory glass for the making of thermometers. In February, 1882, the Jena company became acquainted with Förster's aims. It was a matter of course that Schott should be asked to carry out the new investigation. Preceded by an examination of the varieties of thermometer glass then in use, Schott's new experimental meltings began in March, 1883, and by the end of the year promised so well that on this side also the question of the foundation of a new industrial undertaking merited serious consideration. In January, 1884, the promoters entered into new articles of association, with a capital of 60,000 marks, and, with the value of the work urged on them by various physicists of eminence, the Prussian authorities contributed, in the first two years, a further sum of 60,000 marks.

The present work was written to celebrate the twenty-fifth year of the life and development of the Jena glass works. Dr. Zschimmer's volume gives a popular account, not only of the circumstances which led to the foundation of the world-famous works, but of the technico-scientific problems which, in virtue of the researches there undertaken, have one after another been successfully solved. The relation of chemical composition to optical properties, the questions of homogeneity, durability, freedom from mechanical strain and from colour, these and all the main questions connected with the production of glass for scientific purposes are dealt with in a manner which renders them intelligible to the ordinary reader who is not specially interested in the scientific problems involved.

The processes of manufacture, the various types of furnace, the fabrication of the melting-pots, the methods of production of glass vessels of various forms, glass tubes, &c., the machinery for the production of glass bottles, the manufacture of gas-mantle cylinders, and other problems rather of a technical than a scientific character, are also dealt with. The special socialistic organisation of the undertaking—in common with that of the Zeiss firm—is shortly described.

The book is printed in a clear antique type and well illustrated with woodcuts of the style of the early days of printing, among which the excellent portrait of Schott himself calls for special mention.

THE MILLAIS GAME-BIRDS.

The Natural History of British Game Birds. By J. G. Millais. Pp. xi+142; illustrated. (London: Longmans, Green and Co., 1909.) Price 8*l.* 8*s.* net.

THE elaborate style in which Mr. Millais produces his more ambitious works renders it necessary that each should be restricted to a comparatively small group, as otherwise the price would be prohibitive to ordinary purses. In the present magnificent volume, which forms a companion to the "Natural History of the British Surface-feeding Ducks," the author has had a splendid opportunity for his artistic talents, as few birds offer finer subjects for illustration than do the members of the grouse and pheasant tribes. Not content with his own powers as an artist, Mr. Millais has secured the cooperation of Mr. Archibald Thorburn, and the combined efforts of these two great bird-painters have resulted in the production of a series of coloured and other pictures which it would be practically impossible to surpass, or even to equal, in effect, beauty of colouring, and general truthfulness to nature.

Too often artistic efforts of this kind are more or less completely marred in the process of reproduction, but in this instance Mr. Millais, as he tells us in his preface, has been fortunate enough to discover a method of reproduction which, in his opinion, far surpasses the best chromo-lithography or three-colour process. This opinion, so far as our experience permits, we are disposed to endorse; and we have certainly seen nothing to equal, let alone surpass, the frontispiece of black grouse, or the plate of red grouse in the red spring phase of plumage. In the coloured plates the birds are for the most part depicted in more or less quiescent poses; but in several of the monochrome plates we have in many instances abundance of action. Among these pictures of active bird-life, special attention may be directed to the two depicting, respectively, the courtship of the grouse and the playing-ground of the ptarmigan.

Possibly, nay probably, the expert would detect errors in some of the plates in regard to the number of primary quills in the wings; but such details would certainly not be noticed by the ordinary observer, and probably not by the majority of sportsmen; and if there be errors in this respect, as we believe there are, they in no wise detract from the general effect of the exquisite pictures. Although the price may appear high, it can scarcely be regarded as excessive for such a magnificent volume, especially when the cost of production and the fact that the issue is limited to 550 copies are borne in mind.

Probably it was the author's intention to convey to his readers all the available information in connection with his subject; but two or three points are noticeable where he has failed in this respect. We cannot, for instance, find any mention of the fact that grouse shed their claws during the main moult; neither does there appear to be any reference to the statements current in Scandinavia as to blackcock burrowing in the snow during winter. More serious is the absence of any mention of the various plumage-changes in the red-legged partridge; and in the case of nearly all the species, much more might have been written about the plumage of the chicks. In connection with partridges, the designations of "common partridge" for the grey species and "common red-legged partridge" for the French bird are by no means satisfactory; grey partridge and red-legged partridge would have been preferable and sufficient.

With the very natural tendency common to all writers of monographs to make the most of their subject, Mr. Millais uses the term British game-birds in a very wide sense, although it must be confessed that in this particular instance it is certainly a difficult matter to know where to draw the line. The red-legged partridge, for instance, is known to have been first introduced into our islands only in the second half of the eighteenth century, and yet it certainly cannot be omitted from any work on British birds. The typical pheasant likewise appears to be an introduced bird, although there is evidence that it had become completely naturalised by the time of the Norman conquest, and there can be no question as to its right to be now included in the British fauna. The introduction of the ring-necked pheasant in the early part of the nineteenth century likewise renders it difficult to exclude that species or race from the British list. When, however, we find such birds as Hagenbeck's pheasant, the Mongolian pheasant, the Prince of Wales's pheasant, the Japanese pheasant, and Reeves's pheasant figuring as British birds, we are on much more debatable ground; and if these are entitled to any mention they should not, in our opinion, have been accorded separate headings.

The author, it may be mentioned, is a strong advocate for regarding closely allied geographical forms in the light of local races rather than distinct species, and consequently classes all the birds mentioned above, with the exception of Reeves's pheasant, as local forms of *Phasianus colchicus*. No doubt there is very much to be urged in favour of this view, although when such a markedly distinct bird as the Japanese *P. versicolor* is classed as a phase of *colchicus* it seems a little difficult to know where to stop.

As we have had to mention on previous occasions, whenever Mr. Millais steps out of his proper province he invariably makes mistakes. Instances of this are afforded on p. 77 of the volume before us, where we find Pikerni for Pikermi and Œmingen for Œningen.

With the above exceptions, we have nothing but unstinted commendation to bestow on Mr. Millais's latest work.

R. L.

THE MANUFACTURE OF LEATHER.

The Manufacture of Leather. By H. Garner Bennett. Pp. xxi+420. (London: Constable and Co., Ltd., 1909.) Price 16*s*. net.

IN this work the author has attempted to produce a volume which shall be a text-book to meet the needs of candidates for the examination of the City and Guilds of London Institute, and for the degree and diploma examination of the leather students of the Leeds University. The book is also evidently written for the use of the practical tanner who possesses a limited knowledge of chemistry. We do not think that the author has been altogether successful. The proportion dealing with the scientific aspect of leather manufacture (specially noticeable in the chemistry of the tannins), and the chapter on tannage of chrome leathers, stand out in brilliant contrast with the other part of the book, particularly with the somewhat sketchy and superficial chapters dealing with the practical tanning of sole, belting and harness leathers.

The first five chapters deal with the nature of the skins, fermentation, hides and skins, and water; the author then passes to the first practical process of leather manufacture, viz. soaking, describing the various processes employed. He next deals with the various methods of removing hair and wool, together with a full description of the tools and machinery used for the purpose. Chapter viii. deals with the deliming of hides, a process which has now become universal, owing to the increased technical and scientific knowledge. In chapters ix., x., xi., the author brings together in handy form the chemistry of the tannins, the tanning materials and the methods of analysis. The next chapter deals with the preparation of the tanning liquors and the manufacture of extracts. In this, the author has gracefully glided over a very important subject, and has not dealt with many of the important changes which take place in the leaching nor dealt with some of the most recent plants devised for this purpose. The whole subject of extract manufacture is referred to in two printed pages, whereas on such an important subject as the manufacture of extract, which now forms almost 50 per cent. of the material for modern sole-leather tannage, it might have been expatiated upon at considerable length with advantage to the student.

The next chapters then deal with the tannage of sole, belting and harness leather previously referred to. In the chapters on the tannage of chrome leather but little detail has been given for the practical manufacturing process of this leather. The author then proceeds to the consideration of alum, fat, oil and aldehyde tannages, and to drying of leather, finishing of sole leather, currying and finishing of dressing leather, the dyeing and finishing of light leathers, and the finishing of chrome and other leathers. A special chapter deals with the enamelling and japanning processes and the dressing of wool rugs. This concludes the practical part of the book, at the end of which is a short chapter on the analysis of leather.

The scheme is comprehensive, but the author has failed to bring out any novel feature which has not been dealt with, at least equally satisfactorily, by other authors. The work cannot be looked upon as a standard text-book for the practical tanner, but may certainly appeal to those who, having a knowledge of practical leather manufacture, desire to study further the scientific principles.

The book is well illustrated by photographs of machinery taken from the well-known illustrated catalogues of leather trades' engineers. These do not show the essential features of the machines, but are simply photographic blocks; in no case are the essential principles of the machines described.

MEMOIRS ON MARINE ZOOLOGY.

Liverpool Marine Biological Committee's Memoirs. XVIII., Eledone. By Annie Isgrove. Pp. viii+105; 10 plates. Price 4*s*. 6*d*. net. XIX., Polychæt Larvæ. By F. H. Gravely. Pp. viii+79; 4 plates. Price 2*s*. 6*d*. net. (London: Williams and Norgate, 1909.)

THE editor—Prof. Herdman—is to be congratulated on adding these two useful memoirs to his well-known series. Miss Isgrove has given a clearly written account of a common cephalopod, for which she prefers to retain the well-known Lamarckian name rather than to adopt the name Moschites, which is its correct designation, according to the strict rules of nomenclature. In the first part of the volume interesting observations are recorded on the habits and food of this octopod, and on the conditions under which it has been found in the neighbourhood of Plymouth and Port Erin. Attention is directed to the great preponderance in number of the females, the relative proportion of the sexes of captured specimens being about fifty females to one male. In the following sections of the book the author gives an account of the external features and internal structure of the animal, considering each system of organs in turn. The morphology of the funnel, which is one of the most characteristic organs of the Cephalopoda, is worthy of more extended reference; the sections which deal with the foot and funnel contain no allusion to the homology of the latter with the epipodium of gastropods; this homology is merely parenthetically mentioned, fifty pages later, under the description of the pedal ganglia. The alimentary canal, the circulatory and excretory systems, the nervous and reproductive organs, and the spawning are carefully described, the account of the structure of the gills and the anatomy of the nervous system being worthy of special mention. In the section on the structure of the retina, the author speaks of a *nerve fibre* instead of a neurofibril, running along the axis of each retinal cell. The memoir is well illustrated by means of ten lithographic plates containing above eighty carefully drawn figures.

Mr. Gravely has essayed a difficult task, namely, to give an account of the polychæt larvæ which may be captured in the tow-net at Port Erin during the month of July. The complete identification of many of the larvæ so obtained is impossible, since their characters are totally different from those of adult worms. It is only exceptionally that such larvæ can be reared, in aquaria, to adults, and their identity definitely established. In many cases the larvæ do not present clear specific or even generic characters, and they can therefore be referred only to their respective families. The author has written a careful and detailed account, in most cases drawn from living specimens, of the principal larval forms captured, some of which have not been previously described. Measurements are given of the length and diameter of the larvæ, of some of the parapodia and setæ, and of the cilia; and the colour markings are recorded. The larvæ dealt with are as follows:—three Syllids, several Polynoids, three Phyllodocids (including Mystides and probably Eulalia), Nephthys, Spio, and four other Spionids, one of which is possibly the larva of the elusive Pœcilochætus, Polydora, and two other Polydorids, Magelona, Chætopterus, and Pectinaria, the metamorphosis, to the young adults, of the metatrochophoral larva of the last-named being described. The account of these larvæ, which is illustrated by means of forty-seven figures, will be welcome to many workers on plankton and on polychæts, and, although it is admittedly a preliminary account, it forms a good basis on which to found future observations. The reader is referred for a definition of the numerous technical terms employed in describing the different stages and larval organs to a recently published paper by the same author, but it would have been a considerable advantage and convenience to the reader if brief definitions of these terms had been given at the beginning of the present memoir.

We suggest to the editor of these memoirs that all the volumes published in the future be provided with a table of contents.

ENGINEERING SCIENCE.

(1) *Applied Mechanics, Embracing Strength and Elasticity of Materials, Theory and Design of Structures, Theory of Machines and Hydraulics. A Text-book for Engineering Students.* By Prof. David Allan Low. Pp. vii+551. (London: Longmans, Green and Co., 1909.) Price 7*s*. 6*d*. net.

(2) *Strength of Material: an Elementary Study prepared for the Use of Midshipmen at the U.S. Naval Academy.* By H. E. Smith. Second edition. Pp. ix+170. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1909.) Price 5*s*. 6*d*. net.

(3) *Stresses in Masonry.* By H. Chatley. Pp. viii+142. (London: C. Griffin and Co., Ltd., 1909.) Price 3*s*. 6*d*. net.

(1) THE subject covered by this book is a very extensive one, and the author is to be congratulated on the fact that by judicious compression, without sacrifice of clearness, he has in a volume of only 550 pages covered ground to which usually two or three bulky text-books are devoted. No student can expect, however, to make himself master of the contents of the book unless, as the author himself suggests in his preface, he works conscientiously through the sets of carefully thought-out problems which are given at the end of each chapter. At the end of the first, or introductory, chapter, Prof. Low has given a fairly complete bibliography for the subject, confining himself to works in the English language which have appeared during the last decade, or to those works which have been brought up to date by new and revised editions; this list will be found of considerable use by students who desire to extend their reading in any one branch of the subject.

The first five chapters are devoted to a series of introductory problems, work and energy, polygon of forces, moments and centroids, and for these latter both graphical and analytical methods are discussed; then follow six chapters on strength of materials. In the chapter dealing with compound strains and stresses, the opinion is expressed that in the case of ductile materials, such, for example, as mild steel, it is the resistance to shear which determines the strength, and reference is given to the experimental work of Guest, Hancock, Scoble, and others in investigating this problem. The whole of this chapter is well worth the careful study of the young engineer, who should not be content to leave it until he feels that he has made himself a thorough master of the principles laid down, and of the formulæ deduced for practical use in design work. Another chapter in this section which contains a well-arranged mass of information is that on the behaviour of materials in the testing machine; the latest memoirs have been summarised, and the conclusions to be drawn from these experimental investigations are clearly set forth.

In chapters xii. to xv. stress diagrams and the design of roofs and bridges are discussed, and, though of necessity there is much condensation, all the important points are clearly brought out. A student who has mastered this section will find that his work is much simplified when he comes to the study of one of the more advanced text-books specially devoted to this branch of engineering work.

The next eleven chapters are devoted to the subject of mechanism; such details as friction and lubrication, governors, toothed gearing, balancing of revolving and reciprocating masses, &c., are discussed in a satisfactory manner, and velocity and acceleration diagrams and crank effort diagrams receive due attention, though there is nothing novel in the method of treatment.

The last section of the book treats of hydraulics; the flow of water over weirs and through orifices and pipes, loss of head due to various causes, and the impact of jets on vanes are all in turn discussed, and the application of these principles to the design of such hydraulic machinery as water-wheels, turbines, pumps, and accumulators is then explained.

Prof. Low has succeeded in writing on a well-worn subject a text-book with many new features, and one which should find a place on the bookshelf of every young engineer.

(2) This small text-book was prepared for the use of the midshipmen at the U.S.A. Naval Academy in connection with one of the courses in the department of mathematics and mechanics. It deals, therefore,

only with the mathematical investigation of the subject; the experimental side is entirely omitted. The attempt to compress into one small table (p. 11) the average values of the tenacity, shearing strength, &c., of the chief materials of construction has led to the insertion of figures likely to mislead the unwary; for example, the tenacity of steel is given as 110,000 lb. per square inch; as a matter of fact, the tenacity of most of the mild steel used in constructional work lies between 60,000 and 70,000 lb. per square inch. Again, the shearing strength of wrought-iron is given as 20,160 lb. per square inch; this is much too low a figure; it is less than half the average value of the shearing strength of wrought-iron rivets and pins in double shear.

Each chapter has a series of examples to illustrate the formulæ which are deduced in that chapter, and the answers are in many cases appended; it is noticeable that these answers have a defect, by no means uncommon in text-books of this class, to which attention has often been directed, and which can best be explained by quoting a specimen answer. The student has to determine from certain data the diameter of a wooden spar used as a beam; the answer appended to the question is 7·0025 inches; of what value are the figures to the right of the decimal point? In a subject like strength of materials, one of the first lessons which the student should learn is that the numerical data which he proposes to use in some mathematical formula may, for obvious reasons, vary by some quite perceptible percentage on either side of a mean value (the value he proposes to use), and that, therefore, he can expect to obtain a solution which is only approximately correct, hence to work out a solution to the degree of accuracy of that in the example quoted above is not only a waste of time, but is positively misleading. It is to be hoped that in any future edition these answers will be revised.

The effect of combination of stresses is dealt with in chapter v. in a clear and simple fashion, and it is refreshing to find this portion of the subject taken up at such an early stage of the work, and its importance impressed upon the student.

The book concludes with a number of miscellaneous problems, such as reinforced concrete beams, stresses in thick cylinders and guns, &c.

The book will probably prove an acceptable one to young engineers who are just beginning the study of this important subject, and want to get a general insight into it before they begin to work at one of the more advanced and complete text-books.

(3) As the author points out, there are numerous elementary text-books on steel structural design, but there has been a distinct want of an elementary work on the design of masonry structures. This book will supply this need, for it explains just those underlying principles which the beginner finds it troublesome to understand.

It is difficult to follow the author's reasoning in chapter i., when deducing the safe compressive load for masonry; surely if it took 900 tons per square foot to crush a specimen of granite, there must have been a shearing stress when rupture occurred (most probably by shearing) of something like 450 tons per square foot, and, therefore, the method of deducing a safe compressive working stress given on p. 10 is hardly logical.

The branches of masonry design dealt with include walls, piers, brackets, simple arches, vaults and skew arches, domes, and retaining walls and dams; the treatment of each branch is sufficiently complete for all the practical cases the young civil engineer or architect is likely to meet with, all the more complex theories being wisely omitted.

The last chapter deals in brief fashion with reinforced concrete, the essential principles of this system being fully explained.

POPULAR NATURAL HISTORY.

(1) *Animals and their Ways. An Introduction to the Study of Zoology and Agricultural Science.* By E. Evans. Pp. viii+184. (London: J. M. Dent and Co., 1909.) Price 1s. 4d.

(2) *The Hedge I Know.* Edited by W. P. Westell and H. E. Turner. Pp. 77. (London: J. M. Dent and Co., 1909.) Price 8d.

(3) *The Pond I Know.* Edited by the same. Pp. 78. (London: J. M. Dent and Co., 1909.) Price 8d.

(4) *Butterflies and Moths shown to the Children.* By Janet H. Kelman, described by Rev. Theodore Wood. Pp. xvi+94. (London and Edinburgh: T. C. and E. C. Jack, 1909.) Price 2s. 6d. net.

(5) *Nests and Eggs shown to the Children.* By A. H. Blaikie, described by J. A. Henderson. Pp. xvi+78. (London and Edinburgh: T. C. and E. C. Jack, 1909.) Price 2s. 6d. net.

(6) *The Backwoodsmen.* By Charles G. D. Roberts. Pp. 317. (London: Ward, Lock and Co., 1909.) Price 6s.

(1) ALTHOUGH the title of this review of the above series of books might lead one to suppose that this book would be a popular account of the lives and habits of animals, it is unfortunately necessary to point out that such an idea would be fallacious. It is a matter of regret that the author should have chosen a title which, to our minds, does not convey a correct idea of the contents. The reason may be that we have been spoilt by the previous publication of one or two excellent little works on animal life, and that our criterion has been raised. Be this as it may, the author has not succeeded in doing justice to his theme, and we cannot imagine any young student being filled with enthusiasm for zoological science, still less agricultural science, after having had this introduction. That the author must be a botanist is evinced by such a word as "Crustaceæ" (p. 170). The illustrations are poor, Fig. 3 being especially crude; and an acknowledgment of the source of such figures as are taken from the publications of the U.S. Department of Agriculture, which are good, should surely be given under the figures, as is customary.

(2 and 3). These small books of the same series are marvellous examples of cheap printing, and are unaccompanied by the usual inferior illustrations; they are well illustrated, and, on the whole, are written in simple language. It probably would have been pre-

ferable to have substituted the description of a stickleback for that of a pike in the fauna of the pond as being more characteristic. We should think it rather doubtful whether most children (or grown-ups) would identify the frontispiece of the first of these two books as a hedge, nor should we wish the statement on p. 32 of the same book, that the "sap escapes and takes the form of curiously moss-like growths," to be taken as scientifically accurate by the student of natural history.

(4) Who could describe the butterflies to our children better than the Rev. Theodore Wood, who has done so much to popularise natural history among the young? We should expect that he would do it excellently, and are not disappointed in this little book, which is one of the best of the series. With the exception of one or two of the caterpillars, the illustrations are excellent, as is essential in a book of this nature, where a good coloured figure is so important; for no child could identify a butterfly correctly and with ease from the best of written descriptions.

(5) In describing the eggs of birds to the children it is an excellent idea to associate the nests with the eggs. Children do not dissociate the two to the extent that many older persons in the past have been accustomed to do. To a child as yet unspoilt by the collecting fever characteristic of youth, the nest is as important as the eggs it contains, and this small book will serve as an excellent guide to those budding observers to whom the finding of a nest is an object of interest and pleasure.

(6) Strictly speaking, this book, which is a collection of tales of the backwoods of Canada, does not come within our province; nevertheless, the author is so keen an observer of nature, and so well known as an ardent follower of the "call of the wild," that some of his tales are full of life and interest, and form excellent "light reading."

C. GORDON HEWITT.

OUR BOOK SHELF.

Recent Advances in Physical and Inorganic Chemistry. By Dr. A. W. Stewart. With an Introduction by Sir Wm. Ramsay, K.C.B., F.R.S. Pp. xiv+267. (London: Longmans, Green and Co., 1909.) Price 7*s.* 6*d.* net.

THE present volume is a companion to the author's book entitled "Recent Advances in Physical Chemistry." The issue of two such books by the same author affords a fair gauge alike of their merits and of their demerits. At the present time, no one writer can possibly be a master of organic, of inorganic, and of physical chemistry, and the criticisms that are offered by the author cannot, therefore, be regarded as having more than a superficial value. On the other hand, the production of a second volume so soon after the publication of the first may be taken as evidence of a considerable popular demand, and shows at least that a book of this type was called for by a wide circle of readers. In the circumstances, it is to be regretted that the publishers did not follow out the plan they have adopted in their excellent "Textbooks of Physical Chemistry" and in their "Monographs on Biochemistry" of securing a series of articles by authors who have themselves worked on the subjects which they discuss. A volume compiled on these lines would have been of real value and undoubted usefulness.

In the present instance the author has rendered a service to the student who is working for an honours degree by presenting in a compact form the main results of certain lines of research which have been carried on in recent years, and may from time to time form the subject of examination questions. These investigations can only be mastered by a toilsome perusal of the original literature, and every attempt to reduce the labour involved in this task is sure of a welcome alike from the student and from the teacher. The danger of all such attempts is that the reader may acquire the indolent habit of obtaining his information in this easy way from second-hand sources, and so lose the stimulus and the opportunity of independent judgment which come from a perusal of the original text. On the whole, however, if the work is adequately carried out, the balance of advantage is in favour of the method of summarised presentation, and as the bulk of chemical literature becomes more and more unwieldy, the production of these summaries will become increasingly important. On these lines, Dr. Stewart's volume may be sure of a welcome and a considerable circulation.

(1) *The Elements of Mechanics of Materials. A Textbook for Students in Engineering Courses.* By C. E. Houghton. Pp. viii+186. (London: Constable and Co., Ltd., 1909.) Price 7*s.* 6*d.* net.

(2) *Experimental Mechanics for Schools.* By F. Charles and W. H. Hewitt. Pp. vii+288. (London: G. Bell and Sons, 1909.) Price 3*s.* 6*d.*

(1) IN this elementary text-book the engineering student is provided with a clear and concise account of the practical applications of mechanical principles to the design of simple machine parts and common structures. The first two chapters deal with the properties of materials as disclosed in the experimental laboratory, and with the strengths of tie-rods, cylinders, and riveted joints. Succeeding chapters relate to the strength and stiffness of beams, shafts, struts, and composite structures, including reinforced beams and columns; there is also an investigation of the effect of combined stresses. The most valuable parts of the book are the excellent collections of review questions and illustrative problems with which each chapter closes. These are very suggestive, well graduated, and eminently practical, and will be greatly appreciated by students and teachers alike. The author writes for those students who have only time for a very cursory study of the theory of elasticity, so that the limitations of the various formulæ are scarcely considered. The book will serve a very useful purpose, and will afford great assistance in some parts of practical design.

(2) Messrs. Charles and Hewitt describe or suggest a large number of simple experiments illustrating the principles of mechanics, and give extensive sets of examples in which these principles are enforced and applied. They constitute a mine from which teachers may select such details as are suitable for their own particular circumstances. The earlier experiments are statical, and deal with forces at a point, parallel forces, and friction, and illustrate the principle of the parallelogram and of the lever. A boy easily understands the action of a force because he employs his muscles every day to exert forces. The actions of couples remain more or less of an abstraction, for he seldom applies them. The authors have overlooked the need there is in the laboratory for the frequent muscular application of torques, measured by angular displacements in a simple torque meter placed between the hand and the apparatus.

Experiments in dynamics succeed those on statics, in which velocity, acceleration, inertia, work, kinetic energy, and centrifugal force are measured. The properties of vectors are here developed, though not so fully as might be desired, and occasionally there is a vagueness of language which must give trouble to a student who tries to think clearly.

Remaining chapters deal with the efficiencies of simple machines; the application of the link polygon; the drawing of reciprocal figures for jointed plane frames; and the determination of Young's modulus and of moments of inertia. In addition to the examples appended to each chapter, the authors give, at the end of the book, more than three hundred miscellaneous examples, and copies of recent examination papers, both theoretical and practical. A good index is provided, and teachers will find this book very helpful indeed.

Air and Health. By R. C. Macfie. Pp. vii+345. (London: Methuen and Co., 1909.) Price 7*s.* 6*d.* net.

THIS is a very readable work, containing much useful information. As the subject is dealt with in a manner which renders it interesting and easy of comprehension, even to people who may have no acquaintanceship with chemistry and physics, it should appeal to a wide range of readers; but it will prove of special service to the medical student of hygiene and preventive medicine, and the medical writer doubtless had this end mainly in view. The subject of the CO_2 respiratory impurity in the atmosphere is treated at some length. In this connection the author states (p. 133) that "Anyone who compares his power of mental work in a pure and in a CO_2 laden atmosphere, even if the latter be dry and cool, will find in the latter a considerable diminution, showing that at least nerve metabolism is affected." This statement implies that the CO_2 in a badly-ventilated room (as ordinarily understood) is capable, *per se*, of producing results which more recent experimental work demonstrates to be due to the combined effects of the altered physical conditions of the air—the increased moisture and temperature, in a stagnant atmosphere. The important subject of the composition, &c., of sewer air is inadequately discussed in eight lines.

Mr. Spence's suggestion that all the smoke of a city should be conducted by the sewers to a few enormous chimneys, where it could be completely burnt (p. 155), appears to be commended by the author. Certainly Sir B. W. Richardson proposed to adopt this method in his model city of Hygeia, but it is inconceivable that it could be efficiently applied. The various methods of freeing air from trade dusts and gases might have been included with advantage in such a work, and the volume seems incomplete without some reference to analytical methods—even if the reference were confined to the more simple practical tests for the more important gaseous impurities of the atmosphere of dwelling and working rooms.

But notwithstanding these deficiencies, the matter is, generally speaking, so well dealt with that the work may be confidently recommended for study and reference purposes.

The range of treatment embraces eighteen chapters. These deal with the composition of air; the discovery of the atmospheric gases; respiration; air-pressure in relation to life; the temperature, humidity, and thermolysis of air, and health; air and solar radiation; electricity and radio-activity, and their relation to climate; impure and polluted air; dust and germs; ventilation, draughts, and "colds"; artificial atmospheres; the open-air treatment of consumption; and open-air schools.

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.]*

The Natural History Museum.

IN reference to the article on the Natural History Museum in NATURE of January 20 (p. 343), in which Sir Archibald Geikie is represented as saying that the questions put to him in the letter from the Speaker of the House of Commons "were entirely in reference to the relations between the Trustees and the Museum," historical accuracy demands that it should be stated that the questions of Mr. Lowther were two in number (see NATURE, December 16, 1909, p. 196). They were:—(1) "Whether the Board of Trustees, acting through its Standing Committee, is in your judgment the best authority for the government of such an institution as the Natural History Departments of the British Museum?" and (2) "Whether, under the existing statutes and rules, the scientific management of the Natural History Museum suffers any detriment from its association with the Museum at Bloomsbury?"

It is clear that in his communication to you Sir Archibald Geikie has overlooked Mr. Lowther's second question, with which alone (so far as these two questions are concerned) the present agitation has concerned itself. We have always admitted that "a system of control by Trustees is the best" (see NATURE, December 30, 1909, p. 254). You were therefore quite right in your impression that the main point of contention was the complete separation of the governance and administration of the Natural History Museum from the other collections in the British Museum. Mr. Carruthers's letter does not touch the point at issue, except in so far as it seems to show that Prof. Huxley was in agreement with our view that "a system of control by Trustees is the best." He says nothing to show that Prof. Huxley came to disagree with the conclusion to which he had twice put his signature, once after a prolonged inquiry by Royal Commission, that it was of fundamental importance that the governance and administration of the two Museums should be separate.

A. SEDGWICK.

2 Sumner Place, S.W., January 30.

Markings on Mars as seen with Small and Large Telescopes.

THAT large telescopes are liable to less accurate definition of planetary markings than small ones can easily be verified in the following manner, and tested for any given occasion. The spurious disc and rings made of a star by a telescope is a real image, due to the interference of the light-waves—as real an image, although produced by a different cause, as that of a planet's disc with its markings. If atmosphere and glass be perfect, the image consists of a round disc, encircled by concentric and continuous rings of light. The only difference in the image with different apertures is that the larger the aperture the smaller the disc, and the closer and thinner the rings. If this image assume any other form, it is either because the objective is poor, which is commoner with objectives than is supposed, as Hartmann's tests have shown,[1] or because the seeing is defective. In proportion as the seeing is bad the rings of the image begin to waver, then break up into fragments, a sort of mosaic, and finally end in an indiscriminate assemblance of points. In certain kinds of bad seeing the parts may seem quite steady, but that the mosaic exists is proof positive of poor seeing.

Now this image as made by different apertures may be compared either by observing with different telescopes at the same place and time or by diaphragming down a large objective. When this is done it becomes at once evident that the smaller aperture always gives the more accurate definition of the optical disc and rings in spite of the theoretical greater resolvability of the larger glass. If,

[1] The Lowell Observatory glass has been tested by this method, and proves to yield the best images of any yet examined. (Bulletin in preparation.)

now, under the same conditions of seeing in which the rings appear continuous—their real form—in the smaller glass, the aperture be increased, the rings will be seen to break up into detached masses. It is very rare that they ever appear otherwise in a very large glass, for the seeing is almost never good enough thus to show them, accuracy of definition demanding much better air for a large than for a small aperture.

Now what happens to the lines of the image of a star—for the rings are simply circular lines—must happen in the same manner to planetary lines. They too must break up into a mosaic in a large glass whenever the rings do. This shows that planetary lines would necessarily assume a mosaic in a large glass contrary to their true form of continuous linearity. PERCIVAL LOWELL.

Lowell Observatory, Flagstaff, Arizona.

Colour-blindness.

IN the summary of the case of Mr. John Trattles published in NATURE of January 27 the expression is used:—"Dr. Ettles, who had examined Mr. Trattles, and was of opinion that he was not colour-blind, was also present."

That is only relatively accurate, and it is in the reservation that the real point lies. I examined Mr. Trattles on May 10, 11, and 12 last year. His spectrum range included both B and H lines—actually, 0·75 μ in the red to 0·39 μ in the violet. His sense of colour was less good about 0·54 μ than in the rest of the spectrum. Indeed, it was what one might call "bad." It was the presence of this defect which caused him to give such contradictory replies at Sir Wm. Abney's examination. My certificate, which was read in the House of Lords by Lord Muskerry in the debate referred to, viz. June 30, 1909, expressly stated that Trattles was competent to navigate a ship. It did not state that his colour vision was in all respects perfect.

Sir Wm. Abney and those associated with him concluded that, as the result of their tests, Trattles was "completely red-blind." I saw in those tests simply a confirmation of my own conclusions. We were at one in the symptoms, but we strongly differ in the diagnosis. If the Board of Trade starboard light were a yellow-green, Trattles would be unfit; but it is a blue-green, and he sees it perfectly.

As to red, he is anything but scoterythrous; that is what comes of being obsessed with a colour-vision theory.

One other point, the "recondite test of simultaneous contrast colours" is very much open to criticism. A simultaneous colour contrast is not a "colour" in the ordinary sense; it possesses no dominant wave-length; it is an optical illusion. Is an optical illusion so accepted and clear a test that it may be used as a touchstone to determine whether a man's career shall be ruined or not?

WILLIAM ETTLES.

34 Wimpole Street, Cavendish Square, W., January 30.

WE regret that we were in error in stating that Dr. Ettles was of opinion that Mr. Trattles was not colour-blind. It is interesting to know that he found the colour vision "less good" at a point in the spectrum not far removed from the region where the so-called "red-blind" person has a so-called "neutral band." The accurate determination of the spectrum range and of the deviations from the normal within that range constitutes the fundamental problem in discriminating colour-blindness. The accuracy of the determination, however, depends upon the methods adopted and the precision of the application of these methods.

With regard to the simultaneous contrast test, Dr. Ettles states that it is an optical illusion. If this be admitted, it is constant in its character in all normal individuals; hence any deviation may be fairly regarded as indicating a pathological condition of colour vision. As physiologists we cannot admit as a valid argument against the test that it is difficult or impossible satisfactorily to correlate the physical facts with the physiological manifestations.

But is it necessary or advisable that the divergence of opinion on the exact conditions of Mr. Trattles's colour vision should be further emphasised? The case has been adjudicated upon, and has amply demonstrated the need of reform either in the tests or in the application of the tests. The Board of Trade cannot, and ought not, to accept *any* risk of allowing a man with possibly dangerous defective colour vision to pass the examination. It is better that slight hardship should fall upon a few individuals than that many lives should be endangered; but the hardship must be minimised, and this object will be best attained by ensuring that the individuals shall be eliminated as early as possible in their careers. Hence it is of the utmost importance that the first examination shall be authoritative and conclusive.

THE WRITER OF THE ARTICLE.

Records of the Earthquake of January 22.

ON January 22 the Kew Milne horizontal pendulum recorded a large earthquake, of which the preliminary tremors commenced at about 8h. 52·6m. a.m., and the large waves at about 8h. 56·1m. The limits of registration, 17 mm., were exceeded between 8h. 58m. and 8h. 59m., and again at 9h. 0·4m. Synchronous with both maxima there were burrs on the magnetic declination trace. The largest, which simulated an oscillation of 1·5′ in declination, commenced about 8h. 57m., and lasted about five minutes. The movements on the declination trace were unquestionably seismic in character, and represented the mechanical effect of the principal earth tremors. The horizontal and vertical force traces were not sensibly affected. CHARLES CHREE.

The National Physical Laboratory (Kew Observatory Department), Richmond, Surrey, January 27.

An Earthquake Phenomenon.

A CURIOUS phenomenon connected with the earthquake of January 22 was that the maximum movement was accompanied by a sudden tilt. The amount of this was approximately one second of arc, its direction being towards the north-west. This would correspond to a rise of the ground on the south-east. It took place at about 8 a.m., when the booms of five horizontal pendulums were suddenly displaced from their normal position. Those oriented east and west were swung to the north, whilst those at right angles moved to the west. Pendulums in rooms 80 yards apart were displaced similarly. From 12.45 they crept back somewhat intermittently towards their original position, which they reached about 4 p.m.

Whether this indicates a local change in the dip of the strata (chalk) on which my instruments are founded or a more extended change of level cannot be stated with any certainty. At Bidston a pendulum oriented east-west was displaced towards the north, and at West Bromwich a pair of pendulums swung more on one side of their normal position than on the other. Their behaviour suggested a displacement similar to that observed at Shide. Permanent changes in the ground near the origin of a large earthquake are common. J. MILNE.

Shide, Isle of Wight.

The Preparation of Silicon. A Warning.

A COMMON method of preparing silicon is by mixing silica and magnesium powder in molecular proportions and heating until the following reaction takes place:—

$$SiO_2 + 2Mg = Si + 2MgO.$$

The majority of text-books recommend the use of silica in the form of silver sand or ground quartz, but they do not say it is absolutely necessary, or even desirable, that it should be in this form, and one well-known treatise states that precipitated silica and pure magnesium powder will yield very pure silicon. This authority adds that if the experiment is performed with precipitated silica the reaction is attended by a brilliant flash of light.

Having recently had occasion to prepare some silicon, precipitated silica was heated with magnesium powder in a Hessian crucible. One quarter gram-molecule of each was employed. The heating had proceeded some little time when suddenly the mixture exploded with terrific violence, shattering the crucible to a powder and sending out a great sheet of white flame. So great was the force of the explosion that the iron ring of the retort stand which held the crucible was bent out of shape. On examination it was found that the ingredients were pure, except that they might not have been quite free from moisture.

What I wish particularly to point out is that there is not a word in any of the text-books I have referred to of the danger of a very serious explosion in the above preparation.

Perhaps someone can say, definitely, whether the presence of a trace of water will cause such a mixture to explode on heating.

F. H. POWER.

Lincoln Grove, Radcliffe-on-Trent, Notts, January 26.

Intermittent Glow of the Tail of the New Comet.

IN Mr. Rolston's interesting and valuable article on the new comet (NATURE, January 27) reference is made to the statement of the Rev. F. J. Jervis-Smith that several persons observing at Lymington on January 22 thought the tail appeared to flash slightly and continuously.

Now, on the evening of that day I got the impression, on seeing the comet setting in the west-south-west, that there was an intermittent glow of the tail matter, in no very marked degree, it is true, but still there was a seeming perceptibility.

Later that evening I was told by an unskilled observer that he had seen "faint lights issue from the head and pass up to the end of the tail."

The conclusion I came to at the time exactly coincides with that referred to in the article, which is that the appearance was referable to the low position of the object and consequent atmospheric effects.

The interposition between the observer and the tail of a slight cloud or of some distant mass of smoke, though in itself too filmy to be noticed from afar off against a dark sky, would, doubtless, account for these light changes.

A correspondent once wrote to me—in some alarm, I thought—that Jupiter had on the previous evening behaved in a manner which was, to say the least, extraordinary, in that it had "kept going in and out" for five minutes on end. As the planet was then low in the sky, I concluded that the effect described by my perturbed correspondent was due to rapidly moving patches of unseen denser vapour than that which surrounded the planet, intruding in the line of sight. At the same time, I was far from being unmindful of the way in which Jupiter's light will frequently palpitate when the planet is nearing the horizon.

J. H. ELGIE.

72 Grange Avenue, Leeds, January 28.

Unemployed Laboratory Assistants.

A NUMBER of lads who have been employed as laboratory monitors in secondary schools, and whom the London County Council are unable to retain in their service beyond the age of sixteen years, have been referred to us by the London County Council with the view of our placing them. Some of them we have already been able to place in suitable employment, but there are still one or two on our books for whom we seek situations.

They all have an elementary knowledge of physics and chemistry. Some have learned glass-blowing and bending, and one of the applicants has already passed the Board of Education examination in chemistry (Stage I.). If any readers of NATURE would like to have further particulars of these boys, I should be glad to supply them with information.

GODFREY REISS (*Hon. Sec.*).

Apprenticeship and Skilled Employment Association, 36 Denison House, 296 Vauxhall Bridge Road, London, S.W., January 31.

THE AROLLA PINE.[1]

THE Arve or Arolla pine is the most beautiful of Alpine conifers. The glossy green of its acicular tufted leaves, the curving cone of its outline, the combined strength and grace of its growth, make it yet more attractive in colour and in form than the darker and sturdier spruce. It ranges, though rather fitful and sporadic in distribution, throughout the Alpine chain, passing on to the Carpathians, where, however, it does not grow nearly so high above the sea-level, but it is most abundant in north-eastern Asia, which is apparently its birthplace. There it extends northward to the tree-limit, eastward to the Altai, the Sea of Okhotsk, and the north of Japan, and westward even so far as the Lower Dwina. Between the occupants of these two provinces some marked differences exist, so that Dr. Rikli recognises an Arctic and an Alpine subspecies, to the latter of which his memoir is restricted.

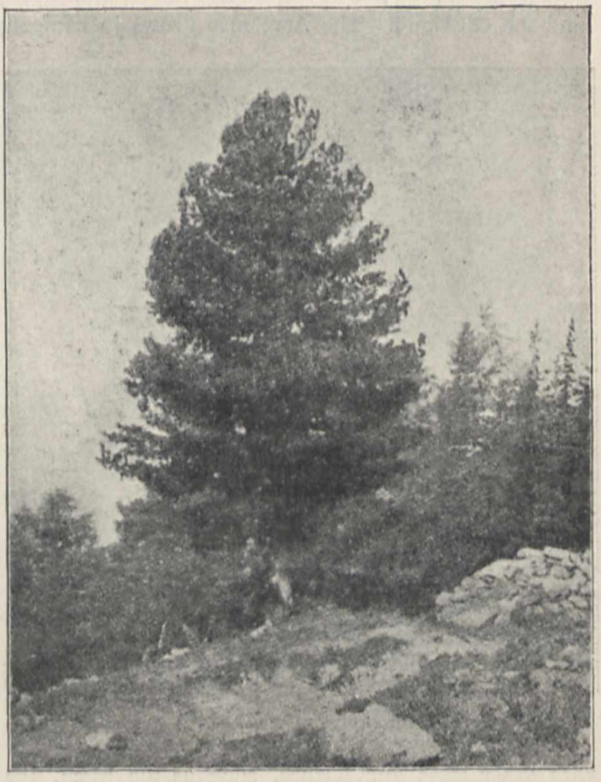


FIG. 1.—The Arve in Youth.

The Arve is a lover of the mountains, and on these it has a rather wide vertical range. When growing wild it is seldom met with below the 1350-metre contour-line. Dr. Rikli mentions as the lowest instance one at about 1200, near Raron, in the Upper Rhone valley. Its upper limit is about 2400 metres, the highest occurrence on record being 2585 metres, on the Plattje, near Saas Fee. Such cases, however, are exceptional, where the tree obviously has had a hard struggle for existence, and it cannot be said to flourish above 2300 metres. On the Northern range of the Alps, the vertical limits within which it grows freely are narrower than in the Central—or Pennine and Lepontine—range, the difference between them, in

[1] Die Arve in der Schweiz. Ein Beitrag zur Waldgeschichte und Waldwirtschaft der Schweizer Alpen von Dr. M. Rikli. Mit einer Arvenkarte der Schweiz, einer Waldkarte von Davos, 19 Specialkarten in Lithographie, 9 Tafeln in Lichtdruck und 51 Textbildern. (Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft, Band xliv.) Pp. xl+455. (Basel: Georg & Cie.; Zürich: Zürcher & Furrer, 1909.)

Canton Valais, being 1385 metres, and in Canton St. Gall only 270 metres.

Sometimes these pines form distinct and close-grown woods, to the exclusion of other conifers, in which each one is similarly developed. Such woods, however, are not common, and are generally restricted to the Grisons and Canton Valais, where the Arve is most abundant. More often, however, even when not mixed with other kinds, individuals grow either in more open order or in small clusters, or even as solitaries. On the slopes of the northern Alps they not unfrequently form trailing lines, the trees in which, as might be expected, often bear the marks of storm and stress. But the Arve more commonly is associated with other conifers—the larch, the spruce, the Scotch fir, and sometimes the silver fir. Another, but more lowly companion, is the Legföhre (*Pinus montana*), that trailing conifer which is more abundant in the eastern than in the western Alps, and altogether absent, so far as Dr. Rikli knows, from the Valais and the Oberland. The Arve also grows in company

FIG. 2.—The Arve in Age.

with other trees and bushes, such as the birch, the beech, the Alpine alder, a service (*Sorbus aucuparia*), and, of course, with the common rhododendron (*R. ferrugineum*), the bearberry (*Arctostaphylos uva-ursi*), the bilberry (*Vaccinium myrtillus*), and another member of that genus; while in the associated flora a mid-Europe Alpine, a north-Europe Alpine, and an Arctic-Altaian element may be detected; the last, as Dr. Rikli remarks, forming a link with the Arve's original home.

This memoir describes, with illustrations from reproduced photographs, the modes of growth which, according to circumstances, the Arve exhibits. A solitary one, when in its full vigour, is a happy combination, as Fig. 1 proves, of beauty and strength. With the advance of age it is apt to lose its symmetry and compactness, though it is still, as Fig. 2 shows, an ornament to the landscape. No more than other trees does it escape being torn by the storm or the avalanche, shattered by the lightning, and nipped, especially when young, by exceptionally severe frosts; but when overthrown, it sometimes puts out new roots and converts side branches into leading stems. But the Arve has its enemies also among other living things. Man is responsible for reckless hacking and felling, for forest fires or damage done in climbing after its cones, the kernels in which have a nut-like flavour. But now that he is restrained by forest laws, other creatures are the more formidable. Goats, sheep, and cattle (especially the first, if carelessly tended) do much damage to the young plants; the roe-deer, the stag, and the chamois take their share when in search of food. The marten, the squirrel, and even the fox, feed on the nuts, though the last, like the wood and hazel mice, must wait until they have fallen. Some birds also have similar tastes. Most conspicuous among these is the nutcracker (*Nucifraga caryocatactes*), which is never so common in the Alps as where the Arve is plentiful and its fruit is ripening. The capercaillie (*Tetrao urogallus*) feeds on the young shoots, and the common sparrow, generally to the front in mischief, has been known to do the same with seedlings. Its insect foes we can only mention.

In short, Dr. Rikli seems to have touched on every point of interest in the life-history of *Pinus cembra* in Switzerland, and has done his work with Teutonic thoroughness. He goes over the country, canton by canton, and valley by valley, citing statistics of the numbers of the trees, their distribution on either slope, and other distinctive features; he gives many particulars of the age, size, and rate of growth of the older trees, and refers to the care which, of late years, has been bestowed on their culture. The maps appended to the volume are interesting as showing the relative abundance or scarcity of *Pinus cembra* in different districts of the Alps, and the numerous photographs, especially the eighteen separately printed, some of which are unusually good, recall to lovers of that mountain chain pleasant memories of this handsome tree. To such Dr. Rikli's work will always be attractive; but to students of forestry it will be indispensable.

T. G. B.

ON HALLEY'S COMET AS SEEN FROM THE EARTH.

THE following table gives ecliptic coordinates of Halley's comet to two decimal places at intervals of four days through an arc extending from one end to the other of the *latus rectum* of its orbit. The zero of time is very nearly the moment of perihelion passage, and the figures apply approximately to any return.

Day	*x*	*y*	*z*	Day	*x*	*y*	*z*
−52	+0·95	+0·73	+0·12	+4	+0·21	−0·54	+0·15
−48	+0·93	+0·64	+0·13	+8	+0·10	−0·59	+0·13
−44	+0·91	+0·55	+0·14	+12	−0·02	−0·64	+0·11
−40	+0·89	+0·46	+0·15	+16	−0·13	−0·67	+0·09
−36	+0·86	+0·37	+0·16	+20	−0·24	−0·69	+0·06
−32	+0·83	+0·27	+0·17	+24	−0·34	−0·70	+0·04
−28	+0·80	+0·18	+0·18	+28	−0·45	−0·71	+0·01
−24	+0·75	+0·08	+0·18	+32	0·55	−0·71	−0·02
−20	+0·70	−0·02	+0·19	+36	−0·64	−0·70	−0·04
−16	+0·65	−0·12	+0·19	+40	−0·74	−0·70	−0·07
−12	+0·58	−0·21	+0·19	+44	−0·83	−0·68	−0·09
−8	+0·50	−0·31	+0·19	+48	−0·91	−0·67	−0·12
−4	+0·41	−0·39	+0·18	+52	−1·00	−0·65	−0·14
0	+0·31	−0·47	+0·17				

The comet attains unit distance from the sun thirty-nine days before and after perihelion passage. On the former occasion its z coordinate perpendicular to the ecliptic is +0·15, on the latter −0·07. It is evident, therefore, that the closest possible approach to the earth will occur after perihelion passage. The heliocentric longitude is 30° on the earlier occasion and 225° on the later. The earth reaches these heliocentric longitudes in October and May respectively.

At the return of 1835 perihelion passage was on November 16. There was consequently a close approach between the earth and the comet about a month earlier. In 1910 the perihelion passage will be on April 20; a month earlier than this, when the comet is close to the earth's orbit, the earth will be at the diametrically opposite point. A month after perihelion, however, there will be a very close approach.

The most unfortunate date for perihelion passage for yielding a close approach to the earth is January. The comet would then be behind the sun at perihelion, and more than an astronomical unit away when crossing the earth's orbit.

On the present return the approach after perihelion will be unusually close. The following table gives the ecliptic coordinates of the earth for the annexed dates:—

Date		x	y
1910, May	10	−0·65	−0·76
,,	14	−0·60	−0·80
,,	18	−0·55	−0·84
,,	22	−0·49	−0·87
,,	26	−0·43	−0·90
,,	30	−0·37	−0·93

When, therefore, the comet crosses the plane of the ecliptic twenty-eight days after perihelion passage (May 18) it will be almost exactly between the earth and the sun, and the earth will probably be in the tail of the comet.

The closest approach at this return takes place a day or two later.

The closest approach possible would correspond to a perihelion passage about a week and a half earlier in the year than the present one.

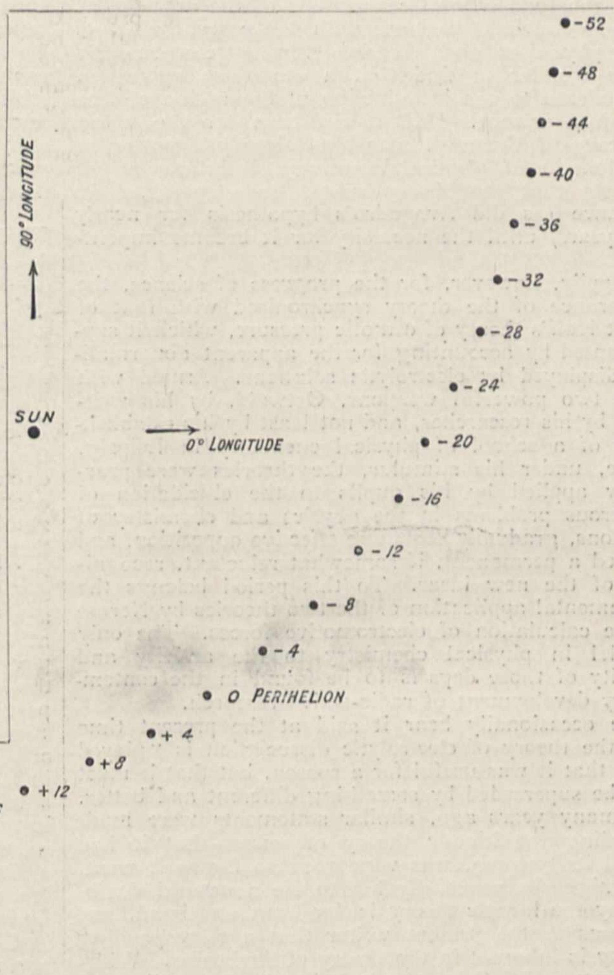
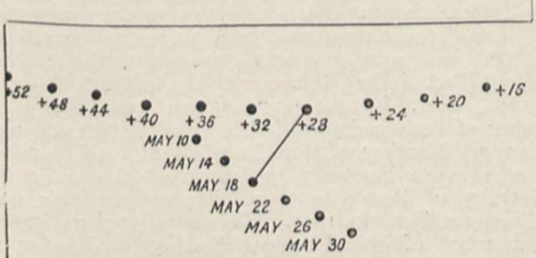
It appears, therefore, that the date of perihelion passage at this return is most fortunately timed, and a fine display may be expected.

The comet's history has been traced back to 240 B.C., and it has very seldom returned to perihelion unrecorded; so seldom, in fact, as to suggest that in the exceptional cases the records have perished rather than that the comet in any circumstances can pass by unseen.

A tail twenty or thirty degrees in length is expected on the present occasion. It will be best seen at the end of May, and in England it will, unfortunately, be lower in the sky than in more southern latitudes. There will, however, be no difficulty whatever in seeing it in England, unless there is a prolonged spell of bad weather.

The approach to the earth is so close that an American astronomer has conceived the idea of weighing the comet by the deviation it produces in the orbit of the earth. We can hardly believe that the effect produced will be one-thousandth part of the least measurable quantity, but the speculation is most interesting in view of the fact that there are unexplained phenomena in planetary movements.

P. H. Cowell.

The diagram gives the position of the Earth for six days in May; also the position of the comet on twenty-seven dates measured from perihelion passage in days. The line of sight is drawn for May 18, twenty-eight days after perihelion, when the comet transits across the Sun.

JUBILEE OF THE THEORY OF ELECTROLYTIC DISSOCIATION.[1]

In his address to the British Association in 1884, the president, Lord Rayleigh, said, "from the further study of electrolysis we may expect to gain improved views as to the nature of chemical reactions, and of the forces concerned in bringing them about. . . . I cannot help thinking that the next great advance, of which we have already seen some foreshadowing, will come on this side."

The first step of the advance spoken of by Lord Rayleigh had already been made, for in that same year the young Swedish physicist, Arrhenius, presented as his doctor's dissertation to the University of Upsala a memoir with the title "Recherches sur la Conductibilité galvanique des Électrolytes. Première Partie: La Conductibilité des Solutions aqueuses ex-

[1] *Zeitschrift für physikalische Chemie.* Bd. 69, Jubelband. Svante Arrhenius zur Feier des 25-jährigen Bestandes seiner Theorie der elektrolytischen Dissociation gewidmet von seinen Freunden und Schülern. Mit einer Einleitung von W. Ostwald. Pp. xxix+685. (Leipzig: W. Engelmann, 1909.)

trêmement diluées," which was published in the "Bihang till Kongl. Vetenskapsakademiens Handlingar," vol. viii., and was followed in the same year by the second part, entitled "Théorie chimique des Électrolytes." These researches contain the germ of the theory of electrolytic dissociation, which, however, only received its complete statement in 1887, in the first volume of the newly founded *Zeitschrift für physikalische Chemie.*

The impression made on the university authorities by Arrhenius's thesis was not favourable. In their view, apparently, it was neither very good chemistry nor very good physics, and only deserved the mild commendation "non sine laude approbatur." Indeed, the fundamental conceptions of the new theory were so much at variance with the current ideas of both physicists and chemists that it can scarcely excite wonder to find that a strenuous opposition was offered to the introduction of the notion of free ions into science. Had it not been for the warm advocacy of Ostwald, who was already a power in the domain of physical chemistry, it is not at all unlikely that the theory would have remained in abeyance (as did Avogadro's hypothesis for nearly fifty years) until the necessity for it became imperative.

Happily, however, for the progress of science, the appearance of the theory synchronised with that of van 't Hoff's theory of osmotic pressure, which it supplemented by accounting for the apparent abnormalities displayed by electrolytic solutions. Armed with these two powerful weapons, Ostwald, by his writings, by his researches, and not least by his establishment of a school of physical chemistry in Leipzig, where, under his stimulus, the theories were practically applied by his pupils to the elucidation of numerous problems in the physics and chemistry of solutions, gradually overcame effective opposition, and secured a permanent, if somewhat reluctant, recognition of the new ideas. To this period belongs the fundamental application of the two theories by Nernst to the calculation of electromotive forces. The only parallel in physical chemistry to the activity and fertility of those days is to be found in the contemporary development of radio-active research.

We occasionally hear it said at the present time that the theory of electrolytic dissociation is "played out," that it was useful for a season, but that it must now be superseded by something different and better. Not many years ago, similar statements were made regarding the kinetic theory of gases—that it had served its purpose, was very good so far as it went, and might be peacefully left to die a natural death. To-day the kinetic theory is far from moribund, and it seems to the present writer that a corresponding vitality is inherent in the theory of Arrhenius. Wide-reaching and fruitful physical theories generally contain a well-defined notion which survives any change of form which the theory or its mechanical interpretation may undergo. Dalton's atomic theory contains the imperishable notion of fixed combining weights for the elements; Avogadro's theory contains the definition of molecular weight; and from these two together we obtain, as Cannizzaro showed, the modern atomic weight. Whether we believe in atoms and molecules or not, these conceptions of combining, atomic and molecular weights will persist unaltered, and survive any upheaval in chemical theory. Similarly, Arrhenius's great positive contribution to physico-chemical science is the notion and practical definition of degree of ionisation. Whatever be our views of the origin and nature of ions, we must, in any quantitative investigation of the properties of electrolytic solutions, have recourse to the notion of degree of ionisation.

Arrhenius has since been active in many fields besides that of physical chemistry, notably in cosmic physics and in serum-therapy, bringing to bear in these branches of science the same clear-headedness and sublimated common-sense which enable him in the multiplicity of the details he so easily masters to detect the simple principles which coordinate and govern the whole. The present volume, however, the sixty-ninth of the journal which in its first volume contained the statement of his theory, is only concerned with his physico-chemical work, and is the first of two volumes written in his honour by pupils and friends to signalise the completion of the fiftieth year of his age and the twenty-fifth of his theory. To it physical chemists in all parts of the world have contributed, testifying to the universal esteem in which Arrhenius and his work are held, and a fitting introduction is written by Ostwald, who relates the early history and development of the theory with many pleasant biographical and autobiographical details. JAMES WALKER.

PROF. F. W. KOHLRAUSCH.

IT is with great regret that we have to record the death of the eminent physicist, Prof. F. W. Kohlrausch.

Kohlrausch was born in October, 1840, at Rinteln on the Weser. His father, Rudolph Kohlrausch (1809–1858), was a physicist of great distinction who, in conjunction with Wilhelm Weber, carried out for the first time a determination of the ratio of the electromagnetic to the electrostatic unit of electric quantity, and thus laid one of the corner-stones of the absolute system of electrical measurement. It was, therefore, natural that the son's attention should be early directed towards physical science. He studied at Göttingen and Erlangen, graduated Ph.D. in 1863, and in 1866 was appointed Professor Extraordinarius at Göttingen. After about a year as professor of physics at the School of Technology at Frankfort-on-the-Main, he was appointed, in 1871, to a similar post at the Grand-ducal Polytechnic at Darmstadt. In 1875 he became professor of physics in the University of Wurzburg, and was transferred thence to Strassburg in 1888. He was appointed president of the Physikalisch-Technische Reichsanstalt at Charlottenburg in 1895, and, in the same year, was elected a member of the Academy of Science of Berlin and also a Foreign Member of the Royal Society of London. He was made honorary professor of physics in the University of Berlin in 1900. He resigned his post at Charlottenburg in 1905. He was elected an honorary member of the Physical Society of London in 1906. He died at Marburg in January of this year.

Kohlrausch was the author of a great number of papers giving the results of experimental investigations in many branches of physics, but the subjects which chiefly occupied him were the methods of measuring magnetic and electrical quantities. Among his contributions to this branch of science we may mention his method for the absolute measurement of the horizontal component of the earth's magnetic field and of the strength of an electric current, by simultaneous observations of the deflection of the needle of a tangent-galvanometer and of a suspended coil where both instruments are traversed by the same current. Another important set of experiments, published in 1874, had for its object the determination of the absolute value of the "Siemens unit" of electrical resistance. The result which Kohlrausch arrived at, though afterwards shown to be appreciably in error, was of considerable importance historically, since it directed attention to the necessity of examining further the result obtained in 1863 and 1864 by Maxwell and his coadjutors for the British Association Committee on Electrical Standards.

In 1871 Kohlrausch introduced a method for measuring the electrical resistance of electrolytes founded upon the employment of alternating currents generated by the revolution of a magnet inside a coil of wire, the relative positions of magnet and coil being like those in an ordinary galvanometer. In this way the disturbing effect due to the polarisation of the electrodes was in a great measure, if not entirely, got rid of, and the results obtained were a great advance in respect of accuracy upon those previously obtained. In later modifications of the method the alternate currents of an induction-coil were used. This investigation formed the starting point of a long series of researches into the conducting power of electrolytic solutions. The examination of a great number of soluble salts in aqueous solutions of different concentrations showed that, although the conductivity decreases with decreasing concentration, the ratio of conductivity to concentration increases, at first nearly uniformly, but approaches a definite limit for each salt when very small concentrations are reached, that is, when the solutions are very dilute. It was further found that, when the proportion of salt in solution was expressed in terms of the equivalent mass of the salt, the limiting (maximum) value of the above ratio varied within comparatively narrow limits for a great number of salts. Another important result of Kohlrausch's experiments was the establishment of a simple relation between the conductivities of dilute solutions and the mobilities, as deduced from Hittorf's measurements, of the ions into which the respective salts may be supposed to be broken up when dissolved.

Kohlrausch rendered an extremely valuable service to the teaching of experimental physics by the publication, in 1870, of his "Leitfaden der praktischen Physik." This was the first, and, in the writer's opinion, the best of numerous works of the same kind that have since appeared in various countries, designed to guide students of physics in a systematic course of practical work in the physical laboratory. The high appreciation it has met with is shown by the number of editions that have been called for—it reached the eighth in 1896; it was translated into English by Messrs. T. H. Waller and H. R. Procter soon after its first appearance, and a second English edition was published in 1883. G. C. F.

SIR CHARLES TODD, K.C.M.G., F.R.S.

FEW men have lived a fuller life or given more freely of their best than Sir Charles Todd, whose death we deeply regret to record. It is only about three years ago that he retired from active service, but he was then above eighty years of age and his career had been unusually long. His scientific life dates back to 1841, when he entered the Royal Observatory, Greenwich. The instruments, as those who used them, have passed away, and he must have been the last survivor of the little band who worked with the old meridian transit and circle. There he acquired a training in scientific methods which he was destined to turn to such useful account in promoting the interests of a new colony. In South Australia he found his work, and there his memory will be treasured. For it was his fortune to organise two departments, the Post Office and the Meteorological Service, which have contributed in no small degree to the growth of that thriving settlement.

It is not given to many to see their exertions and plans so speedily and completely successful as did Sir Charles Todd, or to fill simultaneously the three important positions of Postmaster-General, Superintendent of Telegraphs, and Government Astronomer. But it will be admitted that he filled this trinity of offices with credit to himself and to the advantage of others. The Post Office was practically his own organisation, which, continually growing with the requirements of the Colony, proved itself equal to the increasing demands. It was in connection with the establishment of the Telegraph Service, and its growing needs, that he made that remarkable ride of 2000 miles across the arid interior of the continent of Australia, from Adelaide to Port Darwen. The energy and intrepidity of the man were well illustrated by this memorable venture. No wonder that he loved to tell of that day, when he sat on the ground near Mount Stewart, amid uncomfortable surroundings, but forgot all in the sense of successful achievement, when, with a little pocket relay, he connected the wires and held communication with the extreme north and south of the island.

As Government Astronomer, it will be remembered that Sir Charles Todd took part in organising the expeditions for the observation of the transit of Venus, that he kept the 8-inch refractor steadily at work, and did what lay in his power to maintain an interest in astronomy. Still greater was the service he rendered in promoting a meteorological and climatological servey—so necessary in a new country, where the climatic conditions are of vital importance to the incoming settler. For something like forty years he maintained the meteorological service, and has left to his successor a complete and well-equipped organisation.

His talents were admirably fitted for the field in which they found scope. He knew how to inspire others with the tireless energy that carried him through so many difficulties; his geniality secured him many friends and willing workers that enabled him to accomplish so much; his life and history are written in the progress of the colony during the last fifty years. Amid the regrets of those among whom he laboured so well and so long, he will be remembered as one whose services gained the approval of his sovereign and the cordial appreciation of his scientific colleagues, and especially as a typical specimen of that class which, great in resolve as in achievement, has given strength and impulse to our Colonial Empire.

NOTES.

AT the meeting of the Paris Academy of Sciences on January 24 Lord Rayleigh was elected a foreign associate member in succession to the late Prof. Simon Newcomb. Lord Rayleigh was elected a correspondant of the academy in 1890.

M. EMMANUEL DE MARGERIE has been elected president for 1910 of the Paris Geographical Society, and M. H. Deslandres and Colonel Bourgeois vice-presidents.

DURING his recent visit to St. Petersburg, Sir Ernest Shackleton was presented with the Constantine gold medal of the Russian Geographical Society.

THE Lettsomian lectures on "The Cerebellum and its Affections" will be delivered by Dr. J. S. Risien Russell at the Medical Society of London on February 7 and 21 and March 7.

AT the close of a public lecture by Dr. Sven Hedin in Rome on January 30, the King of Italy handed to him the large gold medal which has been conferred upon him by the Italian Geographical Society.

PROF. J. ARTHUR THOMSON has been elected president of the Royal Microscopical Society for the ensuing year.

WE regret to see the announcement of the death, on January 28, at seventy years of age, of Prof. F. Purser, professor of natural philosophy in the University of Dublin and the author of several notable works on Bessel's functions.

THE following officers have been elected for 1910 by the French Physical Society:—*President*, M. L. E. Bertin; *vice-president*, M. Lucien Poincaré; *general secretary*, M. H. Abraham; and *assistant secretary*, M. Jean Becquerel.

THE *Times* states that the Belgian expedition which will leave shortly for the Congo to make investigations in connection with sleeping sickness will be in charge of Dr. Rhodain, professor of bacteriology at the University of Louvain. Work will be begun in the northern part of the Katanga district.

THE president of the Royal College of Physicians has appointed Dr. H. B. Donkin to be the next Harveian orator, and Dr. G. N. Pitt to deliver the Bradshaw lecture. The Milroy lectures are to be delivered by Mr. A. G. R. Foulerton, on February 17, 22, and 24; the Goulstonian lectures by Dr. J. S. Bolton, on March 1, 3, and 8; and the Lumleian lectures by Prof. W. Osler, F.R.S., on March 10, 15, and 17.

WITH the object of giving still greater publicity to the advantages of intensive cultivation an exhibition of "French Gardening" is to be held at the Royal Botanical Society's Gardens at Regent's Park. Active preparations are now in progress for exhibiting and demonstrating every aspect of the close and scientific cultivation of the soil. The exhibition will take place in July, though the exact date is not yet definitely settled.

WE learn from the *Revue générale des Sciences* of January 15 that the French Guild of Jewellers is desirous of having the artificial "rubies" branded as *imitations*, like paste copies. Dr. Olivier, the editor of our contemporary, protests strongly against such action being taken by the Minister of Commerce, seeing that in composition and properties the natural and artificial materials are identical.

THE death is announced of Dr. J. Volhard, professor of chemistry in the University of Halle, at seventy-five years of age. For several years Dr. Volhard acted as Liebig's assistant, and ultimately was entrusted by him with the delivery of the course of lectures on organic chemistry which he regularly gave during the summer semester. His biography of Liebig, published last year, is a valuable and complete record of the life and work of that great chemist.

ON Tuesday next, February 8, Prof. F. W. Mott will begin a course of six lectures at the Royal Institution on "The Emotions and their Expression," and on Saturday, February 12, Sir J. J. Thomson will commence a course of six lectures on "Electric Waves and the Electromagnetic Theory of Light." The Friday evening discourse on February 11 will be delivered by Mr. C. E. S. Phillips, on "Electrical and other Properties of Sand," and on February 18 by Prof. H. H. Turner, on "Halley's Comet."

WE have received a letter signed by Lieut.-Colonel H. W. L. Hime, Sir G. Greenhill, and Mr. Oscar Guttmann, pointing out that at present there is no memorial of the foremost man of science of the thirteenth century, Roger Bacon, who foreshadowed many of the discoveries of modern science, and is known universally as the inventor of gunpowder. Contributions (however small) towards the erection of a memorial, in a suitable place, of this great Englishman may be sent to Mr. Oscar Guttmann, 60 Mark Lane, E.C.

THE executive committee of the National Physical Laboratory, on the nomination of the advisory committee for the national experimental tank, has appointed Mr. G. S. Baker to the post of superintendent of the tank, the funds for which have been provided by the generosity of Mr. A. F. Yarrow. After a distinguished career at the Royal Naval College, Greenwich, Mr. Baker was in November, 1900, appointed an assistant constructor in the Royal Corps of Naval Constructors. He served four years as assistant to Mr. R. E. Froude, F.R.S., at the Admiralty Experiment Works, and two and a half years as professional secretary to the Director of Naval Construction, and has also had experience in the general design work of the Admiralty Office. Thus he goes to the laboratory with distinguished qualifications, and on the strong recommendation of those who have the best grounds for estimating the value of his previous work.

THE permanent committee of the International Congress of Photography is arranging to hold the fifth International Congress in Brussels early next August, or about that time. The primary object of these congresses is to reduce, as far as possible, the confusing and often inconvenient variations that occur in nomenclature, definitions, standards, &c. Promises of support have been received for the coming congress from all parts of the world, and arrangements are being made for the presentation of reports by specialists on recent progress and the present state of knowledge in many of the branches of photographic work. It is hoped that England will take a full share in the congress. A complete programme will be issued as soon as possible. The membership subscription is ten francs or eight shillings, which entitles the member to a copy of the report of the proceedings. Inquiries may be addressed to either of the honorary general secretaries, M. Ch. Puttemans, 1 Palais du Midi, Brussels, or M. L.-P. Clerc, 52 Boulevard Saint Jacques, Paris XIV.; but for the convenience of English members inquiries and subscriptions may be sent to Mr. Chapman Jones, 11 Eaton Rise, Ealing, London, W.

BY the courtesy of the director of the Meteorological Office, the advisory committee for aëronautics is able to announce that a selection of current autographic records of wind velocity from the twenty-three anemograph stations in connection with the office, and other meteorological documents of interest to aëronauts, will be available for inspection at the Meteorological Office daily from 10 a.m. to 4 p.m. (Saturdays, 1 p.m.). The structure of wind and the changes to which it is liable are of great practical importance in aëronautical work. The association of changes in velocity with changes in direction, which are sometimes quite sudden, make aëronautical work especially difficult. There is sufficient information now available to indicate the conditions in which such changes may be expected. The anemographic records are selected to show good examples of the different kinds of wind structure recorded at the anemograph stations in these islands and to illustrate the changes that take place. The phenomena on any selected occasion can be compared with records from barographs or other self-recording instruments, or with the conditions indicated on the daily charts. The exhibits also include the summaries, which are not published, of the wind tabulations for all the anemometers in connection with the office from 1906 to 1909 inclusive. There is, besides, a series of diagrams representing the variation of wind velocity with height for all the kite ascents reported to the office in 1908 and 1909. These diagrams show a remarkable approximation, on many occasions, to direct proportionality between height above sea-level and the wind velocity in the upper air, irrespective of the height of the station at which the observation is made, and suggest a working practical rule for computing the increase of wind aloft. Opportunity is also afforded for considering the computation of gradient wind which must form the basis of any satisfactory method of dealing with wind measurements.

THE Paris floods have fortunately passed their maximum height, and are now generally subsiding. The information to hand having a bearing on the direct cause of the flood is exceedingly meagre, and until the detailed report of the Service hydrométrique is available little can be said. The data collected by this service is very complete, and extends over a period of fifty years. A series of low barometric systems passed over the northern portion of the Mediterranean and the south of France after January 19, and these occasioned exceptionally heavy rains in the catchment basin of the river and its tributaries. In Paris the aggregate rainfall from January 17 to January 25 was 2·08 inches, but this is quite inadequate to occasion the tremendous rise of the Seine which occurred; on no day did the rainfall amount to 0·5 inch. The rains were heavier near the source of the river, and in parts of France and Switzerland the rainfall for the two days January 18–19 amounted to fully 3 inches. According to the *Bulletin International* of the Central Meteorological Office of France, a swelling of the Seine was forecasted for January 20, but so late as January 20 the flood was not expected to exceed about 13 feet on January 22, and on January 21 this estimate was increased to 16 feet for January 23. On this date the estimate was further increased to 22 feet for January 24, and on January 25 the estimate for the increase was to 25 feet on January 26. At 8 a.m. on this date the actual flood reached 24·6 feet at Pont d'Austerlitz, 24 feet at Pont de la Tournelle, and 27 feet at Pont Royal, whilst a further slight increase was anticipated. The flood is said to have attained its maximum height on January 27–28, when it is reported as having reached 30 feet at Pont Royal. This is apparently higher than any previous record, exceeding that of 1764.

IT is with regret that we announce the death, in his sixtieth year, of Prof. W. Hillhouse, who held the chair of botany and vegetable physiology in Mason College and the University of Birmingham from 1882, when the chair was founded, until last year, when he was compelled by ill health to resign his appointment. Prof. Hillhouse was born at Bedford in 1850, and some of the earliest of his botanical work was in connection with the flora of his native county. He became a scholar of Trinity College, Cambridge, and afterwards a lecturer in that University. He was also keeper of the University herbarium. His life at Cambridge was marked by the birth of the *Cambridge Review*, of which he was one of the founders, and the editing of which he shared with Prof. Arnold and Vice-Principal Dale. He was widely known in the Birmingham district for his interest in educational matters, and in particular his efforts were directed to the establishment of a university extension movement in connection with Birmingham. He was a most energetic worker as honorary director of the Edgbaston Botanical Gardens, and was chairman of the council of the Midland Reafforesting Association. He was for a number of years on the Leicestershire Education Committee, and on retiring in 1909 received a very warm tribute for the services he had rendered in promoting the higher education of the county. One of his latest works on behalf of the University was the direction of the preliminary laying out of the ornamental grounds surrounding the new buildings at Edgbaston. His death will be sincerely regretted by his colleagues and by many of his old students, by whom his genial and kindly personality was much appreciated.

THE Victoria Museum of Launceston, Tasmania, is setting an example to other institutions of a like nature in arranging for the preparation of a series of dissected skeletons of native birds preserved in formalin. Of one of these a descriptive account has been published in the shape of a pamphlet, by Mr. H. H. Scott, the curator, under the title of "A Memoir on the Wedge-tailed Eagle, *Uroaëtus audax*; a Study in Avian Osteology."

ACCORDING to vol. ii. of the Journal of the Ipswich and District Field Club, the local excursions have been well attended during the past season, and have attracted a large amount of interest. Specially noteworthy is the discovery of a new Pleistocene bone-bed in a railway-cutting near the city. In connection with another "find" of mammalian remains may be noticed a repetition of the common error of giving *Cervus elephas* as the name of the red deer. The issue concludes with a reprint of a paper, by Dr. Bather, on crinoid remains from the Red Crag.

THE hairy-nosed wombat, *Phascolomys latifrons*, has hitherto been regarded as peculiar to South Australia. It appears, however, that in the Melbourne Museum are preserved four specimens of this species obtained from a lonely part of New South Wales in or near Denison country so long ago as the year 1884. Whether the species still survives there is unknown, but the donor of the specimens stated that it never occurred in any other part of the colony. These New South Wales hairy-nosed wombats are stated to differ from their relatives in the south in the characters of the nose, while the skull appeared to be shorter and rounder. If these differences are well established, the New South Wales form apparently indicates a distinct species.

IN an article on the menageries of the ancients and the Middle Ages and their influence on modern zoology, published in the January number of *La Revue des Idées*, Mr. Gustave Loisel directs attention to the circumstance that in ancient times Indians, Persians, Chaldeans, and Assyrians appear to have completely tamed the larger felines, carrying out this taming process to a considerably greater extent than is accomplished in the case of the hunting-leopard by the natives of modern India. They tamed the lion, for instance, to such a degree that it could be led in a halter and employed in the chase of deer, wild bulls, boars, and asses. It is also considered that the Chinese were the first to domesticate house-cats, and likewise to train cormorants for fishing.

IN an article on Miocene trees, published in the January number of the *American Naturalist*, Prof. T. D. A. Cockerell points out the remarkable resemblance between the fossil trees of the Florissant beds of Colorado and those of Œningen, in Baden. Out of six species selected from each locality, two are common to both sets of strata, while four are representative of each other. Nine other Florissant trees are quoted as being represented by allied forms at the present day, although in no instance is there specific identity, and it is noteworthy that some of the Florissant generic types are now restricted to Asia. Regarding the Œningen beds as of Upper Miocene age, the author considers that the Florissant deposits should be assigned to the same epoch.

To the January number of the *Zoologist* Prof. McIntosh contributes an article on the red or precious coral, in which he traces the evolution of our knowledge of this product from ancient times. Red coral was well known to the Romans, and about the beginning of the Christian era was exported in such quantities to India that it was difficult to obtain in the countries where it was produced. After describing the nature of the organism, and then giving a sketch of the mode of fishing, Prof. McIntosh states that the great bulk of the coral is sold at Messina, Naples, Genoa, Leghorn, and Marseilles, while the product of the Algerian fishery goes to Pisa and Trapani. About 160 tons of coral are brought yearly into Italy, the articles made from which are valued at nearly 500,000*l.* The total annual value of rough coral has been estimated at 2,000,000*l.*, while after manufacture the value is stated to reach no less than 10,000,000*l.* The finest quality is of a delicate pinkish or flesh-like colour, uniform in tint throughout, and occurring in large pieces. Inferior samples are sold at 2*l.* per ounce, and small fragments, used for children's necklaces, at 5*s.* an ounce. Even worm-eaten coral has a value in the East, as the natives of certain districts believe that gods dwell in the holes.

DR. VICTOR WIDAKOWICH contributes an important memoir on the inversion of the germ-layers ("Entypie") in mammals to the *Zeitschrift für wissenschaftliche Zoologie* (vol. xciv., part ii.). The memoir is very beautifully illustrated, and the drawings of models of various stages in the early development of the rat should be extremely useful to students of this difficult subject.

IN the *Zeitschrift für wissenschaftliche Zoologie* (vol. xciv., part i.), Prof. B. Bachmetjew makes a very ingenious application of biometrical methods to the solution of the difficult problem of parthenogenesis and sex-determination in bees. From an elaborate statistical study of the variation in the number of hooks on the front margins of the hind wings, he finds that the resulting curves show either one or two maxima of frequency. He maintains that fertilisation of the eggs determines two maxima and parthenogenesis one. Thus queens always show two maxima of frequency in each hind wing; they are produced from fertilised eggs. Drones produced by workers show only a single maximum; they are produced from unfertilised eggs. With regard to sex-determination in bees, he adopts the preformation theory of Schultze and Lenhossék, but with the addition that drones may develop from unfertilised "female" eggs, and that the fertilisation of "male" eggs does not prevent the development from them of drones. He finds that one-year-old queens produce drones from unfertilised eggs—this appears to be the normal method. Queens of two or three years produce drones partly from unfertilised and partly from fertilised eggs, because, with advancing age, the closing mechanism of the seminal reservoir no longer works properly, and some of the drone eggs get fertilised, as it were, accidentally. Queens of four years and older produce drones from unfertilised eggs only, because all the spermatozoa have been used up. Several polymorphic forms of drones occur in the same colony, the form depending upon whether they are produced from fertilised or unfertilised eggs. Workers are produced only from fertilised eggs.

THE correct botanical nomenclature of the plants yielding commercial cottons has provided much subject for controversy. A recent paper communicated by Mr. F. Fletcher to the *Cairo Scientific Journal* (November, 1909) discusses the botany and origin of American upland cotton. Evidence is adduced for the opinion that this well-known plant does not show the characters indicated by Miller's type of the species *hirsutum*, but conforms to the description and drawing issued by Tenore for *Gossypium siamense*. The author states that *Gossypium religiosum* of Linnæus also refers to the upland plant, but gives reasons for disregarding this specific name in favour of the former.

THE twentieth number of Notes from the Royal Botanic Garden, Edinburgh, completing the fourth volume, contains several short papers on abnormal developments in plants. Mr. A. J. Gray records an irregular condition in the sporocarp of *Salvinia natans*, where megasporangia were discovered in a microsporangial fruit, and Miss B. Chandler describes cases of anomalous branching at the end of aërial roots of *Tibouchina moricandiana* consequent upon the arrest in growth of the apical meristem. There is also an article, contributed by Mr. F. Darwin, referring to John Hope, a professor of botany in Edinburgh in 1780, and directing attention to certain of his drawings which indicate a knowledge of the light sensibilities of plants much in advance of the published references on the subject.

AN important paper by Dr. M. Greshoff, collating a large number of phytochemical investigations carried out by him in Kew Gardens, is published in the tenth and final index number of the *Kew Bulletin* for 1909, where there also appears the announcement of the author's sudden death. Dr. Greshoff had previously studied the occurrence of alkaloids and hydrocyanic acid in plants, and instituted the investigations here described with the object of discovering new plants of medicinal value, and of testing the presence of chemical constituents as a character of systematic value. The majority of the notes refer to the occurrence of saponin or hydrocyanic acid. Among the plants yielding saponin reactions are several genera of the Leguminosæ, notably Astragalus, which provides some of the American poisonous loco-weeds, and Acacia, of which several species furnish fish poisons; also four genera of the Caprifoliaceæ, three of the Polemoniaceæ and Phytolacca are included. The cyanogenetic list contains, among others, several genera of the Compositæ, Oxytropis, Drosera, Dionæa, Cystopteris, and Davallia.

THE wine industry of South Africa is discussed in a recent number of the *Agricultural Journal of the Cape of Good Hope*. Vines were introduced by the Huguenots, and found congenial soil and climate; the industry has remained in some districts, but is practically stationary, only 6,000,000 gallons of wines and 1,500,000 gallons of brandy being produced. It is urged that these figures are capable of very material improvement. In 1874 Algerian production was no more than that of South Africa, but is now, as the result of careful development, more than 130,000,000 gallons. Cape Colony, it is urged, could produce the light wines of France and Germany and the heavier wines of Spain and Portugal, and there seems to be no insuperable difficulty in the way of creating a flourishing industry.

THE last series of excavations at the amphitheatre known as Maumbury Rings, near Dorchester, has been conducted under the supervision of Mr. St. George Gray, of Taunton Castle, who asks for further support in this undertaking. One remarkable discovery has been made, that of the *cavea* or den in which the animals were housed in readiness for the performances. Here the débris was found to contain coins of the Emperors Constantine the Great and Hadrian, which indicate the approximate date at which games were conducted by the Romans in this amphitheatre.

DR. R. B. BEAN, of the Anatomical Laboratory, Manila, publishes an account of a new cephalograph, an instrument intended to reproduce the outlines of the human head and face, which he has recently invented. It is based on the cranial instruments of Prof. Rudolph Martin, and is an adaptation of the pantograph. He also issues a further instalment of his examination of the Filipino types in the town of Taytay, which corroborates the conclusion at which he had previously arrived, that the population of the archipelago may be resolved into three types —Iberian, Australoid, and Primitive.

A LENGTHY but interesting study of memorising various materials by a new method forms the subject of a monograph by Prof. E. A. McC. Gamble, separately published by the *Psychological Review*. In this method a series of colours, odours, or syllables (all three materials are used in different experiments), is repeatedly presented to the subject, who manipulates the members of the series after each presentation and attempts to arrange them in their original order. The repetitions of presentation of the series are continued until successful reconstruction of the order is attained. Miss Gamble terms this method the "reconstruction method," and compares the results with those given by previous methods of experiment in memory. She finds that a relatively small number of repetitions is required for successful reconstruction, even at the outset of the experiments and apart from the well-marked improvement-effects of subsequent practice. Compared with the "learning method," in the reconstruction method the increase of difficulty with increasing length of the series is remarkably small. Again, in contrast to the "learning method," in Miss Gamble's method there is no sharp limit to the length of the series which is reproducible in correct order after a single presentation, and the subject remembers fully as many sequences and rather more positions in longer as compared with shorter series.

THE Canadian Department of Mines has issued in advance, from its annual report on mineral production, the chapters by Mr. J. McLeish dealing with chromite and asbestos mining in 1907–8. Canada supplies almost the whole of the world's asbestos, and the Canadian output has increased steadily from 27,414 metric tons in 1902 to 60,372 metric tons, of a value of 190,980 dollars, in 1908. The chief mines are in the eastern townships of the Province of Quebec, especially around Thetford. The Canadian output of chromite in 1908 was 7225 short tons (6554 metric tons), a slight increase over that for the previous year, but less than the record in 1906 of 9033 short tons. New Caledonia remains by far the largest producer of chromite; Turkey is second, and Canada has fallen to the fourth place owing to the rapid development of chromite mining in Rhodesia.

DR. V. CONRAD has recently investigated the annual and diurnal variations in frequency of 2497 earthquakes which occurred in the Austrian Alps and neighbouring districts from 1897 to 1907 (*Mitt. der Erdbeben-Kom. der K. Akad. der Wissen. in Wien*, No. 36). The annual variation is well marked, with its maximum in March and minimum in June, the amplitude being 65 per cent. of the mean monthly number of earthquakes. The diurnal variation is also strongly pronounced, the maximum occurring at 2 a.m. and the minimum from 8 a.m. to 4 p.m. Treating the hourly numbers of shocks with the aid of harmonic analysis, the diurnal period is found to have a maximum at 0¾ a.m., and an amplitude which is 87 per cent. of the average hourly number of shocks. In all probability this daily change in frequency is due to the varying conditions under which the earthquakes are observed.

THE *U.S. Monthly Weather Review* for May last (which we have recently received) contains part ii. of Prof. C. F. Marvin's article on "Methods and Apparatus for the Study of Evaporation" (see NATURE, November 25, 1909). In this part the author describes the various instruments devised for the experiments upon evaporation of water from lakes and reservoirs undertaken by the Weather Bureau. The different kinds of apparatus, which were designed more especially for evaporation from pans, are clearly illustrated and their use fully explained. Among them is a self-registering gauge invented by Prof. Marvin which records, side by side on the same sheet, rainfall, wind, and evaporation, and seems to meet in a satisfactory manner most of the conditions required of such an instrument; the traces are legible, and the apparatus is said to be portable and easily installed.

THE January number of the *Illuminating Engineer* of New York contains a well-illustrated article on the electric lighting of the White House, Washington, a dwelling which it characterises as "decidedly unpretentious and plain" in comparison with many mansions of to-day. The imitation candle supporting a miniature incandescent lamp is the unit on which the lighting system is based. In general, they are grouped and supported in an artistic manner, but in one conspicuous case the supports are much too massive.

THE United States Coast and Geodetic Survey has recently published an appendix to the report of 1908 which deals with the magnetic observations made on land and by the four vessels engaged in work at sea during the year ending June, 1908. The observations on land are made with a theodolite magnetometer and a dip circle, and those at sea by means of a Lloyd-Creak dip circle checked at intervals by comparison on land with a magnetometer. The whole of the instruments were previously standardised at the Cheltenham Observatory. The present results are summarised in twenty pages of tables. A comparison with previous results shows that the secular increase of westerly deviation on the Atlantic seaboard is about five minutes of arc per annum. Inland the change becomes very small, but rises again to about four minutes per annum increase in the easterly declination at the Pacific seaboard. It may be noted that these secular changes are not quite in agreement with the representation of them as due to a slow drift of the magnetic system of lines to the west.

UNDER the London Gas Act, 1905, the gas companies were relieved of any obligation to remove sulphur compounds (other than sulphuretted hydrogen), and to replace the standard Argand burner, London Argand No. 1, by another, the London Argand No. 2. The practical effect of this was to enable the gas supplied to be lower in illuminating value by from 1·5 to 2·0 candles. In addition to this, two of the companies were empowered to lower the minimum candle-power from 16 to 14 candles, and in the Gas Light and Coke Company's Act, 1909, the latter company is also permitted to supply 14- instead of 16-candle gas. The 1905 Act also empowered the controlling authority to make tests of the calorific power, and in the 1909 Act, which has just come into force, a statutory minimum net calorific power of 112·5 calories per cubic foot is enforced. As compared with the state of affairs five years ago, the consumer of gas for power or heating purposes has now to burn about 1200 cubic feet of gas in the place of 1000, costing 3*s.* $2\frac{1}{2}$*d.* as against 3*s.*, plus a meter rental (varying with the consumption), plus the extra cost of repairs caused by the additional sulphur present. The consumer, for lighting purposes, if using throughout an incandescent mantle, is not seriously prejudiced; if, however, he retains the batswing burner, his outlay for the same amount of light has increased in the ratio of about 4/3, plus a meter rental and plus an increased cost of internal decoration due to the condensation on the walls and ceilings of an increased amount of sulphuric acid.

THE *Scientific American* for January 15 shows an illustration of the McClean-Lissack automatic rapid-fire gun, which was tested last year by the Ordnance Department of the United States Army. This gun is designed for attacking balloons, and is mounted on a Packard 3-ton automobile truck. The gun fired 3-lb. shots at the rate of 100 per minute, the range being $3\frac{1}{2}$ miles. With brakes on, the truck did not move on firing, and no shock was perceived by those standing on the truck platform. With brakes released there was a slight movement on the recoil, but no shock. Further tests with this gun are being made at Sandy Hook and Springfield for the army, and at Indian Head for the navy. The same article also illustrates two German automobile guns designed for the same purpose. One of these is mounted on an armoured truck of 60 horse-power, capable of a speed of 45 kilometres per hour. The shell from this gun has a maximum height of trajectory of 3800 metres.

THE ninth report to the alloys research committee was presented by Dr. W. Rosenhain and Mr. F. C. A. H. Lantsberry at the meeting of the Institution of Mechanical Engineers on Friday, January 21. Dr. Rosenhain explained that this report dealt with the properties of some alloys of copper, aluminium, and manganese, and is confined to some of the more interesting alloys likely to be of practical service. The greater part of the work was confined to alloys containing less than 11 per cent. of aluminium, and also less than 11 per cent. of manganese. It is impossible to state adequately and briefly the enormous amount of valuable information resulting from this research —the report occupies 174 pages of the institution's transactions. Specific mention might be made of the great tensile strength exhibited by one of the alloys in the form of a cold-drawn bar, having a yield point of 40·88 tons per square inch and an ultimate stress of 52·08 tons per square inch. This alloy had 9·99 per cent. aluminium, 2·01 per cent. manganese, and 88 per cent. copper. Another alloy shows hardness sufficient to enable it to take a cutting edge that will sharpen a lead pencil. In addition to the mechanical tests and microscopic and freezing-point investigations, corrosion in sea water has been examined. Further and more searching tests on the latter are now proceeding at Portsmouth Harbour, and have also been arranged for in the warmer sea water at Malta Dockyard.

THE January number of the Journal of the Royal Statistical Society begins a new series of the journal, to be issued monthly during the session. It is hoped that the greater rapidity of publication thus secured will be of service, as papers read one month will now be in the hands of fellows, and the public generally, by the middle of the following month instead of sometimes not appearing for three months or more, as is necessarily the case with a quarterly journal. Current notes also form a new section of the journal which it is hoped will increase its general interest.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

Feb. 4. 5h. Venus in perihelion.
6. 12h. Mercury stationary.
7. 12h. 25m. Uranus in conjunction with the Moon (Uranus 3° 19′ N.).
9. 12h. 36m. Venus in conjunction with the Moon (Venus 13° 34′ N.).
12. 0h. Venus in inferior conjunction with the Sun.
13. 13h. 22m. Saturn in conjunction with the Moon (Saturn 1° 18′ N.).
15. 6h. 12m. Mars in conjunction with the Moon (Mars 3° 1′ N.).
19. 17h. Mercury at greatest elongation west of the Sun.
19. 21h. 33m. Neptune in conjunction with the Moon (Neptune 4° 10′ S.).
26. 3h. Venus at greatest heliocentric latitude north.
,, 17h. 34m. Jupiter in conjunction with the Moon (Jupiter 2° 29′ S.).

MARS.—Readers of these columns should be fairly well acquainted with Prof. Lowell's views concerning the Martian features and their significance, but they will find interesting the comprehensive summary given by Prof. Lowell in No. 13 of *Scientia*, the international science review published at Bologna, and obtainable from Messrs. Williams and Norgate. Therein the author reviews the observations of the melting snow-caps, of the "canals" and oases, which, by virtue of their dependent vegetation, undergo striking changes in conformity with the Martian seasons, and the theoretical considerations which have led him to conclude that Mars is habitable by organisms not essentially different from those with which we are acquainted. That Mars has no water except that contained in its atmosphere and that which forms the snow-caps, Prof. Lowell avers, but he contends that that water is artificially "engineered" in such a way that organic existence is rendered possible.

CAROLINE HERSCHEL AND HER COMET SEEKER.—At the present moment, with the subject of comets so much to the fore, an article which appears in the January number of *Himmel und Erde* is of especial interest. The writer gives many details of Caroline Herschel's strenuous life and describes her labours with the comet seeker. A facsimile reproduction of a letter, dated August 5, 1831, from her to Director Hausmann, tells how the comet seeker was made and how she wished it to be used after she had finished with it. The instrument was made of odds and ends by her brother "between breakfast and dinner." "The tube had once been used as a Newtonian finder to the 20-foot reflector. The circular board once served for a fly-wheel in some experiment; and for the pole, I was sent to the scullery to find a mopstic. The rest was sawed and chopped in the shapes as they were wanted—as for plaining we could do without, there was no time for niceties." Yet, she adds, it stood for forty-seven years without wanting a single repair, travelling all over the house and garden, at Slough, many a night; and with it she discovered five of the eight comets credited to her name.

EDDY FORMATION IN THE WAKE OF PROJECTING OBSTACLES.

CONSIDER a stream bounded by and moving parallel to the plane OX, with velocity U, and containing a stationary vortex at A (a, b), or, what is the same thing, an unbounded fluid containing a stationary vortex-pair at A, B (Fig. 1). With the notation $w=\phi+i\psi$, $z=x+iy$, ϕ = velocity potential, ψ = stream function, the potential function is given, for this case, by

$$w=U\left(z+2ib\log\frac{z-a-ib}{z-a+ib}\right).$$

Inside a certain surface OQP, the stream lines are closed curves and the motion is cyclic; outside, the fluid streams past the surface as if it were a solid obstacle, as is well known (*e.g.* Lanchester, "Aerodynamics," § 80). If the bounding surface meets the plane boundary OP at O, and O is the origin, then $dw/dz=0$ when $z=0$, whence we easily have $a=b\sqrt{3}$ in the above expression.

Now substitute $z=\sqrt{z'}$, and the solution is obtained of a *continuous* motion round the straight edge past O, with a single vortex in the dead water in the wake of the edge (Fig 2).

Making the substitution, we now write

$$w=A\left(\sqrt{z'}+2ib\log\frac{\sqrt{z'}-(\sqrt{3}+i)b}{\sqrt{z'}-(\sqrt{3}-i)b}\right),$$

where A is a constant, and we find that when $z'=0$, $dw/dz'=-A\sqrt{\tfrac{3}{4}}b$.

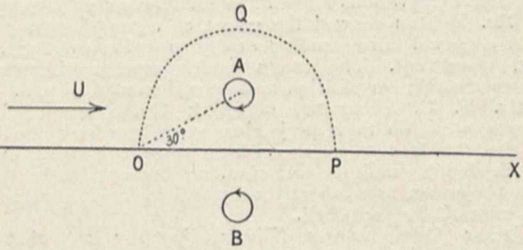


FIG. 1.

The velocity is thus finite where the stream leaves the plate.

With $z'=z^2$ we get a streaming motion round a rectangular corner with a single vortex in the dead water (Fig. 3), and similarly with $z'=z^n$, where $1<n<2$, we get a streaming motion past a projecting corner with re-entrant angle $n.180°$ (Fig. 4). But here comes the difficulty, *if it is a difficulty.*

Except in the above case of $n=2$, the velocity vanishes at the origin, and, further, the stream line bounding the dead water makes equal angles with the two parts of the fixed boundary; thus, for the right angle of Fig. 3, the boundary of the dead water starts from the origin at an angle of 135° with the two walls, and the dead water projects forward into the stream.

But is it not the fact that when a stream flows through the arches of a bridge, the dead water *does* project into the current, the circulating fluid pushing the stream into the

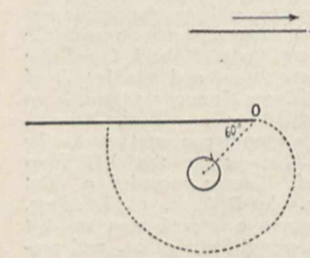


FIG. 2.

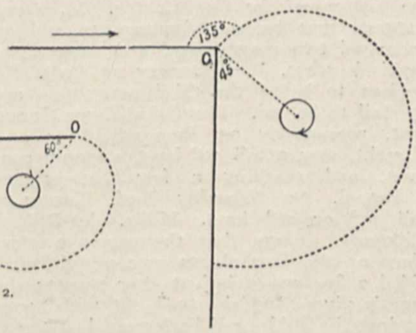


FIG 3.

centre and narrowing it? I believe I have seen something of this very kind.

As regards the velocity being zero, the same would occur in the hydrodynamical problem representing the motion of two streams meeting at an angle, the velocity vanishing at the projecting angle of the boundary.

If, finally, we apply Schwarz and Christoffel's transformation to our original figure, we can obtain various solutions representing continuous motions past projecting obstacles, maintained by a fixed vortex in the dead water behind them. For example, taking

$$\frac{dz'}{dz}=C\frac{z}{(z-c)^{\frac{1}{2}}(z+c)^{\frac{1}{2}}},$$

or (say),

$$z'=\sqrt{(z^2-c^2)},$$

we get the solution for a broad stream with a pier projecting at right angles to the straight bank, or a current impinging perpendicularly on a lamina, with a couple of vortices situated in the dead water behind it. Moreover, if $c<2a$, the whole of the back of the plate will be in the dead water (Fig. 5), while if $c>2a$ the current will flow round and on to the plate, leaving dead water only near the edges (Fig. 6).

The whole point which I wish to emphasise is that hydrodynamical solutions can be obtained of cases of eddy formation in the wake of a projecting obstacle by taking Fig. 1 and the corresponding formula, and transforming by the usual methods of conformal representation, *transforming the point O of Fig. 1 into the projecting or re-entrant angle.* No other point can be so transformed without making the velocity infinite, except P. We should then have the vortices in front of the obstacle, and this would certainly give a solution of the hydrodynamical equations, but it is difficult to see how vortices would get to the right points, and uncertain whether they would be stable there.

I have seen nothing like these solutions, yet it is hard to imagine that anything so simple can have escaped attention in a well-worn subject like hydrodynamics, especially as the

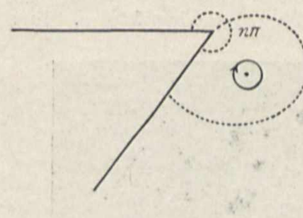


FIG. 4.

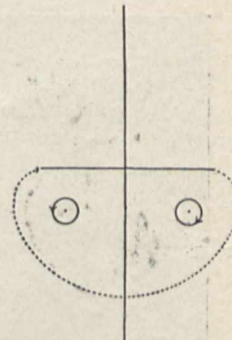


FIG. 5.

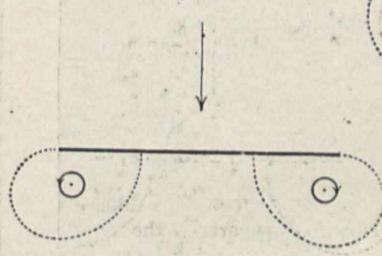


FIG 6.

motions bear a strong resemblance to certain observed phenomena. If it should transpire that these problems have been solved before, it seems desirable that attention should be directed to them in view of the importance which such problems have assumed in connection with aërial and other navigation.

G. H. BRYAN.

THE NEW COMET (1910a).

IN those places where there has been a clear horizon at sunset during the past week, the new comet has provided a striking spectacle for thousands of observers. The observations made at the established observatories will have to be reduced and discussed, and some time will elapse before they are generally available, so at present we have only the meagre details of telegraphic summaries.

From these we learn that excellent photographs have been obtained at Oxford, Cambridge, Dublin, Stonyhurst, and other observatories, including the Harvard, Yerkes, and Lick institutions. Numerous observers have recorded changes in the appearance of the comet, and it will be interesting to see if these are shown on the photographs.

The elements and ephemeris issued from Kiel are evidently considerably in error; according to Prof. Turner, the error was 3° in declination on January 26, and was increasing 40′ daily. On that day the comet's position was determined at 5.35 p.m. by Dr. Rambaut, at the Radcliffe Observatory, as R.A.=21h. 20m. 40s., dec.=2° 17′ S.; according to the ephemeris, it should have been approximately 21h. 26.9m., 0° 52.5′ N. According to Mr. Crommelin, speaking at the British Astronomical Association, the perihelion distance given in the elements, viz. nearly 4,000,000 miles, is probably much too small. Prof. Kobold has calculated the following elements and ephemeris from observations made on January 18, 20, and 23:—

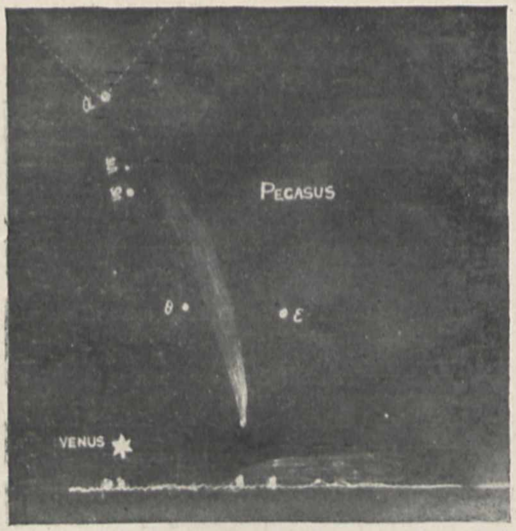
Elements.

T = 1910, January 17·07 G.M.T.
$\omega = 311^\circ\ 53'$
$\Omega = 83^\circ\ 50'$
$i = 138^\circ\ 25'$
Perihelion dist. = 0·109

Ephemeris 5 p.m. *G.M.T.*

1910	R.A. h. m.	Decl. ° ′
February 1	21 38·5	+ 3 20
,, 5	21 47·0	+ 5 50
,, 9	21 53·0	+ 7 48
,, 13	21 59·8	+ 9 25
,, 17	22 5·2	+ 10 52

The spectrum of the comet has been observed a number of times at Cambridge, and found to consist of a bright yellow line in a continuous spectrum, thus far confirming the Lick observation. To the *Times* Sir Robert Ball reported this line as being due to sodium or helium, and stated, on January 26, that it was growing fainter. In a subsequent interview Mr. Hinks is reported to have said that Prof. Newall's observations showed that the spectrum of the comet's tail was purely monochromatic, the one line being due to sodium or helium, probably the latter. It will be remembered that Copeland and Lohse observed bright yellow lines in the spectrum of the great comet of 1882, but they were confirmed by Thollon and Gouy in ascribing them to the sodium, D, lines; further, they found them displaced towards the red sufficiently to give a measure of the comet's velocity of recession which agreed fairly well with the velocity determined geometrically. Should the presence of helium in the spectra of comets which have small perihelion distances be established, it might throw more light on Prof. Newall's suggestion that possibly the cyanogen spectrum so frequently observed is produced in the medium through which the comet is travelling; but the observation of cometary spectra is a delicate one, and not until the details of the observations have been thoroughly discussed by those who made them may any semblance of a definite conclusion be arrived at.



View of the New Comet on January 29 (W. E. Rolston).

Prof. Dreyer reports (the *Times*, January 27) that observations made with the 10-inch refractor at Armagh on January 21 and 24 showed a fan-shaped jet on the side of the comet's head turned towards the sun. The matter issuing from the fan, and turning back on both sides to form the tail, was distinctly broader south-east of the nucleus than west of it.

Observations at the London observatories have been greatly interfered with by the smoke and haze at the horizon and by clouds. On January 25 the comet was "glimpsed" at Greenwich, and its position was determined the following day.

Successful photographs were obtained on January 28 and 30, and show, in addition to the two main streamers, a much fainter tail which makes a considerable angle with the main tail and gives the comet an appearance similar to that of the great southern comet of 1901.

At the Solar Physics Observatory, South Kensington, Dr. Lockyer saw the comet on Friday evening, January 28, just before 6 p.m., but there was not time to determine its position exactly before clouds again interfered.

Visual observations made at South Harrow on January 29 by Mr. Rolston showed the comet as a magnificent object with a curved tail extending nearly to ξ Pegasi, that is to say, about 20°. The rough sketch reproduced herewith shows the relative position and extension at 6.20 p.m.

Mr. F. C. Constable, of Wick Court, near Bristol, directs attention to a projection extending from the base of the double tail on the side nearer to Venus. In a rough sketch, made at 6.20 p.m. on January 30, he shows this projection as a short, bushy tail inclined some 20° to the axis of the main tail.

Father Cortie states (*Times*, January 29) that on January 26 the comet was seen at Stonyhurst from 5.40 to 7 p.m.; the nucleus was as bright as a first-magnitude star, and the tail could be traced to a distance of 10°. Observed with the 15-inch refractor, the region near the head showed a deep, wide, dark segment running down the tail, recalling to mind the drawings of Donati's comet made by Bond and Pape.

Two photographs taken with the 6-inch Dallmeyer portrait lens show a cloud of particles to the east of the main tail, bounded by a ray making an angle of about 30° with the main axis; presumably this is the projection also observed by Mr. Constable.

On the Stonyhurst photographs the tail can be traced to a distance of 4°, and has the appearance of being a hollow cone, the two bright wings of the tail being the sides of the cone in projection. A glimpse at the spectrum with a small McClean direct-vision spectroscope showed that it was continuous, with a decided brightening in the green, presumably due to a hydrocarbon band; the colour of the comet was decidedly yellowish.

A number of observations are recorded in No. 4385 of the *Astronomische Nachrichten*. M. Gonnessiat, Algiers, suggests that between January 19 and 20 the brightness decreased two magnitudes, and other observers record the rapid decrease. On January 23 Prof. Kobold found the nucleus to be of the third magnitude and the length of the tail to be 15°. From the *Times* (January 31) we learn that, presumably on January 28 or 29, Prof. Nijland, Utrecht, saw a tail 30° long, strongly convex towards the west, and reaching a few degrees to the left from α Pegasi. On Saturday Prof. Turner recorded a faint tail 15° or 20° long. Mdlle. de Robeck, of Inistioge, Kilkenny, reports that the comet was well seen at that place on the four nights succeeding January 22, and provided a fine spectacle just after sunset; she likens it to an egret's plume, which stood out with remarkable clearness against the golden-red background of the sunset sky.

A *Times* correspondent, writing from Malvern, directs attention to a remarkable glare which he saw, on January 30, extending from the concave, or southern, side of the tail well up into the square of Pegasus. This lateral extension through an angle of nearly 80° set with the stars.

THE MESSINA EARTHQUAKE AND THE ACCOMPANYING SEA-WAVES.

A SUMMARY of Dr. M. Baratta's preliminary report on the Messina earthquake has been given recently in NATURE (December 16, 1909, p. 203). Since then two other memoirs have appeared, one a preliminary report by Prof. Omori (Bulletin of the Imperial Earthquake Investigation Committee, vol. iii., No. 2, Tokyo), and the other a detailed account by Prof. G. Platania of the accompanying sea-waves (*Boll. della Soc. Sism. Ital.*, vol. xiii.).

Prof. Omori states that the area of violent motion was elliptical in form, and about 30 km. long from north to south and about 20 km. wide. Judging from the form and position of this area, the origin seems to be situated beneath the Straits of Messina, and the directions of maximum motion at several places radiate from a spot within the Straits between Messina and Reggio, and somewhat nearer the latter town. The sea-waves caused the greatest damage along the Calabrian coast from Pellaro to Lazzaro, where many houses were destroyed by them, and the sandy shore-ground to a maximum breadth of 100 metres was swept away. It is remarkable that the sea-waves were greatest at those places where the shock was not most violent. They appear to have radiated from two centres, which may, however, be portions of a continuous zone of disturbance. Prof.

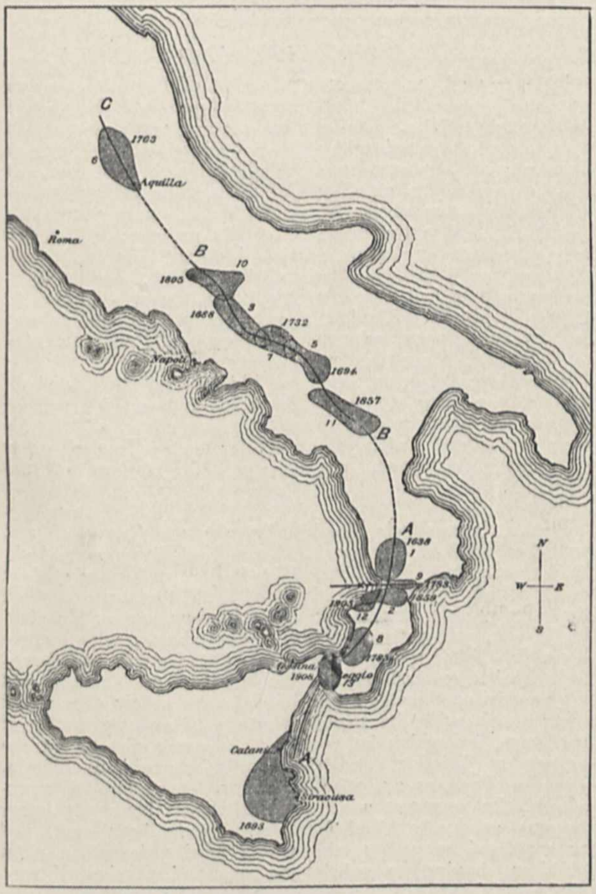


FIG. 1.—Map showing the mutual relations of the great destructive earthquakes in Central and Southern Italy. The shaded area No. 13 is the violent motion district of the Messina-Reggio Earthquake; the other areas, Nos. 1–12, are the similar districts for the previous twelve great earthquakes.

Omori believes that the sea-waves were principally due to the depression of the ground under the portion of sea in question. This latter action, he says, might consist in the vertical settlement through one or two metres of the loose superficial deposits at the bottom of the Straits, such as was known to occur along the shores. The report is illustrated by some interesting maps and diagrams. One of these, here reproduced (Fig. 1), shows the curved band along which lie the areas of violent motion of thirteen great earthquakes in central and southern Italy. These areas being almost distinct, Prof. Omori concludes that great disturbances are not repeated from one and the same centre, that Messina and Reggio are therefore comparatively safe from further harm, while the portions of the seismic band intervening between those mapped are, seismically, the most dangerous in southern Italy.

Prof. Platania's report on the seismic sea-waves is one of unusual interest and value. According to Prof. Omori, the maximum height of the waves (of 10·6 metres) was reached on the Calabrian coast between Pellaro and Lazzaro, but for the opposite coast, at S. Alessio, Prof. Platania gives a height of 11·7 metres, or 37 feet. All along the east coast of Sicily the waves were perceptible, though at the northern point (Torre di Faro) they only attained a height of 0·8 metre, and at the southern point (Capo Passero) of 1·5 metres. Along the north coast they were observed as far as Termini, and along the south coast as far as Porto Empedocle. The limits along the Calabrian coast are still unknown. In the Lipari Islands they passed unnoticed, while they were very conspicuous at Malta. At Catania the mareograph was inundated, and the driving clock was stopped by the shock; but good records were given by the mareographs at Malta, Palermo, Mazzara, Cagliari, Ischia, Naples, Civitavecchia, Livorno, and Ravenna. With the exception of Cagliari, the period of the oscillations was approximately the same at each place as that of the seiches due to meteorological causes—a coincidence already noticed by Omori and Honda in other cases. The wave-velocity obtained from the formula $V=\sqrt{(gh)}$ is always much greater than the observed velocity by from 25 to 57 per cent. Taking variations of depth, however, into account, the discrepancies tend to disappear. Of the four submarine cables beneath the Straits from Torre del Faro to Bagnara, only one was broken, and this was close to the shore, and was probably caused by the drifting of a ship's anchor. Two telephone cables were broken by the earthquake, one at about 3 km. from Gallico, and at a depth of 500 metres, the other at about 12 km. east of Vulcano. Interruptions also occurred in the Malta-Zante cable ten and eighteen hours after the shock, and at distances of eighty and fifty-eight miles from Malta.

C. D.

THE MARINE AQUARIUM, MADRAS.

THE Marine Aquarium at Madras, which has recently been thrown open to the public, deserves notice as it is the first institution of its kind in India, if, indeed, it is not the first in the tropics. It owes its inception to Lord Ampthill, who, while Governor of Madras some four years ago, drew up in conjunction with Mr. Edgar Thurston, superintendent of the Madras Museum, the first rough plan of a public aquarium. The building, a low, unpretentious brick edifice, is situated on the seaward side of the famed Madras Marina, less than a hundred yards from the sea. The main entrance leads into a large paved area with a central fresh-water pond and fountain, and on either side five tanks with plate-glass fronts, lit from above, each measuring $7 \times 3 \times 3\frac{1}{2}$ feet. The entire seaward side of the central area is occupied by a large open tank, at present stocked with turtles (*Chelone midas*). On either side of the entrance passage are two rooms designed for committee meetings, for storage of materials, &c., and one of them is at present occupied by the aëration plant.

With the exception of two tanks for fresh-water fish (at present containing species of Megalops, Ophiocephalus, Notopterus, &c.), which are oxygenated by living Vallisneria, the remaining eight contain salt water, which circulates from tank to tank, and in addition are supplied with air from two compression cylinders, forced into each tank through a filter candle. At present the cylinders are filled by hand-pumps, but the use of an oil engine is contemplated. Sea water is conveyed to a covered well in the rear of the aquarium along a pipe filled by hand at the seaward end. From the well it is pumped into filter beds, and from these passes to large elevated cisterns, whence it is distributed to the tanks. The shore water on the Madras coast is so disturbed by the surf that this filtration is unavoidable, though the removal thereby of small organisms is undoubtedly a drawback. The water which has circulated through the aquarium tanks can, if desired, be brought back to the filter beds and used a second time.

The director of the aquarium is the superintendent of the Madras Museum, and he is assisted by a local committee. A small admission fee is charged, and already there are signs of the place becoming very popular, more than 1100 visitors having been admitted on a single day. The magnificent colours of many of the fish, in particular, form a most attractive display. The exhibits include sea-snakes (Enhydrina and species of Distira), and among the fish species of the following:—Ginglymostoma, Stegostoma, Chiloscyllium, Muræna, Arius, Therapon, Serranus, Lutjanus, Myripristis, Trachynotus, Pterois, Caranx, Antennarius, Heniochus, Julis, Teuthis, Balistes, Tetrodon. The invertebrates comprise cuttle-fish, holothurians, hermit-crabs (Clibanarius, &c.), swimming-crabs (Scylla and Neptunus), lobsters (Panulirus), prawns (Penæus), &c. All the specimens have been taken on the Madras coast within a few miles of the aquarium.

INDIAN MUSEUM PUBLICATIONS.

ACCORDING to the report for 1908–9, the organisation of the Indian Museum has been in need of reform, and the views of the trustees in this respect are shared by the Government of India. The trustees have accordingly "accepted the Government of India's proposals as regards fresh legislation whereby a re-organisation of the museum may be effected. The two main principles that they have had before them in the suggestions they have made to the Government as regards this new legislation have been (1) that each section of the museum should be under proper expert management, and (2) that the heads of the different sections should be *ex officio* trustees themselves. They believe that the new Act which it is proposed to introduce shortly, and of which they have received a draft, will enable them to give effect to these principles.

"The trustees have also to express their gratitude to the Government of India for the support given them in their proposals regarding an increase in the scientific staff and in the pay of the superintendent of the natural history section. They are of the opinion that the alterations sanctioned in these respects will not only enable them to retain the services of their officers in a way that has not proved possible in the past, but will also increase the utility of the museum in many directions. . . . They note with satisfaction the increase, not only in the collections, but also in the scope of the scientific work accomplished by these means; but they are convinced that only a permanent re-organisation of the staff such as has now been rendered possible will enable the museum to maintain and expand its work as a centre of zoological work both purely scientific and directly practical."

No. 3 of the second volume of "Memoirs of the Indian Museum" is devoted to a description, by Dr. R. E. Lloyd, of the deep-sea fish caught by the R.I.M.S. ship *Investigator* during the present century. Colonel Alcock's catalogue of the deep-sea fish taken by the same vessel during last century was published ten years ago, and the present memoir includes notices of such forms as have been named since that date, together with the descriptions of five new genera and species. Four of the new genera appear to be nearly allied to previously known types, but the small, tadpole-like *Liparoides beauchampi* differs from other deep-sea Cyclopteridæ (misprinted Clycopteridæ in the memoir) by the possession of a diphycercal tail and small pelvic fins not fused into a sucker. The memoir concludes with a notice of supposed evidence of mutation in a small pediculate fish of the genus Malthopsis from the Andamans. These fishes were taken from four separate but not very distant stations in the Andamanese Sea, where they appear to form distinct communities; they include five types differing from one another in the relative breadth of the disc and the form and arrangement of the dermal ossicles. These differences can scarcely, however, be regarded as of specific value, while as two or more types occur at each station they obviously do not indicate local races.

The trustees have sanctioned the publication of an annotated list of the Asiatic beetles in the collection of the Indian Museum, under the editorship of the superintendent of the natural history section, of which the first part, dealing with the tiger-beetles (Cicindelinæ), has been issued. The text is in somewhat small type, and it is unfortunate that the specific names are printed in italics similar to those used for the publication-references. Moreover, the references are not free from misprints, as witness *Deutshe* on p. 9, while to others than specialists such references as *Jahrb.* (p. 10) and "*Ent.*" (p. 12) are meaningless.

The third part of vol. iii. of "Records of the Indian Museum" contains a large number of papers dealing mainly with invertebrates, and especially insects. Dr. Annandale has, however, a note on lizards from Travancore, in which reference is made to colour-changes in *Charasia blanfordiana*, a relative of the well-known *Calotes versicolor*. The lizards of this genus appear to take the place in India occupied in the Himalaya, and Asia and Europe generally, by Agama. The colour-changes do not seem always for the purpose of concealment, as the author has seen a specimen temporarily pale in colour basking on a red mud-wall, and a second in full sunshine on a black rock. Other specimens, on the contrary, in similar situations, were more in harmony with their surroundings in the matter of colouring.

MENDELEEFF'S LIFE AND WORK.[1]

TO many of the present generation of English chemists the commanding, patriarchal figure of Mendeléeff was quite familiar. Though his several visits to London were often connected with official business of the Russian Government Department of Weights and Measures, of which he was the chief official during the later years of his life, he came several times with more purely scientific objects. In 1889 the occasion of his presence in London was the Faraday lecture, which he had been invited to give to the Chemical Society, but which, owing to a sudden and urgent recall to his home, he was unable to deliver in person. His last appearance in this country was in November, 1905, when the Copley medal was awarded to him by the Royal Society.

The Chemical Society can see his face no more, and all that it can now do is to inscribe high on its roll of honour the name which, more than any other, will be for ever associated with the development of the great generalisation known as the periodic system of the elements.

Dmitri Ivanovitsch Mendeléeff[2] was the fourteenth and youngest child of his parents, Ivan Pavlovitsch and Maria Dmitrievna, *née* Kornileff. His father, a former student of the Chief Pedagogic Institute of St. Petersburg, obtained the appointment of director of the gymnasium at Tobolsk, in Siberia, where he met Maria Dmitrievna, who became his wife. After a few years at Tobolsk he was transferred to school directorships in Russia, first at Tambov and afterwards at Saratov; but in order to satisfy the ardent wish of his wife, he took advantage of an opportunity of exchange, by which he became once more director of the college at Tobolsk, and the family returned to Siberia. Here on January 27, 1834 (O.S.) was born Dmitri Ivanovitsch, the youngest son. Soon after his birth the father became gradually blind from cataract in both eyes, and was obliged to resign, the whole family, including eight children, having to subsist on a small pension of 1000 roubles (about 100*l.* per annum). The mother, Maria Dmitrievna, belonged to the old Russian family Kornileff, settled at Tobolsk. They were the first to establish in Siberia the manufacture of paper and glass. In 1787 the grandfather of Dmitri opened at Tobolsk the first printing press, and from 1789 produced the first newspaper in Siberia, the *Irtysch*. The glass works were situated in the village of Aremziansk, a short distance from Tobolsk.

There can be no doubt the mother was a woman possessed of remarkable vigour of mind, who exercised great influence over her children. Her activity and capacity are further illustrated by the fact that when her husband became blind she revived the business of the glass works, and carried it on until after his death from consumption in 1847.

[1] The Mendeléeff Memorial Lecture delivered before the Chemical Society on October 21, 1909, by Sir William A. Tilden, F.R.S. Abridged from the Journal of the Society for December, 1909.

[2] For many of the details of Mendeléeff's career and of his home life the writer is indebted to the family chronicle compiled, soon after his death, by his niece, N. J. Gubkina (*née* Kapustina), and published in St. Petersburg, also to pamphlets by A. Archangelsky and P. J. Robinowitsch. He also desires to express his thanks to Mr. D. V. Jéquier, of St. Petersburg, as well as to several Russian friends, for valuable assistance in translation.

Tobolsk was at that time a place of banishment for many political exiles, the so-called Decembrists, one of whom, Bassargin, married Olga, an elder sister of Dmitri. To these Decembrists the boy owed his first interest in natural science. His mother had always cherished the hope that at least one of her children would devote himself to science, and accordingly, after her husband's death and the destruction of the glass works by fire, and spite of failing health and scanty means, she undertook the long and tedious journey from Tobolsk to Moscow, accompanied by her remaining children, Elizabeth and Dmitri Ivanovitsch, with the object of entering the latter, then nearly fifteen years of age, at the university. Disappointed in this object, owing to official difficulties, she removed in the spring of 1850 to St. Petersburg, where ultimately, with the assistance of the director, Pletnoff, of the Central Pedagogic Institute, a friend of her late husband, she succeeded in securing for her son admission to the physico-mathematical faculty of the institute, together with much-needed pecuniary assistance from the Government.

The debt which Dmitri Ivanovitsch owed to his mother he acknowledged later in the introduction to his work on "Solutions," which he dedicated to her memory.

In the Pedagogic Institute Dmitri Ivanovitsch was thus able to devote himself to the mathematical and physical sciences under the guidance of Profs. Leng and Kupfer in physics, Woskresensky in chemistry, and Ostragradsky in mathematics. Unfortunately, at the end of his course his health failed, and about this time his mother died. Having been ordered to the south, he fortunately obtained an appointment as chief science master at Simferopol, in the Crimea. The southern climate soon alleviated the serious symptoms of lung disorder, and removal being necessary in consequence of the Crimean War, he was able soon afterwards to undertake a post as teacher of mathematics and physics at the gymnasium at Odessa. In 1856 he returned to St. Petersburg, and at the early age of twenty-two was appointed privat-docent in the University, having secured his certificate as master in chemistry.

At this time he appears to have passed rapidly from one subject to another, but he soon found matter for serious and protracted study in the physical properties of liquids, especially in their expansion by heat; and when, in 1859, by permission of the Minister of Public Instruction, Mendeléeff proceeded to study under Regnault in Paris and afterwards in Heidelberg, he devoted himself to this work, communicating his results to Liebig's *Annalen* and the French Academy of Sciences. Returning two years later to St. Petersburg, he secured his doctorate, and was soon afterwards appointed professor of chemistry in the Technological Institute. In 1866 he became professor of general chemistry in the University, Butlerow at the same time occupying the chair of organic chemistry.

As a teacher, Mendeléeff seems to have possessed a special talent for rousing a desire for knowledge, and his lecture-room was often filled with students from all faculties of the University. Many of his former students remember gratefully the influence he exercised over them.

One of Mendeléeff's most remarkable personal features was his flowing abundance of hair. The story goes that, before he was presented to the late Emperor, Alexander III., his Majesty was curious to know whether the professor would have his hair cut. This, however, was not done, and he appeared at Court without passing under the hands of the barber. His habit was to cut his hair once a year, in spring, before the warm weather set in. His eyes, though rather deep-set, were bright blue, and to the end of his life retained their penetrating glance. Tall in stature, though with slightly stooping shoulders, his hands noticeable for their fine form and expressive gestures, the whole figure proclaimed the grand Russian of the province of Tver.

At home, Mendeléeff always wore an easy garment of his own design, something like a Norfolk jacket without a belt, of dark grey cloth. He rarely wore uniform or evening coat, and attached no importance to ribbons and decorations, of which he had many.

As to his views on social and political questions, many people thought him a rigid monarchist, but he said of himself that he was an evolutionist of peaceable type, desiring a new religion, of which the characteristic should be subordination of the individual to the general good. He always viewed with much sympathy what is called the feminine question. At the Office of Weights and Measures he employed several ladies, and about 1870 he gave lectures on chemistry to classes of ladies.

Mendeléeff held decided views on the subject of education, which he set forth in several publications, especially "Remarks on Public Instruction in Russia" (1901). Here he says:—"The fundamental direction of Russian education should be living and real, not based on dead languages, grammatical rules, and dialectical discussions, which, without experimental control, bring self-deceit, illusion, presumption, and selfishness." Believing in the soothing effect of a vital realism in schools, he considered that universal peace and the brotherhood of nations could only be brought about by the operation of this principle. Speaking of the reforms desirable, he says that "for such reforms are required many strong realists; classicists are only fit to be landowners, capitalists, civil servants, men of letters critics, describing and discussing, but helping only indirectly the cause of popular needs. We could live at the present day without a Plato, but a double number of Newtons is required to discover the secrets of nature, and to bring life into harmony with the laws of nature." Mendeléeff was evidently a philosopher of the same type as our own Francis Bacon.

In 1863, when twenty-nine years of age, Mendeléeff married his first wife, *née* Lestshoff, by whom he had one son, Vladimir,[1] and a daughter, Olga; but the marriage proved unhappy, and after living apart for some time there was a divorce. In 1881 he married a young lady artist, Anna Ivanovna Popova, of Cossack origin, and lived first at the University and afterwards in the apartments built for the director at the Bureau of Weights and Measures. Here his younger children were born, Lioubov (Aimée), Ivan (Jean), and the twins, Maria and Vassili (Basile).

In 1890, in consequence of a difference with the administration, Mendeléeff retired from the professorship in the University. During the disturbances among the students in that year, he succeeded in pacifying them by promising to present their petition to the Minister of Education. Instead of thanks for this service, however, the professor received a sharp reprimand from the authorities for not minding his own business. The consequence was that Mendeléeff resigned. Independently of the petition, however, there were probably deeper reasons for his being out of favour with the Ministry, connected with his irreconcilable enmity to the classical system of education already referred to. Of this he had made no secret, and it had already brought him into conflict with the authorities. In 1893, however, he was appointed by M. Witte to the office of director of the Bureau of Weights and Measures, which he retained until his death.

Such are the chief features of a great personality. If it be admitted that stories are told of his occasional irritability of temper, we can well place on the other side of the account the cordial relations always subsisting between the professor and his assistants, the confidence and respect between the master and his servants, the deep affection between the father and his children, which are known to have persisted throughout his life, and which could be illustrated by many anecdotes. These stories merely serve "to give the world assurance of a man."

For us who live on the other side of Europe, separated as we are by race, by language, by national and social customs, and by form of government, it is not easy to understand completely the texture of such a mind, the quality of such genius, and the conditions, social or political, which may have served to encourage or to repress its activity. The Russian language may be eloquent, expressive, versatile, and harmonious, or it may possess any other good quality that may be claimed for it by those to whom it is a mother tongue, but the fact remains that it is a barrier to free intercourse between the Russian people and the world outside the Russian Empire. This alone creates a condition which must influence the development of thought, and must give to Russian science and philosophy a colour of its own. Mendeléeff was, like many educated Russians, a man of very liberal views on such

[1] Died in 1899, aged thirty-four.

subjects as education, the position of women, on art and science, and probably on national government. We can hardly guess what would be the influence on such a nature of a rigid administrative *régime* which forbids even the discussion of such questions. We in England are almost unable to imagine such a state of things as would be represented by the closing of, say, University College for a year or more, because the question whether the House of Lords ought to be abolished had been debated in the Students' Union. Imagine the professor of chemistry, along with his colleagues, for such a reason deprived of the use of his laboratory by the police, and only allowed to resume his studies when someone down at Scotland Yard thought proper. Such being the experience of most of the Russian universities and technical high schools, it is not surprising that the output of Russian science, notwithstanding the acknowledged genius of the Russian people, appears sometimes comparatively small. The amount of work done by Mendeléeff, both experimental and theoretical, was prodigious, and all the more remarkable considering the cloudy atmosphere under which so much of it was accomplished.[1]

In 1882 the Royal Society conferred on Mendeléeff, jointly with Lothar Meyer, the Davy medal. In 1883 the Chemical Society elected him an honorary member, and in 1889 it conferred upon him the highest distinction in its power to award, namely, the Faraday lectureship, with which is associated the Faraday medal. In 1890 he was elected a Foreign Member of the Royal Society, and in 1905 he received the Copley medal. So far as England is concerned, his services to science received full acknowledgment. It is all the more remarkable, therefore, that he never became a member of the Imperial Academy of Sciences of St. Petersburg.

Towards the end of 1906 Mendeléeff's health began to fail. Nevertheless he was able to attend the Minister on the occasion of an official visit in January to the office of Weights and Measures, but he caught cold and, enfeebled as he had been by influenza in the preceding autumn, inflammation of the lungs set in. Retaining consciousness almost to the last, he requested even on the day of his death to be read to from the "Journey to the North Pole," by his favourite author, Jules Verne. He died in the early morning of January 20 (O.S.), 1907, within a few days of his seventy-third birthday. He was buried in the Wolkowo Cemetery beside the graves of his mother and son.

Turning now to a survey of Mendeléeff's work as a man of science, it will be sufficient if we pass lightly over his first essays. Like so many other chemists, he began by handling simple questions of fact, his first paper, dated 1854, when he was twenty years of age, being on the composition of certain specimens of orthite. It was not until 1859 that he settled down to serious examination of the physical properties of liquids, which led him to a long series of experiments on the thermal dilatation of liquids, of which the chief ultimate outcome was the establishment of a simple expression for the expansion of liquids between 0° and the boiling point. This formula is liable to the same kind of modification which has been found necessary in the case of gases. It is, of course, applicable only to an ideal liquid from which all known liquids differ by reason of differences of chemical constitution and consequent differences of density, viscosity, and other properties.

Mendeléeff devoted a large amount of time and of experimental skill to the estimation of the densities of various solutions, especially mixtures of alcohol and water and of sulphuric acid and water, and of aqueous solutions of a large number of salts. In 1889 he embodied the whole in the monograph already referred to. In a paper communicated to the Transactions in 1887 (li., 779), he stated his views in the following words:—"Solutions may be regarded as strictly definite atomic chemical combinations at temperatures higher than their dissociation temperatures. Definite chemical substances may be either formed or decomposed at temperatures which are higher than those at which dissociation commences; the same phenomenon occurs in solutions; at ordinary temperatures they can be either formed or decomposed." These views, however, did not prevent his recognising van 't Hoff's gas theory as applicable to dilute solutions.

In conjunction with some of his students, Mendeléeff also studied minutely the question of the elasticity of gases, and published several papers on the subject (see Royal Society Catalogue), extending over a period of some ten years from 1872.

Another subject to which Mendeléeff gave a good deal of attention was the nature and origin of petroleum. Having already reported in 1866 on the naphtha springs in the Caucasus, in the summer of 1876 he crossed the Atlantic and surveyed the oil fields of Pennsylvania. In the course of these investigations, he was led to form a new theory of the mode of production of these natural deposits. The assumption that the oil is a product of the decomposition of organic remains he rejects on a variety of grounds, which are set forth in a communication to the Russian Chemical Society (Abstract, see *Ber.*, 1877, x., 229). Mendeléeff assumes, as others have done, that the interior of the earth consists largely of carbides of metals, especially iron, and that hydrocarbons result from the penetration of water into contact with these compounds, metallic oxide being formed simultaneously. The hydrocarbons are supposed to be driven in vapour from the lower strata, where temperature is high, to more superficial strata, where they condense and are retained under pressure. In 1886, in consequence of rumours as to the possible exhaustion of the Russian oil fields, he was sent by the Government to Baku to collect information, and in 1889 he made a communication on this subject to Dr. Ludwig Mond, which is printed in the Journal of the Society of Chemical Industry (1889, viii., 753).

The influence of the great generalisation known as the periodic law can best be estimated by reviewing the state of knowledge and opinion before the announcement and acceptance of the principle by the chemical world, and subsequently glancing at the influence which, directly or indirectly, it has produced on scientific thought, not only in regard to the great problems to which it immediately relates, but to the whole range of chemical theory.

The use of the expression "atomic weight" implies the adoption of some form of atomic theory; but forty or more years ago Dalton's atomic theory was by many of the most philosophical chemists and physicists regarded as only a convenient hypothesis, which might be temporarily useful, but could not be accepted as representing physical reality. Since that time, however, a variety of circumstances have contributed to consolidate the Daltonian doctrine. The estimation of the ratios called atomic weights has been the subject of research, attended by more and more elaborate precautions to secure accuracy, from the time of Dalton himself onward through successive generations down to the present day. Though the atomic weights of the majority of the common elements are now known to a high degree of accuracy, the acknowledged errors have been sufficiently great to render abortive various attempts to reduce them to any common scheme of mathematical relationship. As is well known, the most important step toward the systematisation of atomic weights was taken about 1860, mainly on the grounds eloquently and convincingly set forth by Cannizzaro,[1] in consequence of which the arbitrary selection of numbers for atomic weights was superseded by the practical recognition of the law of Avogadro and the application of the law of Dulong and Petit, so that a common standard was established. No general scheme of atomic weights was previously possible, partial and imperfect efforts in this direction being represented by Dœbereiner's triads and the principle of homology made use of by Dumas. Only so soon as numbers representing the atomic weights of calcium, barium, lead, and other metals were corrected and brought into the same category as those of oxygen, sulphur, and carbon was there some chance of determining whether these numbers possessed a common factor or were capable of exhibiting mathematical inter-relations which might be regarded as symbolic of physical relations or even directly

[1] Prof. Walden, at the end of a biographical notice recently published in the *Berichte d. Deut. Chem. Ges.*, April, 1909, gives a list of 262 printed publications by Mendeléeff. These include, not only memoirs on physical and chemical subjects, but books, pamphlets, reports, and newspaper articles relating to exhibitions, to the industries of Russia, to weights and measures, to education, to art, and even to spiritualism.

[1] 1858, and later, Faraday Lecture, 1872.

dependent upon them. The first step in this direction was taken by J. A. R. Newlands, who, after some preliminary attempts in 1864–5, discovered that when the elements are placed in the order of the numerical value of their atomic weights, corrected as advised by Cannizzaro, the eighth element starting from any point on the list exhibits a revival of the characteristics of the first. This undoubtedly represents the first recognition of the principle of periodicity in the series of atomic weights, but whether discouraged by the cool reception of his "law of octaves" by the chemical world or from imperfect apprehension of the importance of this discovery, Newlands failed to follow up the inquiry. It was not long, however, before the matter was taken up by others, and doubtless the improvements in the estimation of atomic weights, following on the work of Stas, then only recently published, inspired greater confidence in the approximate accuracy of the numbers adopted as atomic weights, and thus encouraged inquiry into their relations. The subject is, indeed, an attractive one, for it involves considerations which lie at the foundations of all our notions respecting the physical constitution of matter, and accordingly we find papers by many chemists dealing with the question of these numerical relations. Odling especially seems to have given much thought to the subject, and, ignoring Newlands's previous attempts, he drew up towards the end of 1864 [1] a table containing a list of all the then well-known elements, arranged horizontally in the order of their generally accepted groups, and perpendicularly in the order of their several atomic weights. He concludes an article in Watts's Dictionary a few months later with these words:—"Doubtless some of the arithmetical relations exemplified in the foregoing table are merely accidental, but, taken altogether, they are too numerous and decided not to depend on some *hitherto unrecognised* law." It is important to note the words I have italicised.

Such, then, was the state of knowledge about this time. Evidently the way was being prepared, but the prophet had not made his appearance—the seer who could look with the eyes of confidence beyond the clouds of uncertainty which obscured all ordinary vision.

In March, 1869, Mendeléeff communicated to the Russian Chemical Society an enunciation of the principle of periodicity and a statement of some of the consequences of this recognition of the relation of properties to atomic weight throughout the whole range of the known elements, and this statement was accompanied by a table which, while it bears a close resemblance to Odling's table of 1864, was apparently connected in his mind with an idea which became clearer and more decisive in the modifications which he immediately afterwards introduced into the arrangement.

Mendeléeff's First Table of the Elements.

			Ti = 50	Zr = 90	? = 180
			V = 51	Nb = 94	Ta = 182
			Cr = 52	Mo = 96	W = 186
			Mn = 55	Rh = 104·4	Pt = 197·4
			Fe = 56	Ru = 104·4	Ir = 193
			Ni = Co = 59	Pd = 106·6	Os = 199
H = 1			Cu = 63·4	Ag = 108	Hg = 200
	Be = 9·4	Mg = 24	Zn = 65·2	Cd = 112	
	B = 11	Al = 27·4	? = 68	U = 116	Au = 197?
	C = 12	Si = 28	? = 70	Sn = 118	
	N = 14	P = 31	As = 75	Sb = 122	Bi = 210?
	O = 16	S = 32	Se = 79·4	Te = 128?	
	F = 19	Cl = 35·5	Br = 80	I = 127	
Li = 7	Na = 23	K = 39	Rb = 85·4	Cs = 133	Tl = 204
		Ca = 40	Sr = 87·6	Ba = 137	Pb = 207
		? = 45	Ce = 92		
		?Er = 56	La = 94		
		?Yt = 60	Di = 95		
		?In = 75·6	Th = 118		

From this arrangement, in which the elements are placed in vertical columns, according to increasing atomic weight, so that the horizontal lines contain analogous elements, again according to increasing atomic weight, Mendeléeff deduced the fundamental principle which he expressed as follows:—The elements arranged according to the magnitude of atomic weight show a periodic [2] change of properties.

[1] Quart. J. Sci., 1864, i, 643; and Watts's Dictionary, vol. iii., 975.

[2] Here an error in the German translation does an injustice to the original, inasmuch as the Russian word for periodic is rendered "stufenweise" (gradual).

Previous students of the subject had been, for the most part, struck with the relations obviously subsisting between the members of the several natural families of elements, but had, with few exceptions, failed to perceive that there must be a *general* law binding the whole together. However, Mendeléeff, with that noble sentiment of justice which always animates the truly scientific mind, admits that the idea of a general law had already been foreshadowed by others (Faraday lecture, 1889).

Mendeléeff's table of 1869 was subsequently in 1871 modified so as to assume the form with which we have all been so long familiar, and which is to be found in every modern text-book. Thus it may be claimed for Mendeléeff that he was actually the first, not only to formulate a general law connecting atomic weights with properties, but was the first to indicate its character, and, as himself ("Principles," 1905, ii., p. 28) has pointed out, he was the first "to foretell the *properties of undiscovered* elements, or to alter the accepted atomic weights" in confidence of its validity. The time was, in fact, ripe for the enunciation of this general principle, and, the suggestion once given, the relations embodied in the law could not fail to attract other chemists. Accordingly, in December, 1869, Lothar Meyer, with such knowledge of Mendeléeff's scheme as could be derived from the imperfect German version of his paper of the previous March, proved himself a convinced exponent of the idea by contributing to Liebig's *Annalen* a paper containing a table, substantially identical with that of Mendeléeff, and his famous diagram of atomic volumes, which, more clearly even than the tabular scheme, illustrates the principle of periodicity.

The history of science shows many instances of the same kind. Great generalisations have often resulted from the gradual accumulation of facts which, after remaining for a time isolated or confused, have been found to admit of coordination into a comprehensive scheme, and, this once clearly formulated, many workers are found ready to assist in its development. The case is nearly parallel to the recognition of the operation of natural selection by Darwin and Wallace, or it might be compared to the discovery of oxygen by Priestley and Scheele and the utilisation of this knowledge by Lavoisier. In each case much preparatory work had been done, and a body of knowledge had been gradually accumulated which, when duly marshalled and surveyed by the eye of a master, could scarcely fail to reveal to him the underlying principle. The full consequences, however, would appear only to a few.

I regard it as unnecessary, in the presence of the fellows of the Chemical Society, to review with any detail the multitudinous applications of the scheme of the elements constructed on the basis of the periodic law. These are the commonplaces of modern theoretical chemistry. They are embodied in every text-book of any importance, and are related by every lecturer and teacher as familiar and indisputably recognised consequences of the system. We may therefore pass lightly over the story of the prediction by Mendeléeff of the properties of undiscovered elements, confirmed so remarkably by the discovery of scandium, gallium, and germanium, and related in dramatic language by Mendeléeff himself (Faraday lecture). We may also pass over the applications of the system to the correction of atomic weights, illustrated by the case of beryllium, the recognition of previously unnoticed relations, and the discovery of new elements, notably the companions of argon (Ramsay, Presidential Address to Section B, British Association, 1897, and Proc. Roy. Soc., 1898, lxiii., 437).

It will be more profitable to consider a few of the difficulties which still encumber the application of the law, and which, while limiting our acceptance of it in an unqualified form as applicable to the whole of the elements, tempt the speculative mind to wander in wide fields of conjecture.

Can it be truly said that the elements arranged in the order of their atomic weights show without exception periodic changes of properties? This question has been propounded already, but has never been fully discussed, even by Mendeléeff. An examination of the facts seems, however, to indicate the possibility of some other principle, which, while it does not supersede the periodic scheme, would, if it could be recognised, supplement it.

From a consideration of the almost unbroken sequence in the atomic weights of the known elements, it seems probable that few additional elements are to be expected, except possibly one following Mo and another following W, save in the region from Bi to Ra. This suggests the remark that, after all, it is not necessary to assume that the materials of which the earth consists should necessarily include a sample of every possible element indicated by such a scheme. Some which are missing from terrestrial matters may perhaps be responsible for phenomena recognisable by the spectroscope in stars or nebulæ far distant in cosmical space. The unexpected, however, often happens, and, remembering the discovery of terrestrial helium, it is permissible to hope that some of the vacant spaces may hereafter be filled by earthly occupants.

There is one important point to be noted here, namely, that if the so-called rare earth metals, praseodymium, neodymium, samarium, gadolinium, terbium, dysprosium, erbium, ytterbium, and others of which the existence is doubtful, do lie in the position indicated, the original statement of the periodic law breaks down at this point.

One result of the recognition of the periodic law is that theories concerning the genesis of the elements have received a stimulus previously unknown. It is, however, interesting to note the attitude of Mendeléeff toward this question, and the small extent to which this attitude appears to have become modified with the lapse of time. When, in 1889, twenty years after the discovery of the law, he composed the Faraday lecture, he seems to have regarded speculation in this direction as a kind of abuse of the periodic system.

Fifteen years later, after the discovery of the argon group of elements, of the phenomena of radio-activity, and of radium, it became necessary to consider the relations of these substances to the periodic scheme. In a remarkable article contributed to the new Russian Encyclopædia, and subsequently printed as Appendix iii. to the "Principles" (English edition, 1905), Mendeléeff gives a new table of the elements, in which places are found, not only for the argon group and radium, but for two hypothetical elements, which are placed before helium and designated x and y.

The y in the table is supposed to be an analogue of helium, and may be identified hereafter with "coronium," which has been recognised in the sun's coronal atmosphere. This gas would have, according to Mendeléeff, a density about 0·2, and therefore a molecular weight about 0·4, or about one-tenth that of helium.

x is the "ether" of the physicist, for which Mendeléeff, disregarding conventional views, supposes a molecular structure. He also assumes that, like the argon group, this element is chemically inert and possesses a very low density and atomic weight, estimated at 0·000,000,000,053.

Chemists and physicists have, however, found it impossible to resist the fascination of this problem, and accordingly there have been many hypotheses as to the origin of the elements and the nature of their connection with one another. These seem to be inseparable from the periodic scheme itself, which at once provokes the inquiry, Why do these numerical relations occur, and what is the meaning of them if they do not point to a common genesis or the operation of some process of evolution?

Hypotheses concerning the evolution of the elements have hitherto been usually based on the assumption that the successive stages of condensation of elemental matter proceeded from a single primary stuff, which by a process analogous to polymerisation among carbon compounds gave rise to atoms of greater and greater mass, which were stable at the prevailing and any lower temperature. The physical cause of the successive condensations is supposed to be a falling temperature. It is, of course, possible to imagine that if to the stuff of which hydrogen atoms consist are added successive portions of matter of the same kind, stable structures may at intervals result which we know as the atoms of the elements helium, lithium, beryllium, boron, carbon, nitrogen, oxygen, and fluorine, provided the idea of internal structure in these atoms is allowed. Otherwise, from the mere accretion of matter upon a central nucleus, there seems no sufficient reason why there should not have been formed an indefinite number of intermediate masses corresponding to an indefinite number of what would be called elements. Further, it is difficult to understand why simple increase of mass should change, say, oxygen into fluorine, while a further addition of the same kind should change negative fluorine into inert neon or positive sodium. The possibility of the condensation of a single "protyl" so as to produce, at successive though unequal stages of cooling, the elements known to the chemist, has been most ably discussed long ago by Sir William Crookes.

This hypothesis, however, was put forward long before the work of Sir J. J. Thomson and his school was given to the world and the electron was accepted as a physical reality. The hypothesis that one elemental stuff may give rise to the whole array of known elements by a process of condensation accompanied by a loss or gain of electrons, the mass of which is approximately one-thousandth of the mass of an atom of hydrogen, forms the subject of a paper by Mr. A. C. G. Egerton in a recent number of our Transactions (1909, xcv., 239). The atomic weights calculated by his formula agree closely with the experimental atomic weights of the first fifteen elements, but the hypothesis gives no explanation of the facts observed in the physical properties of the elements arranged according to the Mendeléeff scheme, their alternation of odd and even valency, the transition from positive on one side of the table to negative on the other, the periodicity of properties shown by the sudden change of character in passing from fluorine to the next element, whether it be neon or sodium.

Another paper by Messrs. A. C. and A. E. Jessup (*Phil. Mag.*, 1908 [vi.], xv., 21) has recently provided a hypothesis of an entirely different character. From a study of the spectra of the nebulæ, these authors have been led to assume the existence of two hitherto unrecognised elements, to which the names protoglucinum and protoboron are assigned. These with hydrogen and helium are supposed to represent *four* initial substances, or protons, which, by condensation directly or indirectly, give rise to all the rest of the elements. The arguments of these authors are ingenious, but rather artificial in view of the fact that the number of groups in the periodic scheme to be provided for is greater than four.

In the Mendeléeff chart of the elements there is nothing more striking than the gathering of the negative elements toward what may be called the N.E., and the segregation of the positive elements toward the S.W., the centre of the intermediate territory being occupied by elements which play a more or less undecided part. I have elsewhere (Presidential Address, 1905, Trans., lxxxvii., 564) directed attention to the fact that carbon, at any rate, is not directly deposited by electrolysis from any of its compounds, with positive hydrogen on the one hand, or negative chlorine on the other. I believe the same is true of silicon, these two elements standing in a middle position between the extremes occupied by lithium and fluorine respectively.

If we assume that atoms are made up of two parts (protyls), positive and negative, in proportions which determine by the preponderance of one or the other whether the element shall exhibit the positive character of a metal like lithium or the negative character of a halogen, we arrive at a hypothesis which recalls the ideas put forward nearly a century ago by Berzelius. His views are familiar to every student of the history of chemistry, but have long been relegated to the lumber-room of worn-out doctrine. The last few years have, however, given us the remarkable experimental investigations of J. J. Thomson already referred to, and the new conceptions concerning the nature of atoms, which revive the fundamental idea that they are made up of two components.[1]

[1] Carnelley, in 1885 (Brit. Assoc. Reports), brought forward the idea "that the elements are not elements in the strict sense of the term, but are, in fact, compound radicals made up of at least two simple elements, A and B." The element A was supposed to be identical with carbon, while to B was assigned a negative weight, −2, and it was suggested that it might be the ether of space. C. S. Palmer (Proc. Colorado Scient. Soc.) assumed the existence of two sub-elements, to which he gave the names "kalidium" and "oxidium," and his views appear to have a general resemblance to the hypothesis suggested in the text. The original article is abstracted in Venables's "Periodic Law," and is referred to in footnotes in Palmer's translation of Nernst's "Theoretical Chemistry."

Setting out the known elements in the order of the numerical value of their atomic weights, we find that between the first three elements, H=1, He=4, and Li=7, the difference, 3, is greater than would be expected by comparison with the differences noticed between the elements of greater atomic weight which immediately follow them. In order to satisfy the hypothesis just put forward, there appears to be wanting an element which should stand in the same relation to fluorine as hydrogen to lithium. This would have an atomic weight 2·7 approximately. Whether this exists, and whether its existence is indicated by the unappropriated spectral lines of nebulæ or corona, can only be a matter of conjecture. Mendeléeff, in his (1905) latest speculations concerning the possibility of still undiscovered elements, has suggested the existence of a new element of the halogen group with an atomic weight about 3;[1] but, as already sufficiently shown, he accepted no hypothesis which involved any idea of the composite nature of the elements. It would therefore have been foreign to his system to employ this element in any such manner.

The conceptions presented to us in J. J. Thomson's work permit of several supplementary hypotheses, especially the idea that if atoms are really made up of smaller corpuscles these are not thrown together in confusion, but, as he has shown, must be distributed within the mass in a definite order, which is determined by the attraction of the electro-positive shell and the self-repulsion of the negative corpuscles included in it. Once the idea of structure within the atom is admitted, the possibility presents itself of there being for the same mass more than one arrangement corresponding to what is called isomerism in compounds.

I have dwelt at some length on these various hypotheses, because the discussion of the subject to which they relate indicates, in my opinion, one of the consequences of the promulgation and general acceptance of the periodic scheme of the elements. This is, however, not the only result of the recognition of its validity and usefulness by chemists generally. That the elements stand in a definite relation to one another implies that their compounds also fall into their places in an orderly system, and consequently a basis is provided for the complete systematisation of the whole science of chemistry. There is scarcely a treatise on chemistry which does not bear evident witness to this influence; and this is perhaps not the least among the services rendered by this generalisation, for not only is the learner enabled to remember a much larger number of facts than previously, but he is led to perceive a connection between phenomena and processes which was almost entirely wanting so long as practical chemistry consisted mainly of a bundle of recipes. Here it is fitting that we should glance at the famous treatise by Mendeléeff himself, "The Principles of Chemistry," of which we possess three editions in English, the last of which, issued in 1905, is a rendering of the seventh edition (1903) of the original. An eighth Russian edition began to be issued in 1905, but is incomplete. To this remarkable book it is impossible to do justice in a brief notice or to communicate to those who have not read it an adequate impression. Clearly it is a work of genius, but such works are not always the most suitable for beginners, though for the advanced student nothing can be more inspiring. The "Principles" embody in reality two distinct treatises, for the text, which is written in an easy style, open to quite straightforward reading, is accompanied by notes which are often more voluminous and usurp entire pages. Even the preface is attended by these commentaries, which are all interesting as showing the spirit of the writer and the restless activity of his mind.

Little more remains to be said. In the seventeenth century Robert Boyle taught us how to distinguish elements from compounds, and how to give to the word "element" a definite connotation clearly distinguishing it from the elusive and fantastic language of the alchemists. In the eighteenth century Lavoisier showed the true nature of the most familiar of chemical compounds, namely, acids, bases, and salts, and helped to lay the foundation of quantitative chemistry. At the beginning of the nineteenth century Dalton gave to chemistry the atomic theory, of which it is not too much to say that it provided the scaffold by the aid of which the entire fabric of modern theoretical chemistry has been built up. Sixty years later this conception, developed and adorned by the labours of an army of earnest workers, has been shown to us in a brilliant new light thrown over the whole theory by Mendeléeff.

The views of Boyle, of Lavoisier, and of Dalton have been corrected by experience and broadened by extended knowledge, but the fundamental and essential parts of their ideas remain, and their names are immortal. In like manner the expression of the periodic law of the elements as known to the present generation is destined, we may believe, to be absorbed into a more comprehensive scheme by which obscurities and anomalies will be cleared away, the true relations of all the elements to one another revealed, and doubts as to the doctrine of evolution resolved in one sense or the other; but as with the atomic theory itself, there is no reason to doubt that the essential features of the periodic scheme will be clearly distinguished through all time, and in association with it the name of Mendeléeff will be for ever preserved among the fathers or founders of chemistry.

[1] It may also, perhaps, be worthy of note that Mr. Egerton's calculations (*loc. cit.*) lead him to postulate an element of nearly this atomic weight, namely, 2·9844, although his paper gives no indication as to its character.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. Forster Cooper has been appointed demonstrator of animal morphology by the professor of zoology and comparative anatomy for five years from Christmas, 1909.

Dr. Hobson has been appointed chairman of the examiners for the mathematical tripos, part ii. (new regulations), 1910.

The special board for physics and chemistry has appointed Mr. F. W. Dootson as assessor in chemistry to the examiners for the mechanical sciences tripos in 1910.

The Quick professor of biology commenced on February 2 six lectures on the pathogenic Protozoa, to be given on Wednesdays and Fridays. Attendance is free to members of the University. There will be two lectures on February 23 and 25 on "Recent Progress in the Treatment of Protozoal Diseases." These two lectures will be free to all desiring to attend.

The chairman of the board of anthropological studies gives notice that Mr. Roscoe's lectures on the natives of Uganda will be given on Tuesdays, at 5 p.m., in the archæological museum.

DURHAM.—The University this term comes under the operation of a new constitution established by an unopposed Act of Parliament last session. Originally the effective control of this University rested with the Dean and Chapter of Durham, who founded it, but gradually, after the incorporation of the Newcastle College of Medicine in 1852 and the establishment of the Durham College of Science, now Armstrong College, in Newcastle, actual power passed into the hands of an academic body, the Senate. This body, showing the anomalies of its growth, lately left much to be desired in representing a balance among the interests involved. Fortunately, the interests were not really competitive, and a solution has been found by consent. The Durham colleges retain their original endowments, and remain constituent colleges on the model of the old universities. A new Senate is established, elected in equal shares from Durham and Newcastle, which assigns the conditions for graduation, while each division is at liberty to propose for the approval of the Senate independent courses for the same degree. Thus the degree of B.A., which has hitherto been reserved to students from the Durham colleges, will now be open to students from Newcastle as soon as an approved course is established, and it is hoped that this will lead to a considerable development of Armstrong College upon the arts side, hitherto much stunted in comparison with its equipment for science. The first Vice-Chancellor, appointed on January 25, is Dr. F. B. Jevons, the well-known principal of Hatfield Hall, in Durham. It is much regretted that Sir Isambard Owen, to whose tact the success of the negotiations is largely due, is removed from participation in the first steps of the new plan by his acceptance of the Vice-Chancellorship of the University of Bristol. It will be seen that the new constitution does not bear directly upon the interests of science, but all scientific men will feel that it is an indirect step of the greatest importance to develop thoroughly the arts faculty of a scientific college, and that the added weight of the two Newcastle colleges in the councils of the University cannot fail to enhance their general prestige.

THE governors of the South-eastern Agricultural College, Wye, have resolved to extend considerably the college buildings, which are at present inadequate owing to the increasing number of students. The proposed extension, which will be ready for the next session in October, will provide extra rooms for in-college students, and will at the same time increase largely the teaching and research accommodation.

THE *Times* correspondent at Ottawa states that, as a first step towards the adoption of a system of technical education in Canada, a Royal Commission is to be appointed to report upon conditions in Great Britain, France, Germany, and the United States. Canada has hitherto done little to give a technical training to her artisans owing to the conflict of opinion between the Federal and provincial Governments in respect to jurisdiction.

IT is announced in *Science* that Mr. J. Pierpont Morgan has given 20,000*l.* to Yale University, to establish a chair of Assyriology and Babylonian literature in memory of Mr. W. M. Laffan, late editor of the New York *Sun*. From the same source we learn that the directors of George Washington University have announced that they propose to raise an endowment fund of 400,000*l.* Mr. H. C. Perkins, a member of the board, made an initial subscription of 10,000*l.* toward the fund on condition that the sum be raised.

ACCORDING to the *Revue scientifique*, in 1909 the teaching staff of fifteen French universities was composed of 366 full professors, 102 lecturers, 148 demonstrators in charge of courses of practical work, and 336 assistants. Of these totals, 173 professors, 29 lecturers, 69 demonstrators, and 174 assistant were engaged in pure science. The university grant authorised by the 1910 Budget amounts to 11,679,553 francs for salaries and so on, and 2,229,827 francs for material requirements. These amounts represent an increase over 1909 of 288,086 francs for salaries and 31,000 francs for materials. The increase for salaries includes the first annual grant of 57,000 francs for improving the emoluments of demonstrators in science and pharmacy and of scientific assistants.

THE first number of a monthly magazine to be devoted to the discussion of methods for the improvement of the physical and mental conditions under which the work of schools is done has been issued under the title *School Hygiene*. The review is intended for educational workers and doctors, and is published by the School Hygiene Publication Co., Ltd., 2 Charlotte Street, London, W., at sixpence net monthly. To the present issue Prof. H. Griesbach, president of the first International Congress on School Hygiene; Sir Lauder Brunton, F.R.S., president of the second congress; and Dr. A. Mathieu, president of the forthcoming congress in Paris next August, contribute in German, English, and French, respectively, short essays on cooperation in education. The remaining articles deal in an interesting and informative manner with numerous aspects of the health of school children, and when it is added that among the contributors are the headmaster of Eton and Dr. James Kerr, it will be evident that there is a judicious mixture of practical acquaintance with school conditions and of medical knowledge.

THE annual statement has been issued referring to the operation of the Rhodes scholarship scheme. After several years' experience, the University of Oxford seems satisfied with the type of scholar sent to Oxford. There were in residence during the academic year 1908–9 179 Rhodes scholars. Of these, 78 were from the colonies, 90 from the United States, and 11 from Germany. At the end of June 33 completed their course, and in October 31 new scholars came into residence. Five were given permission to suspend their scholarships temporarily, while six ex-scholars remain in residence engaged in teaching, research, or special study for examination. The total number of scholars and ex-scholars at the beginning of the new academic year 1909–10 was 178. Of 83 scholars from the United States who completed their course at Oxford, 82 returned to their own country, and one accepted work in England. Of 23 Germans, all returned home except one, who had accepted a teaching post in America. Of 78 colonial students, 12 are still engaged in courses of study preparatory to professions. Of the remaining 66, 51 have either returned already or are about to return to their own countries; four are teaching in England, but looking for colonial appointments in the future; one is for the present engaged in parochial work in England, with the view of service ultimately in his own colony; two have gone to colonies other than their own; three have accepted appointments in India; two, business positions in foreign countries; and three have decided to follow their professions in England. It is interesting to note that, of the total number of scholars, while 16 only took a distinctly classical course in the honour schools, 20 took up natural science, and that mathematics, forestry, and anthropology each attracted a few men only. Jurisprudence and history seem to have been the most popular subjects among the scholars.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 27.—Sir Archibald Geikie, K.C.B., president, in the chair.—Sir James **Dewar**: Long-period determination of the rate of production of helium from radium.—Sir James **Dewar** and Dr. H. O. **Jones**: Note on carbon monosulphide. No doubt decomposition is known which results in the direct production of a substance of the composition of carbon monosulphide. We have found that nickel carbonyl and thiophosgene react at the ordinary temperature according to the following equation:—

$$n\mathrm{CSCl_2} + n\mathrm{Ni(CO)_4} = n\mathrm{NiCl_2} + 4n\mathrm{CO} + (\mathrm{CS})_n,$$

to produce a polymerised form of *carbon monosulphide*. The solid products were separated by treatment with water, and the insoluble residue, after drying at 150° C. under reduced pressure, was obtained as a very dark brown or black amorphous solid, which is sparingly soluble in some solvents, such as ethylene dibromide, carbon disulphide, and phenol, to give deeply coloured solutions. The solubility was not sufficient to enable the molecular weights by lowering of freezing point to be determined. The specific gravity of carbon monosulphide is 1·6, and hence its molecular volume is 27·5, while that of solid carbon disulphide is 52·4. A comparison of these values with the corresponding values for solid carbon monoxide (28) and carbon dioxide (28·7) shows that carbon monosulphide is formed from carbon disulphide with considerable condensation. On heating carbon monosulphide no change takes place below 360° C., but at a red heat it gradually decomposes into carbon disulphide and carbon. Carbon monosulphide dissolves in concentrated sulphuric acid to a brownish-purple solution, from which it is precipitated unchanged on the addition of water. It dissolves in alkalies to a dark brown solution, from which acids precipitate it unchanged. Other reactions are being investigated.—Sir W. de W. **Abney**: The extinction of colour by reduction of luminosity. In this paper the author gives the results of reducing the luminosity of all the rays of the spectrum to the point at which they become colourless when compared with white. The white itself varies in hue according to the amount of reduction in its luminosity. No notice is taken of this variation, so some parts of the spectrum do not require so much reduction to match the white as they would do if the white is kept of a uniform hue.—G. W. **Walker**: The initial accelerated motion of electrified systems of finite extent, and the reaction produced by the resulting radiation. The present investigation forms a development of a paper already communicated to the Royal Society (Proceedings, A, vol. lxxvii., p. 260). Its chief aim is to obtain, directly from the fundamental equations of electro-magnetism, a method of dealing with small disturbances from a steady state of motion, and thus avoid possible errors that may arise if one relies entirely on the principle known as that of the "quasi-stationary state." The method is explained in the first six sections, which include the problem of initial uniformly accelerated motion of a charged conductor of finite size, either from rest or from uniform motion in a straight line. It appears that the electric inertia calculated by this method does not always agree with the value obtained from the energy of a steady state. As the results obtained include the case of a conductor of small dimensions, several formulæ are compared with the experiments of Kauffmann on Becquerel rays, and a fair proportion of inertia of ordinary kind is found to be indicated by these experiments. Application of the method to uniformly accelerated linear and rotary motion of insulators has been made. It is found that the electric inertias for linear and rotary motions are the same, provided half of it is located at the centre and half is uniformly distributed over the surface of the spherical body, supposed an insulator. Several sections deal with vibratory motion of electrified systems. Some new features connected with emission and absorption, and dependence of frequency and damping on speed, are indicated.—H. **Thirkill**: The nature of magneto-kathodic rays. In the experiments described a variable longitudinal magnetic field acts upon an electric discharge. The experiments support the hypothesis that the luminous band, which, in a strong magnetic field, follows the direction of the lines of magnetic force and has the kathode for section, consists of slowly moving kathode rays. These have been bent by the magnetic field into the form of a very fine spiral. The charge was detected by using a sensitive galvanometer. On this view, the following facts observed by Villard and Righi are explained:—(1) the magneto-kathodic rays very often appear quite suddenly, and (2) their appearance is accompanied by an increased difficulty in detecting a charge on them; (3) the rays are deflected by an electric field in a direction at right angles to the directions of both the magnetic and electric fields; (4) the distance the rays extend from the kathode depends on the strength of the magnetic field. The conclusion arrived at is that there is not sufficient evidence to prove that the magneto-kathodic rays constitute a new kind of rays.—E. **Cunningham**: The velocity of steady fall of spherical particles through a fluid medium. In view of experimental work on the fall of small spherical particles through air, a discussion is made in this paper of two of the main causes of deviation from Stokes's law for the limiting velocity. The first effect considered is that arising from the radius of the particle being comparable with the mean free path of the air molecules. The following modification of Stokes's formula is obtained:—

$$W\left(1+\frac{1{\cdot}63l}{a(2-f)}\right)=6\pi\mu a V,$$

where l is the mean free path of the molecules of air, W is the weight, a the radius, and V the limiting velocity of a falling particle, f being a fraction depending on the nature of the surface of the particle, being unity for a perfectly smooth elastic surface. For most actual cases f probably lies between 0 and $\frac{1}{2}$. The formula agrees with Zeleny's recent experimental verification that for particles of radius greater than 10^{-4} cm. the deviation found is not large. The second effect discussed is that due to the simultaneous presence of a large number of particles distributed throughout the fluid, assumed in this case to be a continuous viscous medium. A formula is obtained which indicates that, as the number of particles per unit volume increases, the limiting velocity diminishes. The following table gives the ratio of the estimated limiting velocity (V^1) to that given by Stokes's law for different values of the ratio of a, the radius of the particle, to b, the mean distance between the centres of two adjacent particles:—

b/a	1·63	2·45	3·26	4·08	4·90	5·71	6·50	7·35	8·16	16·3	24·5	∞
V^1/V	7·29	3·02	2·10	1·76	1·57	1·46	1·38	1·32	1·28	1·14	1·08	1

—Dr. S. B. **Schryver**: The photochemical formation of formaldehyde in green plants. On the addition of phenylhydrazine hydrochloride, potassium ferricyanide and hydrochloric acid to solutions containing formaldehyde, a fuchsine-like colour is developed, by means of which the aldehyde, when present in small quantities, can be estimated. The reaction can also be applied to the estimation of formaldehyde when present in combination in such substances as oxymethylene tetramine, if the reaction mixture be boiled after addition of the phenylhydrazine reagent and before the addition of the ferricyanide and hydrochloric acid. By means of this method, formaldehyde can be readily detected when present to the extent of only one part in a million. The reaction has been applied to demonstrate the presence of the aldehyde in chlorophyll prepared from grass gathered after some hours of sunshine. The chlorophyll was extracted by alcohol, the solvent was then evaporated off, and the residue re-extracted with ether. In the product thus obtained, the presence of the aldehyde could be demonstrated after warming it or allowing to stand for some hours with the phenylhydrazine reagent. The ethereal solution of chlorophyll, on standing for some days, yielded a product which no longer showed the formaldehyde reaction. Formaldehyde was absent also in a sample of chlorophyll prepared from grass on a foggy morning. By exposing films of such aldehyde-free chlorophyll to sunlight in the presence of moist carbon dioxide, the formaldehyde reaction reappeared. Even in the absence of carbon dioxide slight traces could be detected after exposure to sunlight; in this case the carbon dioxide is apparently formed by photochemical decomposition of some constituent of chlorophyll. In the dark, formaldehyde was never generated. The results indicate that formaldehyde, as it is formed in plants, enters into somewhat stable combination with a constituent of the chlorophyll. Such a methylene derivative will, in the presence of water, undergo only slight hydrolysis, and equilibrium will be maintained in the presence of only a very small amount of free formaldehyde. As this is removed from the sphere of action by polymerisation or otherwise, the chlorophyll methylene derivative will undergo further hydrolysis, with the scission of further small amount of aldehyde. In this way the amount of free formaldehyde present at any moment in the plant can be regulated, and thus the highly toxic aldehyde will never be present in such quantities as to harm the plant.

Faraday Society, January 18.—Dr. F. Mollwo Perkin, treasurer, in the chair.—S. **Field**: The conditions which determine the composition of electro-deposited alloys. Continuing the study of the quantitative composition of electro-deposited alloys, those of copper and silver have been examined. For the electrolyte, a mixture of the double cyanides was again used. Ordinarily, silver is more negative than copper, but the difference in their character is such as would not seem to indicate any difficulty in depositing them simultaneously from a cyanide solution. The composition of the deposits was obtained by dissolving in nitric acid, and estimating the silver as chloride, except where the copper was obviously small, when that metal was determined. When a copper coulometer is in circuit the ratio (R) of the weights of alloy and copper deposited in the coulometer gives a figure from which, under ideal conditions, the composition of the alloy may be determined thus:—

$$\text{Percentage of silver} = \frac{241}{R}(R-2).$$

Experiments soon proved that simultaneous deposition only occurs within very narrow limits. Thus when the metals in the solution are in the proportion of even 1 equivalent silver to 34 equivalents of copper no deposition of copper occurs under ordinary conditions of current density, but when in the proportion of 1 equivalent silver to 100 equivalent copper, simultaneous deposition proceeds more readily.—F. P. **Burt**: The compressibilities of helium and neon. The compressibilities of the two gases were measured between the pressure limits of 850 and 150 mm. of mercury. With the object of determining the lie of the isothermals over this pressure range as accurately as possible, a large number of volume and corresponding pressure readings were made. On plotting pv against p, a straight line was obtained in the case of both gases. Helium was found to obey Boyle's law, the value of pv being independent of the pressure. In the case of neon, pv diminished as the pressure diminished, and the value of $d(pv)/dp.1/pv$ was found to be 0·00105.—Dr. A. C.

Cumming: Gas-washing bottles with a very slight resistance to the passage of a gas. Three forms are described. In one a short side-tube is joined to the inlet-tube of an ordinary washing bottle and bent upwards, so that the gas bubbles passing through it carry some liquid with them, causing constant circulation of same. In a second and more efficient form, the gas passes through a length of 5 mm. tubing, slightly inclined to the horizontal. Below this, and connected to its ends, is a bulb of liquid, so that here again the passage of gas through the tube causes a circulation of liquid. The third form described is a modification of the Richardson wash-bottle, in which the pressure is reduced by lengthening the nozzle through which the gas enters the washing bulb.—Dr. F. Mollwo **Perkin** and W. E. **Hughes**: Studies in the electro-deposition of metals. The authors describe a rotating kathode employed for rapid electro-deposition of metals. It consists of sheet platinum spun up so as to form a narrow thimble, the upper end being open and having a stout iridium wire fused to it. This electrode, which has an active surface of 16·3 cm., is rapidly rotated within a cylindrical platinum gauze anode. In other cases, particularly when graded potential methods are employed, a spiral anode of platinum is rotated within the gauze cylinder, which then functions as kathode. In the potential measurements a cylindrical glass funnel with a glass tube sealed in the side is employed for holding the electrode.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 3.

ROYAL SOCIETY, at 4.30.—The Thyroid and Parathyroid Glands throughout Vertebrates: F. D. Thompson.—The Transmission of *Trypanosoma lewisi* by the Rat-flea (*Ceratophyllus fasciatus*): Prof. E. A. Minchin and J. D. Thomson.—On the Relative Sizes of the Organs of Rats and Mice bearing Malignant New Growths: Dr. F. Medigreceanu.—Further Evidence of the Homogeneity of the Resistance to the Implantation of Malignant New Growths: Dr. E. F. Bashford and Dr. B. R. G. Russell.—The Contrast in the Reaction to the Implantation of Cancer after the Inoculation of Living and Mechanically Disintegrated Cells: Dr. M. Haaland.

RÖNTGEN SOCIETY, at 8.15.—The Essential Ambiguity of X-ray Representation, and some Methods of Solution: Dr. W. Cotton.

LINNEAN SOCIETY, at 8.—Further Discussion of the Origin of Vertebrates: Dr. A. Smith Woodward, F.R.S., Prof. A. Dendy, F.R.S., and other speakers, with Dr. Gaskell's reply.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Waves in Water, Sand, and Snow: Dr. Vaughan Cornish.

FRIDAY, FEBRUARY 4.

ROYAL INSTITUTION, at 9.—The Heredity of Sex: Prof. W. Bateson, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Construction and Setting-out of a Low-level Sewer: L. T. Wilson.

GEOLOGISTS' ASSOCIATION, at 8.—Presidential Address: Fifty Years' Work of the Association: Prof. W. W. Watts, F.R.S.

MONDAY, FEBRUARY 7.

ROYAL INSTITUTION, at 5.—General Meeting.

ROYAL SOCIETY OF ARTS, at 8.—The Petrol Motor: Prof. W. Watson, F.R.S.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Manufacture of Ammonia-Soda; its Present State and its Future: Prof. A. Colson (Paris).

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—The Geographical Conditions affecting the Development of Australia: Prof. J. W. Gregory, F.R.S.

ARISTOTELIAN SOCIETY, at 8.—Kant's Account of Causation: A. D. Lindsay.

VICTORIA INSTITUTE, at 4.30.—Species and their Origin: Rev. John Gerard.

TUESDAY, FEBRUARY 8.

ROYAL INSTITUTION, at 3.—The Emotions and their Expression: Prof. F. W. Mott, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Notes on the Sheffield Water-supply and Statistics relating thereto: L. S. M. Marsh.—Statistical and Experimental Data on Filtration: W. R. Baldwin-Wiseman.

WEDNESDAY, FEBRUARY 9.

ROYAL SOCIETY OF ARTS, at 8.—Colour Blindness: Dr. F. W. Edridge-Green.

GEOLOGICAL SOCIETY, at 8.

THURSDAY, FEBRUARY 10.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: Some Phenomena of Magnetic Disturbances at Kew: Dr. C. Chree, F.R.S.—On a Novel Phenomenon in the Diurnal Inequality of Terrestrial Magnetism: R. B. Sangster.—The Absorption Spectra of Vapours of the Alkali Metals: Prof. P. V. Bevan.—On the Shapes of the Isogeotherms under Mountain Ranges in Radio-active Districts: Prof. C. H. Lees, F.R.S.—On the Propagation of Disturbances in a Fluid under Gravity: F. B. Pidduck.—On the Flow of Water through Pipes and Passages having Converging or Diverging Boundaries: Dr. A. H. Gibson.—The Effect of Pressure upon Arc Spectra: Titanium: R. Rossi.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Losses off Transmission Lines due to Brush Discharge, with Special Reference to the Case of Direct Currents: E. A. Watson.

MATHEMATICAL SOCIETY, at 5.30.—A Note on Double-sixers of Lines: H. W. Richmond.—On the Diffraction of a Solitary Wave: Prof. H. Lamb.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Waves in Water, Sand, and Snow: Dr. Vaughan Cornish.

FRIDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 9.—Electrical and other Properties of Sand: C. E. S. Phillips.

PHYSICAL SOCIETY, at 8.—Annual General Meeting. President's Address.

ROYAL ASTRONOMICAL SOCIETY, at 8.—Anniversary Meeting.

MALACOLOGICAL SOCIETY, at 8.—Unio, Margaritana, Pseudanodonta, and their Occurrence in the Thames Valley: Fritz Haas.—(1) Pleistocene, Holocene, and recent Non-marine Mollusca from Mallorca; (2) Marine Mollusca from Alcudia, Mallorca: Rev. R. Ashington Bullen.—Description of a New Species of Vivipara from New Guinea: H. B. Preston.—Description of a New Species of Unio from the English Wealden Formation: R. Bullen Newton.

SATURDAY, FEBRUARY 12.

ROYAL INSTITUTION, at 3.—Electric Waves and the Electromagnetic Theory of Light: Sir J. J. Thomson, F.R.S.

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