THURSDAY, FEBRUARY 11, 1892.

THE VACANT CHAIR OF ASTRONOMY AT CAMBRIDGE.

OUR Note of last week has brought us several communications with regard to the Chair of Astronomy rendered vacant by the lamented death of Prof. Adams. Before the note was written only certain names had reached us; but since then we have heard from the Rev. A. Freeman that he is a candidate for the Chair, and he has also been good enough to forward to us copies of papers on astronomical subjects which he has communicated to the Royal Astronomical and the Cambridge Philosophical Societies. We are very glad, therefore, to comply with what we presume is his desire that we should state that he is a candidate.

The other communications to which we refer are of more general interest, as they raise questions almost of national importance. We are informed, for instance, that it has been suggested that the Observatory should be disconnected from the vacant Chair. That is the first point. Another is that there is an idea prevailing at Cambridge that in such a subject as Astronomy the Professorships may be well regarded as honourable rewards or pensions to men who have rendered the University service as College tutors, or who have spared the professors and tutors labour by acting as coaches, the contributions these gentlemen may have made to astronomical science being considered as a matter of secondary importance.

With regard to the first point, we believe it will be generally conceded—it certainly will be conceded by those who know anything about the organization of that land of Universities, Germany—that an astronomical Observatory must take exactly the same place with regard to astronomy as physical, chemical, and biological laboratories do with regard to the sciences for which their aid is now regarded as essential, even at Cambridge. It should be clear, therefore, that in an University which professes to teach astronomy—to say nothing of that University rendered illustrious by the name of Newton—it would be as impolitic and as stupid a thing to dissociate the physical laboratory from the Professorship of Physics, the chemical laboratory from the Professorship of Chemistry, and the biological laboratories from the Professorships of Biological Science, as it would be to sever the astronomical Observatory—which in a University should always be a laboratory as well—from the subject of astronomy. And we confess it does not seem possible to us that such a step can be seriously contemplated; but certainly, were it done, the University would become a laughing-stock; and more than this, Cambridge would be reversing its scientific history. As far back as 1704, the Plumian Professorship of Astronomy was founded for the promotion of practical astronomy, especially to describe the parts and uses of astronomical instruments, and to prove and exemplify the mathematical formulæ required in the reduction of observations. It is worth while to point out that the wisdom of this foundation is proved by the fact that this is exactly the basis on which the astronomical subjects are generally treated in the German Universities. Take, for instance, the Observatory at Leipzig. Prof. Bruns lectures to his students for four hours a week on the parts and uses of astronomical instruments and the cognate subjects; and, in addition to these, the mathematical treatment required in the reduction of observations and in ordinary computations are included in a separate course of instruction of two hours a week, and the students of both these courses join in the work of the Observatory, and are glad to do it.

We do not know whether the terms of Dr. Plume's bequest are still adhered to by the present Plumian Professor of Astronomy, but there is no doubt that it was in relation to the work so definitely laid down for this Chair that the Cambridge Observatory was established; and it is a matter of history that, when Prof. Woodhouse was succeeded in 1828 by Airy as Plumian Professor and Director of the then newly-erected Observatory, his work in the direction laid down by the foundation marked an epoch in modern astronomy. There are few first-class Observatories in the world at the present time in which the method of publishing adopted by Prof. Airy for the Cambridge Observatory is not followed with faithful accuracy, and let it be mentioned that all of the work, down to the minute computations and even the copying, was done by Airy himself.

During the tenure of the Lowndesian Professorship by Adams, the Observatory was separated from the Plumian Professorship and transferred to the Lowndesian, and this represents the present condition of things.

It is perfectly obvious, from what has been said, that to transfer now the Observatory from both the Professorships would be to run counter to the past history of Cambridge. It should be equally clear that this among many bad results might, in all probability, follow. The modicum of astronomy in the general sense now taught at Cambridge would be taught by men who, by the absence of material means, would not only be incapacitated from teaching the subject properly, but even from learning the new developments of it. The Professorship might soon become an intensified sinecure; while the Director of the Observatory, who would be the only one in the position of being able to learn, would yet, by the conditions of the problem, not be in a position to teach.

We now come to the second point—that relating to the astronomical qualifications of those who are candidates for the Chair. We cannot believe that this present year of grace—with a new astronomy breaking in upon us on all sides by the introduction of physical inquiries, experimental work, application of new instruments, and the like—can be a good time for dispensing with a practical acquaintance with the subject among the candidates for a Chair of Astronomy at Cambridge or anywhere else.

The subject, indeed, is one in which we are at present scarcely holding our own, while America and Germany are spending hundreds of thousands of pounds for the new equipments necessitated by the new methods. Surely Cambridge cannot be content that the Professor appointed is to be absolutely ignorant of the material equipment of the science; that he shall have no instruments to demonstrate to his students; nay, that he may not know one end of one from the other, and at the same time be rather proud that it is so, on the ground that contact with masses of metal might probably interfere with the purity of the conceptions of his mathematical mind.

It is, of course, agreed by everybody that there are mathematical investigations required in astronomy which can be, and have been, brilliantly carried out without the use of astronomical instruments. Looming large among these are tables such as those produced by Leverrier, Newcomb, Hansen, and many others that might be named; and were there at present among us a man who was distinguishing himself in such investigations, it might, under certain circumstances, be permissible to *waste* an Observatory by placing him at the head of it. But these are not the present circumstances. As it is, although England and Cambridge have made noble contributors to astronomy in the past, at the present moment there is no such man. The raw material produced by Greenwich is worked up abroad, and reimported for home consumption; while, on the other hand, the number of Observatories and Astronomical Chairs in this country is so small, that there are no inducements to an astronomical career, so that astronomy bids fair to be soon an extinct profession.

This is why we believe that it is essential, to save the situation, that astronomical professorships should be conferred upon astronomers, and that the existing Observatories should be saved from becoming sleepy hollows for mathematicians, however distinguished, who have given no hostages to fortune in the shape of noble astronomical work achieved.

The recent gift to the University by the late Mr. R. S. Newall even suggests that the present time might be taken advantage of to extend the present Observatory—if by no other means, then by a national subscription—so that it may become an institution as important for the promotion of astronomy as the Cavendish Laboratory, and others which might be named, are for the sister sciences.

We believe that there would be a general enthusiasm to contribute towards a building which should be a national memorial to Newton and Adams in the University which they have rendered illustrious by their labours; and if such a consummation could be aided by the suppression or suspension for a time, of one of the existing Chairs, we believe that the Cambridge authorities would have public opinion with them. We do not think that the number of astronomical students is now very great, or that the classes of the Plumian Professor are inordinately large; probably, therefore, no inconvenience would be caused by such a temporary suspension, while the gain to science and to the University would be permanent.

EDITOR.

THE CATALOGUE OF SCIENTIFIC PAPERS.

Catalogue of Scientific Papers (1874–83). Compiled by the Royal Society of London. Vol. IX. (Cambridge: University Press, 1891.)

THE Royal Society's "Catalogue of Scientific Papers," of which the ninth volume has just appeared, is the outcome of a movement which dates back nearly forty years. At the Glasgow meeting of the British Association which was held in 1855, a communication from Prof. Henry, of Washington, was read, "containing a proposa for the publication of [a catalogue of] philosophical memoirs scattered throughout the Transactions of Societies in Europe and America, with the offer of co-operation on the part of the Smithsonian Institute." This proposal was referred to a Committee consisting of Mr. Cayley, Mr. Grant, and Prof. (now Sir Gabriel) Stokes; and their report was presented next year at the Cheltenham meeting of the Association. The scheme set forth in this report was that of a catalogue embracing only the mathematical and physical sciences, but comprising a subject catalogue as well as a catalogue according to the names of authors. There were to be paid editors, "familiar with the several great branches respectively of the sciences to which the catalogue relates," and the work was to include, besides Transactions and Proceedings of Societies, journals, ephemerides, volumes of observations, and "other collections not coming under any of the preceding heads."

In this form the scheme came before the Royal Society in March 1857, General Sabine having requested, on the part of the British Association, the co-operation of the Society in the undertaking. The scheme, after the usual amount of discussion in Committees and Councils, at length got upon its feet, walking, however, at first, in a wary and tentative manner. It was narrowed to a *manuscript* catalogue, the question of printing being deferred; it was to be a catalogue of periodical works in the Royal Society's library only (though it may be remarked, by the way, that that library is particularly rich in scientific serial literature); the suggested American co-operation, moreover, was dispensed with, and the work undertaken at the Society's own charge. In one important respect, however, the scheme was greatly widened, for the idea of confining the Catalogue to the mathematical and physical sciences, which had been put forward in the report to the British Association, was thrown overboard, and it was wisely decided "that all the sciences should be comprehended." The tentative restrictions were, of course, finally relaxed. It was resolved to extend the indexing to works in other libraries not contained in the library of the Royal Society; and in 1864, when the question of printing had to be faced, it was decided to offer the Catalogue to Government for publication.

The cost to the Society of compiling the material for the first series of the Catalogue was considerable, and many of the most eminent of the Fellows had spent no small amount of time, not only in superintending the progress of the work at home, but in corresponding with Academies abroad, with the view of making the list of serials to be catalogued as complete as might be. It was therefore with some reason that the Lords of the Treasury, in resolving to print the Catalogue at the public expense, stated that they had regard "to the importance of the work, with reference to the promotion of scientific knowledge generally, to the high authority of the source from which it comes, and to the labour gratuitously given by members of the Royal Society for its production." The printing of this first series of the Catalogue covering the scientific serials from the year 1800 to 1863, was commenced by the Stationery Office in 1866, seven Fellows of the Royal Society undertaking to read the proof-sheets gratuitously. The sixth and last volume of the series, completing the alphabet, was issued in 1872.

It is in the nature of such an undertaking that it never comes to an end, and no sooner is Z reached than the compiler has to begin again at A. An additional decade of serials, embracing the years 1864–73, containing about 99,000 titles, and filling two additional quarto volumes (vols. vii. and viii.), was completed in January 1876, and published by Her Majesty's Stationery Office in 1879. But now the troubles of the Royal Society began. The work of the next decade went steadily forward; but as it neared completion it was found, so rapidly does the bulk of scientific serials increase, that, even keeping the Catalogue on the old lines, and making no considerable addition to the number of serials catalogued, ten years of memoirs, which formerly filled two volumes, would now fill three; and, to add to the difficulty, the Treasury now informed the Society that the "'Catalogue of Scientific Papers' would not be continued as a publication of the Stationery Office." Parliament voted, however, a gift towards the charges of publication, and this, supplemented by the Royal Society's own funds, and the enterprise of the Cambridge University Press, has enabled the decade to be printed.

So much for the past of the Catalogue; and now a word as to its future. The preface to the volume under review states—what we have hinted at above—that the list of works catalogued "by no means comprises the whole of the scientific periodicals which at the present day are being constantly published in various languages." We believe it is no secret that the Committee of the Royal Society who have the superintendence of this great work have themselves printed and distributed among the Councils of various scientific Societies, for revision or additions, a list of no less than 540 additional serials, which may, might, should, or could be catalogued, so far at least as regards the principal memoirs which they contain; and it is well known to every scientific man how rapid is the multiplication of scientific serials, and how increasingly difficult becomes the task of keeping oneself acquainted with their contents. We are glad to learn, from the preface already quoted, that "the President and Council have it in contemplation to issue a supplementary volume, in which will be catalogued all the most important papers that have appeared from 1800 to 1883 in periodicals not hitherto indexed." We wish them well through their task, only venturing the gentle hint, "Bis dat qui cito dat." Nothing is said in the preface about future decades, but we sincerely trust that, notwithstanding the alarming increase of periodicals and the unfortunate withdrawal of Government aid, some means will be found for continuing the work: perhaps a hint might be taken from the British Association Report which initiated the whole undertaking, and by which it appears that America was willing to help.

One other matter needs to be mentioned—the important matter of a subject-index. uch an index, as we have already stated, formed a part of the original scheme, and as certain correspondence in our own columns (vol. xli. p. 341; xlii. p. 126) would seem to show, the Royal Society, though they have not yet seen their way to undertake it, still bear this great *desideratum* in mind. The undertaking was perhaps nearer than at any other time to being actually set on foot, when, in 1870, Dr. Carus visited London, and actually spent some weeks at the Royal Society's apartments in planning and making specimens of such an Index Rerum. Unfortunately, the Franco-Prussian War prevented the return of Dr. Carus to London as had been arranged, and the work was never continued. How difficult such an undertaking is, perhaps few fully understand, requiring as it does, at the very threshold of the work, a complete and perfect classification of all the sciences, and involving, moreover, all kinds of difficult questions and perilous cross-divisions. But, difficult as it is, we trust that, to the great advantage of science, and the true "promotion of natural knowledge," the Royal Society may yet accomplish a work so greatly needed.

X.

THE ANEROID IN HYPSOMETRY.

How to Use the Aneroid Barometer. By Edward Whymper. (London: John Murray, 1891.)

IN undertaking a somewhat laborious investigation of the behaviour of the aneroid under great variations of pressure, and in publishing the results in the little pamphlet that bears the above title, Mr. Whymper has rendered a service to travellers and geographers, which they will acknowledge not the less cordially that it brings with it the bitter reflection that very much of their past work in determining mountain heights by means of that convenient instrument, is probably seriously in error.

All who have had any experience in testing aneroids in the usual way, viz. by subjecting them to gradually reduced pressures under the air-pump, and comparing their readings with the concomitant indications of the manometer, are aware that the variations of the two instruments with falling and then with increasing pressure are by no means concordant; but it will probably be new to most that, when the aneroid is allowed to remain for some weeks under the reduced pressure, its indications continue falling, and to such an extent that its final error in certain cases is five or six times as great as when the exhaustion was first completed. Now this is precisely the condition experienced by travellers on high plateaux or great mountain tracts, where days or perhaps weeks are passed at altitudes of many thousands of feet above the sea-level. The instrument on which they rely for their elevations has been undergoing a rapid and not inconsiderable fall, which is merely an after-effect of the ascent already accomplished and recorded; and if, after returning to low levels, some weeks elapse before they again compare it with a mercurial standard, the whole of this accumulated error will have disappeared, and it may even have been replaced by an error in excess of the original reading. The Kew certificate of the aneroid's performance will afford no clue to its detection, and the elevations they have determined during their sojourn at high levels will be uniformly in excess of the truth.

It was an experience of this kind on the high plateau of Ecuador that first drew Mr. Whymper's attention to this peculiarity in the behaviour of the aneroid. But he was not working in the dark. Together with a battery of aneroids he carried with him a mercurial barometer, and by dint of frequent comparison with this standard, he was enabled to follow the erratic variations of the former instruments through all the changes of pressure to which they were subjected in the course of his travels. Armed with this experience, on his return to London, he undertook a series of systematic experiments, not only with the instruments that he had used on the Andes, but also with a large number furnished for the purpose chiefly by Messrs. Hicks and Casella. These were subjected to conditions which reproduced as nearly as possible those experienced on the journey, and their behaviour was noted under all the varying circumstances. The results of these experiments were that all aneroids, when brought under a low pressure, continue falling for four or five weeks, and in some cases longer; that the amount of the total fall varies greatly with different instruments; and that, in general, two-thirds of the fall takes place in the first week. Mr. Whymper says: "I have seen the index error of an aneroid grow to as much as four inches; in several instances there have been alterations of more than an inch, and in numerous instances there have been alterations from scarcely appreciable errors to + or − errors of two or four tenths of an inch." On the other hand, aneroids that have been kept for some weeks at a low pressure, when restored to the full pressure of the atmosphere, take many weeks to regain their condition of equilibrium; and when they have attained this final condition, their readings are sometimes higher, sometimes lower, than their original values at the same pressure. The greater part of the recovery takes place in the first week, and a considerable part in the course of the first day.

Notwithstanding this sluggishness of action, Mr. Whymper finds that the aneroid may be usefully employed for measuring differences of altitude when all the readings are taken within a short interval of time; the shorter the better, so that the data compared are only the first effects of the changes of pressure; and this equally whether the base station is at a high or low level. He gives an instance of this in his determination of the depth of the great ravine of Guallabamba, north of Quito, at the top of which his mercurial barometer read 21·692 inches, and the two aneroids that he carried with him gave readings respectively 0·552 and 0·752 inch too low. But when the three instruments were next read, two and a half hours later, at the bottom of the ravine, the mercurial barometer indicated a rise of 2·237 inches, and both the aneroids a rise of 2·260 inch, involving an error of only 1 per cent. In this instance, the difference of elevation as shown by the aneroids was vitiated by a very small error, but the absolute heights above sea-level as obtained from their readings would involve errors of more than 600 and 800 feet respectively.

That this was no accidental result was subsequently confirmed by an experiment on twenty-two aneroids (all having large but very varied errors). After these had been kept a week at a pressure of 21·692 inches (of the manometer), they were gradually restored in the course of two and a half hours to a pressure of 23·929 inches; and, with a single exception, the rise of the aneroid readings ranged between 2·130 and 2·360 inches, the mean of the whole being 2·218 inches.

As the general result of his experience, Mr. Whymper concludes that all aneroids lose on the mercurial barometer when subjected to diminished pressure, and that the loss is the greater the greater the reduction of pressure; that when diminished pressure is maintained continuously, the loss commonly continues to augment during several weeks, but in a constantly diminishing ratio; that when pressure commences to be restored, the aneroid endeavours to recover the previous loss, and some gain more than they have lost; but the recovery is gradual, and usually extends over a greater length of time than the period during which the diminished pressure has been experieneed; finally, that the index errors of aneroids are never constant, so that apparently no process of verification can be trusted to yield corrections for permanent application, even though time be made a factor of the correction formula.

It was no part of Mr. Whymper's purpose to go deeper into the matter, and to ascertain wherein lay the source of the irregular action of his instruments. But it is evident that this must be known before we can look for any important improvement in the construction of the aneroid. In all probability it lies in the varying elasticity of the thin corrugated disk that forms the cover of the exhausted chamber, the alternate rings of which are thrown into a state of strain and stress in the process of exhaustion, and which strain and stress are varied with every change of the external pressure. Perhaps some clue to the cause may be found in the results of Mr. Herbert Tomlinson's experiments on the elasticity of metallic wires after deformation by tension or torsion,[1] since he found that, after such treatment, the metal takes a considerable time to recover its normal elasticity. It is, indeed, by no means certain that such changes of pressure as were dealt with by Mr. Whymper are sufficient to produce deformation, but the aneroid affords a very delicate measure of any change of elasticity in the corrugated disk, and there is so much resemblance in the results of Mr. Whymper's and Mr. Tomlinson's experiments as to make it at least not unlikely that there is a community of cause.

Meanwhile, travellers must bear in mind that unless the aneroid can be frequently verified by comparison with a mercurial barometer, its indications can be trusted only for such small differences of elevation as can be measured within an interval of a very few hours. A rough verification can, indeed, be obtained with the boiling-point thermometer, as is recommended by the authors of "Hints to Travellers," and this will at least enable them to avoid large and accumulated errors. A fair idea of the degree of accuracy that may be expected of this latter instrument in practice, is afforded by Dr. Scully's simultaneous observations of the mercurial barometer and the boiling-point thermometer in his journey over the Karakoram from Leh to Yarkand, which will be found in vol. i. of the "Indian Meteorological Memoirs." H. F. B.

WALLER'S HUMAN PHYSIOLOGY.

An Introduction to Human Physiology. By Augustus D. Waller, M.D. (London: Longmans, Green, and Co., 1891.)

In these days, when the cult of the examination fetish is in the ascendant, and we are rapidly approaching the condition of the unchanging students of Confucius

[1] Phil. Trans. 1883.

it is natural that the first question a student asks about a new book on physiology should be, "Is it the book for the College?" or the M.B., or whatever may be the examination most in vogue at his school. And this question is typical of the effect of examinations for evil, of their tendency to make men read exclusively up (or down) to the requirements of the examiners, disregarding the fact that the elementary physiology and anatomy they learn are to furnish their only weapons with which to attack the, for them, far weightier problems of pathology and treatment in their medical and surgical aspects.

On the other hand, it is a consolation to think that a good text-book must extend its beneficial influence to examinations as well as examinees, and thus improve the physiological teaching, not only by providing a trustworthy book of reference for the students, but also by putting a stop to cramming for examinations, which now forms so large a part of the teaching at London schools; for so surely as examinations improve will cramming assimilate itself to the proper teaching, and so become a work of supererogation.

I may say at the outset that Dr. Waller's book falls into the latter category, and is really the best recent work in the English language on human physiology. It presents a complete elementary account of the present state of the science, and is especially distinguished from the text-book most in vogue at the present time by its objectivity. Without loading his text with references and names, Waller retains personal interest in his work, and quotes original experiments sufficiently to attract the attention of the reader, and to give him (so far as is possible in a text-book), a real knowledge of the subject, and opportunity to discriminate between the diverse views with which the science is burdened.

I mean, no reader is compelled to accept the facts he learns here on the *ipse dixit* of the author. The facts are presented plainly enough, and their significance discussed, but the student can, if he has the habit of thought, weigh the evidence for himself, and perhaps come to a different conclusion from the author.

If we may be allowed to alter the context of a sentence of the preface, giving references and original experiments is useful "because it helps to correct that credulous bias or primitive 'suggestibility' which is a physiological property of the human brain, and only too apt to be fostered by unmitigated bookwork."

Dr. Waller follows the time-honoured division of the subject into vegetative and animal physiology; the latter, which includes the nervous system and its instruments, occupying half the entire work (270 pages).

Some might consider this too much space to be devoted to this part of the subject in a book intended primarily for, and certain to be used chiefly by, medical students. But one must consider that no other department of physiology can be so immediately applied to clinical work as that treating of the nervous system. In fact, a third year's man, who has learnt this well, requires merely a little book knowledge to recognize the most recondite forms of nervous disease, which would hopelessly elude the diagnostic powers of many an older practitioner, less versed in the latest advancements of neurological science.

In the eye wards, too, an exact knowledge of the working of the normal eye is absolutely essential, and one often hears oculists complain that they have to teach students the physiology of the normal eye before they can start on their own proper subject; and this is partly owing to the fact that these subjects are perhaps the hardest part of physiology, and partly because the student comes to them at the end of the session, and is tempted to treat them as coming last also in importance. This, however, he will be unable to do if he takes the work before us for his text-book.

The second part is treated evidently *con amore*, and is an excellent account of this branch of physiology. The introductory chapter on "The General Plan of the Nervous System" (which occupies only ten pages) is especially to be commended for its lucid brevity, the outcome of a masterly grasp of the subject.

This chapter is followed in order by the physiology (1) of the peripheral organs, muscle and nerve; (2) of the sense-organs, eye, ear, &c.; (3) of the central organs, spinal cord, spinal bulb, and brain.

The section on muscle is prefaced with a short account of the chief instruments used in electrical experiments on muscle and nerve, and of Ohm's law.

The fulness with which nervous physiology is treated will make the work very acceptable to general readers, and especially to those who wish to acquire a physiological standpoint from which to attack the problems of psychology.

The first part of the work—"The Phenomena of Nutrition"—treats adequately of the subjects of the blood and circulation, respiration, nutrition, excretion, and animal heat, but does not quite reach the high standard of excellence of the second part.

In a second edition one would like to see the questions of coagulation and of the origin of urea treated a little more fully and precisely. Its value, too, as a text-book would be much improved if the headings at the beginning of each chapter were also incorporated in the text, or put at the side of the page so as to arrest the reader's attention.

The whole work shows evidence of careful revision, and is marvellously free from mistakes or printers' errors. On p. 103, in describing the effect of the interrupted current on the ventricle, it should be mentioned that the frog's ventricle is meant, and not the mammalian.

In conclusion, I may mention that the work is furnished with a useful bibliography (confessedly incomplete) and a good index. E. H. STARLING.

OUR BOOK SHELF.

Bulletin of the New York Mathematical Society. Vol. I. Nos. 2, 3. (New York: 1891, November, December.)

No. 2 opens with an article by Truman H. Safford founded upon three volumes of the "Catalog der Astronomischen Gesellschaft" (vols. iii., iv., xxiv., Leipzig, 1890), in which a sketch of the modes of observation since Bradley's time is given, and the excellence of the plan formulated by Argelander upheld. Prof. M. Merriman discusses the problem in least squares,—"to determine, by the method of least squares, the most probable values of a and b in the formula $y = ax + b$ when the observed values of both y and x are liable to error." An account is then given of a new Italian mathematical journal (*Rivista di Matematica*), edited by G. Peano, the character of which is said to be somewhat similar to that of the *Bulletin.* Reviews follow of a work on the "Photochronograph (Hagen and Fargis, of the Georgetown College Observatory), and of Dr. Craig's "Treatise on Linear Differential Equations, vol. i. (by J. C. Fields). Besides there is a note on "Nomenclature of Mechanics" (our readers are familiar with the discussion raised by Prof. Greenhill, anent the same matter, the equation $W = Mg$). The "Notes" (in both numbers) give information respecting the Society and its doings. One property of numbers, out of many given, we give here—

$$4^5 + 5^5 + 6^5 + 7^5 + 9^5 + 11^5 = 12^5.$$

In No. 3 Dr. Fiske prints a *résumé* of a lecture, before the Society, "On the Doubly Infinite Products," which bristles with references to papers on the subject. Prof. Hathaway then, in a very interesting note on the "Early History of the Potential," sums up, in correction of an error that occurs in Todhunter's "History of the Theories of Attraction" (vol. ii. § 789, 1007, and 1138), "the evidence in favour of assigning to Lagrange" (as against Laplace) "the honour of the introduction of the potential into dynamics." Mr. J. E. Davies contributes a favourable review of Preston's "The Theory of Light."

To each number is appended a long list of new publications. This *Bulletin*, it will be seen, breaks new ground, and presents several points of interest to mathematicians.

Guide to the Examinations in Chemistry. By W. Jerome Harrison, F.G.S. Pp. 56. (London: Blackie and Son.)

THE greater portion of this little book consists of answers to the questions which have been set in elementary inorganic chemistry in the examinations held by the Science and Art Department during the period 1884 to 1891. The rest of the book contains general information regarding the Department and its examinations, and also supplies hints for the successful working of the papers.

The answers are but moderately satisfactory; it may be taken that the author has frequently underrated the difficulty of expressing concisely, and at the same time clearly, the meaning which he wishes to convey. The following extracts may be taken as instances:—

"Gunpowder . . . . depends for its energy upon the suddenness with which the nitre parts with its oxygen."

"The terminations *-ide*, *-ite*, and *-ate* are given to the names of the acid-forming portions of salts."

"Nitrous water [oxide ?] dissolves in water equally, and as a whole. Air dissolves *unequally* in water, the oxygen being more soluble than the nitrogen."

The book is intended to be a companion to Sexton's "Chemistry, Theoretical and Practical."

Manipulation of the Microscope. By Edward Bausch. (New York: Bausch and Lomb Optical Company, 1891.)

THIS little treatise on the microscope, which is now in its second edition, is sure to find favour with workers with this instrument, as it forms a good introduction to books of a more advanced nature. The subject is not treated extensively, but just so far as to enable a beginner to know the whys and the wherefores of the various manipulations.

The first two chapters deal with the simple and compound microscopes, describing their adjustments, &c. Under "Objectives and Eye-pieces," which forms the heading of the next chaper, we find short but good descriptions relating to achromatism, resolving power, flatness of field, magnifying power, &c. In the chapters on "Requisites for Work," "How to Work," and "Advanced Manipulation," the beginner is shown how to set up his instrument, to illuminate the field properly, to use the high-power objectives, and, among other things, receives instruction in the dry and immersion adjustable objectives.

The selection of an instrument is always an important item to be thought of, and the author here gives some good sound advice both about it and the choice of its accessories, and about the care which should be bestowed on it to keep it in the best working condition. The appendix contains some considerations in the testing of objectives.

The work is one which all beginners with the microscope should read, while many a hint might be gathered by an advanced student.

Harrow Birds. By G. E. H. Barrett-Hamilton. (Harrow: Sold for the Harrow School Scientific Society by J. C. Willbee, 1892.)

THIS little volume ought to be of good service to the Harrow School Scientific Society, for whose benefit it has been prepared. The author was a member of Harrow School from 1885 to 1890, and evidently made excellent use of his opportunities for ornithological study. For facts which have not come within his own observation he has had recourse to the best authorities, and various gentlemen, whose names he gives, have contributed notes on the birds observed about Harrow during their school-life. The district covered in the list is contained within a radius of about five miles around Harrow. The list includes 197 species, of which 55 are partially or wholly resident, 27 are regular summer visitors, about 22 appear annually on migration or in winter, and the remaining 94 are visitors of rare or accidental occurrence. The species which breed regularly number 82.

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 Theory of Solutions.

IN NATURE, vol. xlv. p. 293, appears a letter by Prof. Ostwald, in which he replies to a portion of my review of his book on solutions (NATURE, vol. xlv. p. 193).

Prof. Ostwald finds his main cause for objection in my conclusion that he is a supporter of the "physical" as distinguished from the "chemical" theory of solution. To such a statement he objects on the ground that he "cannot at all admit the existence" of a "contrast" between the two theories; and further that he intentionally neither set up nor attempted to answer the question—Is solution a physical or a chemical process?—because he holds it to be "unclear and therefore very harmful." In the rest of the letter he concerns himself mainly with expounding what he prefers to name the "new theory" of solution, and seeks to show that between it and the hydrate theory there is no antagonism or rivalry.

The first point to consider as bearing on the question at issue is the definition of the "new theory" which may be gathered from extracts such as the following:—

"The theory of solutions which I represent and defend consists" "of a certain number of laws, *i.e.* of exact relations between measurable quantities."

"The presentation of laws of solutions, as known up to the present, . . . forms the subject of my book."

But surely it cannot be admitted that a number of exact relationships constitute a theory; for theory is concerned with saying why such relationships should exist, with supplying ideas to connect them together. Now, contrary to the apparent meaning of the last quotation given above, Prof. Ostwald's book contained much of the nature of a true theory. Indeed, the ideas which seemed to determine the general treatment of the subject, and which formed the only justification for the free use made in the book of gaseous laws, were the hypothetical functions ascribed to the solvent and the dissolved substance. The hypothesis here involved, in conformity with what has been the usual custom in this country I termed the "physical theory," and I am at a loss to see how any reasoning based on the definition of the "new theory" affects the use of this term. For the theoretical matter given in the book evidently refers to ideas differing from those involved in the "new theory," which, so far as extracts such as the above go, appears to include nothing whatever of a theoretical nature.

Even in Prof. Ostwald's letter there are, however, indications that in his book he went beyond the mere statement of the laws of solutions. For example, he says: "In my book the question is this one of facts, and although I have therein made more use of *molecular considerations* than I should at present hold to be proper, yet I have done so only to render more clear the actual relations, and never to prove quantitative laws."

Now it was solely the "development of the consequences of facts"—this use, which Prof. Ostwald admits to have been excessive, of "molecular considerations"—which has generally been, and was by me, styled the "physical theory." The facts themselves no one can question; indeed, I took pains to point out in my review that the facts, as given in the book, would alone serve to make it valuable. The theoretical matter, however, called for separate consideration. It alone was, and, so far as I can see, it alone could be, designated the "physical theory."

In denying the contrast between the so-called chemical and physical theories, Prof. Ostwald declares that he never maintained "that no interaction takes place between the solvent and the dissolved substance." If such was his opinion when writing his book, it may be asked, Why in all fairness should he have defined solutions as homogeneous *mixtures?* Why did he not state clearly that interactions between solvent and dissolved substance were possible? It is quite true that, in my review, instances were given of chemical expressions used in the book, but no stress was put upon these by the author as indicating the general occurrence of chemical changes in solutions. They seemed to arise, not because of, but rather in spite of, the author's idea of the nature of solution, and could only be regarded as inconsistencies. The theme of the book was the explanation of the properties even of concentrated solutions by considering the interactions of molecules of the *same* kind, by treating the dissolved substance as if it were gasified. If such a method of treatment were described as "physical," I think the commonly accepted meaning of the word was in no way impaired.

Indeed, much of Prof. Ostwald's book can hardly be justified if interactions of a chemical nature are probable in solutions. For instance, several pages are devoted to the use of van der Waals's equation in dealing with solutions. To anyone familiar with the deduction of this equation, the validity of its application to a solution even when the solvent is regarded as indifferent is highly questionable. If, however, it is admitted that something of the nature of a chemical reaction may occur between solvent and dissolved substance, that the latter may not be in a pseudo-gaseous condition, then the application of the equation can hardly be termed otherwise than meaningless.

In conclusion, I can only express regret if my review has tended to create further misconception on this vexed question of solution. At the same time, I hope I have been able to indicate to Prof. Ostwald the points which led to my use of the terms to which he objects; and I venture to think that in the discrepancies which appear to exist between the ideas as given in his letter, and those which the reader has to gather from his book, is to be found sufficient reason for the use of the statements to which exception has been taken. J. W. RODGER.

London, February 1.

Arrow Poison.

LAST year a French naval surgeon, M. Ledantec, published in the *Annales de l'Institut Pasteur* the result of some investigations he had made into the nature of the arrow poison of the natives of the New Hebrides. Wounds from these arrows give rise, as is well known, to tetanus, and M. Ledantec was able, by the subcutaneous injection of the scraped off poison, to kill guinea-pigs under typical tetanic symptoms. He learnt from a Kanaka that they are prepared by smearing the arrow-heads (which are made of human bone) first with tree gum and then with mud from a swamp, which mud he found to contain numbers of Nicolaier's tetanus bacillus.

As far as I am aware, this has been recorded only of the natives of the New Hebrides and some of the neighbouring groups (the arrow poison of Stanley's dwarfs is certainly *not* the same), and I was therefore much interested some days ago by coming accidentally upon an old record which seems to show that the natives of the Cape Verd coast were accustomed, more than three hundred years ago, to get rid of their enemies in a similar manner. In Hakluyt's "Voyager's Tales," published in 1589 (I refer to the little reprint edited in 1889 by Henry Morley), is the narrative of one Miles Phillips, in which occurs the following passage:—"Upon the 18th day of the same month (November 1567) we came to an anchor upon the coast of Africa at Cape Verde, in twelve fathoms of water, and here our General landed certain of our men, to the number of 160 or thereabouts, seeking to take some negroes. And they, going up into the country for the space of six miles, were encountered with a great number of negroes, who with their envenomed arrows did hurt a great number of our men, so that they were enforced to retire to the ships, in which contest they recovered but a few negroes; and of these our men which were hurt with their envenomed arrows, there died to the number of seven or eight in a very strange manner, with their mouths shut, so that we were forced to put sticks and other things into their mouths to keep them open." In the language of modern medicine, they succumbed to tetanus traumaticus. The voyagers left the coast soon after, and there is no further mention of the natives or of the wounded.

There is, of course, no proof that the arrows were poisoned with mud or earth, but the probability is considerable. The chief interest lies in the age of the record, which forms in some manner a pendent to the researches of M. Bossano (*Comptes rendus*, 1888), which showed the tetanus bacillus to have a very wide distribution in space.

It is a curious consideration that this and the other famous arrow poison, curare, both kill by their action on the voluntary muscles, the action of one being diametrically opposed to that of the other. A. COPPEN JONES.

Davos Platz, Switzerland, January 30.

The Implications of Science.

HITHERTO prevented from again writing, I cannot now remain passive and allow Mr. Dixon to escape from his irrational position under cover of a cloud of verbiage—like a cuttle-fish through water made turbid by its ink.

In my lecture I pointed out that certain truths are implied in all physical science. They *are* so implied. If Mr. Dixon thinks they are not, it is for him to show how experimental science could be carried on, with any real, serious doubt about them. This he has certainly not yet done.

Our knowledge of our own existence "in the present," is knowledge of a particular concrete fact, not of an abstract necessary truth. That "whatever feels, simultaneously exists," *is* such a "necessary truth," but it is an abuse of language to apply that term to anything which may cease to exist the moment after its existence is recognized.

That "nothing can simultaneously be existent and non-existent," does not at all depend upon "terms" or "definitions," but is a law of "things." It would not lose its validity and objective truth, not only if there were no such things as "terms" and "definitions"; it would not lose it if the whole human race came to an end.

I am glad to find my critic does "not doubt" that if he lost an eye his condition would thereby be modified, but if he does not also see that this applies and must apply everywhere and everywhen, I do not envy him his power of mental vision.

Oriental Club, February 2. ST. GEORGE MIVART.

The New Forest in Danger.

IN connection with my letter which appeared in NATURE of the 28th ult. (p. 295), it may interest some of your readers to know that the petitions, to which I referred, in support of the Bill for excepting the New Forest from the operation of the Ranges Act, 1891, have already been signed by Lord Walsingham, F.R.S. Prof. C. Stewart (President of the Linnean Society), Sir Joseph D. Hooker, F.R.S., Dr. P. L. Sclater, F.R.S., Mr. Osbert Salvin, F.R.S., Dr. A. Günther, F.R.S., Dr. H. Woodward, F.R.S., Mr. W. Carruthers, F.R.S., Dr. D. Sharp, F.R.S., Mr. Thiselton-Dyer, C.M.G., F.R.S., Mr. H. W. Bates, F.R.S., Mr. F. DuCane-Godman, F.R.S., Dr. G. Buchanan, F.R.S., Dr. B. Richardson, F.R.S., Prof. J. O. Westwood (Professor of Zoology, Oxford), Dr. Thorne-Thorne, F.R.S., Mr. J. G. Baker, F.R.S., Mr. W. H. Preece, F.R.S., Mr. Botting Hemsley, F.R.S., Mr. E. B. Poulton, F.R.S., Mr. R. McLachlan, F.R.S., Mr. C. B. Clarke, F.R.S., Major-General Carden, Prof. Jeffrey Bell (Secretary of the Microscopical

Society), Dr. Franklin Parsons, Mr. Daydon Jackson (Secretary of the Linnean Society), Mr. J. E. Harting, Dr. Bowdler Sharpe, Mr. J. Britten, Mr. E. Saunders, Colonel Swinhoe, Mr. A. W. Bennett (Vice-President of the Linnean Society), Mr. Percy Sladen (Secretary of the Linnean Society), Mr. D. Morris, Mr. Miller-Christy, and by a large number of other Fellows of the Linnean, Geological, Zoological, and Entomological Societies of London; and by the editors of the *Geological Magazine*, the *Journal of Botany*, the *Zoologist*, the *Entomologists' Monthly Magazine*, and the *Entomologist*. HERBERT GOSS.

Linnean Society, Burlington House, W., February 6.

ON THE NEW STAR IN AURIGA.

WE were enabled last week to make an announcement of the discovery of a new star in the constellation Auriga, as we received on Wednesday the Edinburgh Circular giving an account of the manner in which the first information had been received. A telegram was sent by Dr. Copeland to the Astronomer-Royal on the date of the reception of the post card—Monday, February 1—and, as we have since learnt from the *Astronomische Nachrichten*, a telegram was also sent by Dr. Copeland and the Astronomer-Royal to Kiel. Unfortunately there is at present in England no local system for the distribution of astronomical intelligence of this character, so that it will probably be found that the fine night of Monday was only devoted to observations of the new star in a very restricted number of Observatories. The necessity for correcting this state of things has been pointed out by Mr. Lockyer in the *Times* of Friday, and it is to be hoped that some steps may be taken to rectify the defect. As it turns out, however, no very great harm has been done, for the new star, instead of degrading its light rapidly from the day of its discovery on February 1, seems if anything to have brightened, so that the changes in its light between Monday and Wednesday were probably not so great as those observed in Nova Cygni during the first two or three days of its visibility.

A telegram from Prof. Pickering communicated by the Astronomer-Royal to the *Times* of Monday seems to show that the star, instead of bursting forth suddenly about the date when the anonymous post-card was sent to Dr. Copeland, has really been visible since last December, perhaps even for a longer time; but in any case it has not been registered in any recognized Catalogue. Prof. Pickering states that he finds this star visible on three plates belonging to the series of the Draper photographs at different dates during the month of December. The telegram through the "Centralstelle für Astronomische Telegramme," Kiel, runs as follows:—"Copeland's Nova bright on photograph December 10, faint December 1; *maximum* December 20; spectrum unique.—PICKERING." It would thus appear that Prof. Pickering had photographed the new star on the three dates named in the course of the photographic mapping of stars and their spectra which he is carrying out at Harvard College Observatory. We do not yet know whether the plates were examined at the date on which they were taken, or whether the telegrams relating to the appearance of the Nova may have caused an examination to be made, but the spectrum was visible on all three plates.

As we stated last week, the observations in England commenced on Monday night at Edinburgh, on which date Dr. Copeland saw bright lines, and at the Royal Observatory on the same evening, when the new photographic 13-inch refractor was used for determining the exact position of the star. With this fine instrument the Astronomer-Royal was able to detect that the star differed from the other stars on the plate in appearance.

As to the work on Tuesday night, at present we know nothing. An announcement of the discovery appeared in the *Times* of Wednesday, on which date also, as we have already stated, Dr. Copeland's Edinburgh Circular was received in London. On that night, therefore, which happened to be fine, observations were commenced at South Kensington, and two photographs were obtained, together with some eye-observations, which were communicated to the Royal Society by Mr. Norman Lockyer on the next day in a preliminary note, from which we make the following extracts:—

"Last night was fortunately fine, and two photographs were taken of the spectrum—the first exposed from 7.30 to 9, or for 1h. 30m.; the second exposed from 9.30 to 12.30, or for 3h. 0m. The first registered 13 lines; the second appears to contain some additional ones, but they are very faint, and have not yet been measured.

"A complete discussion of these photographs will form the substance of a subsequent communication, but already the following approximations to the wave-lengths have been obtained, the photographs being treated absolutely independently, means, however, being taken for the four least refrangible lines, as there has not yet been time to construct a proper curve for this region:—

Lines measured in the first photograph.			Lines measured in the second photograph.		
Wave-length.	Hydrogen lines.	Probable origin.	Wave-length.	Hydrogen lines.	Probable origin.
3933 K		Ca	3933 K		Ca
3968	H		3968	H	
4101	*h*		4101	*h*	
4128			4130		
4172			4172		
4226		Ca	4227		Ca
4268			4268		
4312		Hydro-carbon	4310		Hydro-carbon
4340	G		4340	G	
4516			4516		
4552			4552		
4587			4587		
4618			4618		

"I have recently taken up the question of stellar spectra, and find that a 6-inch object-glass with a prism in front of it is all that is required for the brighter stars. This instrument was employed upon the Nova, which is of about the fifth magnitude, so the exposures were necessarily long.

"For the eye-observations, the new 3-foot mirror which has recently been presented to the Astro-Physical Laboratory by Mr. Common was employed, but unfortunately the clock is not yet mounted, so that the observations were very difficult.

"C was the brightest line observed. In the green there were several lines, the brightest of which was in all probability F, the position being estimated by comparison with the flame of a wax taper. Another line was coincident—with the dispersion employed—with the radiation at wave-length 500 from burning magnesium wire. A fainter line between the two last-named was probably near λ 495, thus completing the trio of lines which is characteristic of the spectra of nebulæ. There was also a fairly bright line or band coincident with the edge of the carbon fluting at λ 517 given by the flame of the taper. A feeble line in the yellow was coincident under the conditions employed with the sodium line at D.

"The hydrogen line at G was distinctly seen, as well as a band, or group of lines, between G and F.

"Nearly all the lines appear to be approximately, if not actually, coincident with lines seen in the various types of Cygnus stars, the chief difference being the apparent existence of carbon, hydrocarbon, and calcium in the Nova.

"The colour was estimated by Mr. Fowler as reddish-yellow, and by Mr. Baxandall as rather purplish. My own impression was that the star was reddish, with a purple tinge. This was in the 10-inch achromatic. In the 3-foot reflector it was certainly less red than many star of Group II. No nebulosity was observed either in the 3-foot or the 10-inch refractor, nor does any appear in a photograph of the region taken by a 3½-inch Dallmeyer lens with three hours' exposure. It should be stated that the camera was carried by the photographic telescope, the clock of which had had its normal rate purposely changed to give breadth to the spectrum.

"The photographs were taken and reduced by Messrs. Fowler and Baxandall. The eye-observations and comparisons were made by Mr. Fowler."

The nights of Thursday, Friday, and Saturday were hopelessly bad, but on Sunday night the weather cleared, and more photographs were taken at South Kensington, an account of which, we believe, has been communicated to the Royal Society. Observations of the Nova are therefore well in hand, and there is no doubt that a comparison of the photographic plates obtained in December and February will provide us with much minute information regarding the behaviour of our new visitor.

The remark in Mr. Lockyer's communication to the Royal Society, that the spectrum of the star contained nearly all the lines visible in the stars in Cygnus, is one of considerable interest and importance, because, if it be confirmed by subsequent observations, it will show that these stars in Cygnus cannot be stars in the true sense—that is, bodies like our sun. This seems pretty evident from the fact that their spectroscopic phenomena can be reproduced by another body which suddenly appears, and probably will rapidly become invisible. The idea that any of these bodies are "worlds on fire," as was once thought, need now no longer be discussed.

MR. TESLA'S LECTURES ON ALTERNATE CURRENTS OF HIGH POTENTIAL AND FREQUENCY.

IT is not often that the outward and visible signs of a great scientific success are so prominent as they were last week at the Royal Institution. The reports which have reached this country of the work of Mr. Nikola Tesla have made his name known to those who are watching or aiding the progress of electrical science. He was recently invited by the Institute of Electrical Engineers to lecture before it, and the interest which his coming excited spread in widening circles as the day on which he was to exhibit his experiments drew near.

It was evident that the ordinary meeting-room of the Institute would be too small, and the Managers of the Royal Institution placed their theatre at its disposal. Members of the Royal Institution, were, however, anxious to hear and see for themselves; and finally Mr. Tesla consented to lecture on two consecutive nights to the Institute and the Institution respectively.

On both occasions the room was full; on the first it was overflowing. Gathered round the lecture table was a crowd of those whose business it is, either as theorists or as practical men, to keep abreast of the wave of scientific advance; but as the youthful lecturer—who looks even younger than his years—with a modesty and charm of manner which were altogether irresistible, showed wonder after wonder, the interest of this critical audience deepened into enthusiasm. The speaker's broken English and imperfect explanations did not detract from his success. His marvellous skill as an experimentalist was evident and unmistakable, and his hearers left the room convinced, not only that another step forward has been taken, but also that in Mr. Tesla we have a scientific explorer, who, if health and life be granted him, will travel fast and far.

Briefly, Mr. Tesla has done much to attain the continuous stream of electrical oscillations which Prof. Fitzgerald, at a recent meeting of the Physical Society, compared to a continuous whistle. The oscillations which Hertz studied die out almost instantaneously. Could they be maintained, a practically new weapon would be placed in our hands. Tesla does not, indeed, maintain them, but he renews them many times per second, and the results are marvellous.

Though the potential is enormous, the electrode of the apparatus can be safely handled. If a person in conducting communication with it touches a vacuum bulb or tube it glows, and if the tube is brought near to others it sets them a-glowing too. No return is needed, the current is completed through surrounding space. The phosphorescent materials in some of the beautiful tubes lent by Mr. Crookes shone brightly when one electrode only was connected with the coil. If the terminal is surrounded by an aluminium tube, the glow is notably increased. The experiment of making a vacuum-tube luminous by simply holding it in an oscillating field was successfully performed, and the lecturer himself received with impunity a crackling discharge, some six or eight inches in length, by holding his hand at that distance from the terminal of his coil.

All these things are not merely wonders. Mr. Tesla is working with an object. He is one of those who hold that a phosphorescent glow is the light of the future. He hints at artificial auroræ spreading from the summits of towers of hitherto undreamt-of height, and he has at all events got as far as producing in air at atmospheric pressure a glowing plane bounded by two rings about a foot and thirty inches in diameter respectively. Whether his visions will all be realized may be doubtful. There is is no doubt that they are guiding him aright. As Lord Rayleigh said in moving the vote of thanks, a door has been opened into a new region of inquiry, into which Mr. Crookes and Mr. Tesla have entered almost alone.

Those who some fifteen months ago heard Prof. Hertz acknowledge in terms of genuine emotion that he had built upon a foundation laid by Englishmen, that Englishmen had first recognized the importance of his work, and that from England its first reward had come, must have listened with pleasure when the part that this country has taken in the development of electrical science was referred to in a like appreciative tone by Mr. Tesla. It is not indeed that the achievements of our great electricians are bettered or rendered more important by acknowledgment, but it is pleasant to note how cosmopolitan science is becoming, and that among scientific workers the feeling of fellowship is overcoming that of rivalry. For the rest we can only congratulate Mr. Tesla alike upon his work and his reception, and the scientific world on the exhibition of a number of beautiful experiments which will afford food for useful reflection to theorist and experimenter alike.

A. W. R.

The announcement of Mr. Nikola Tesla's lecture to the Institution of Electrical Engineers excited widespread interest among all in the least degree interested in electrical science. The succession of almost marvellous experiments in which in great measure it consisted must have gone far beyond the anticipations of the most sanguine of those of the audience who had had no previous account of the nature and results of his work. It is not too much to say that the Royal Institution lectures mark a distinct epoch in the progress of theoretical and applied electricity. While, on the one hand, the experiments which the lecturer showed seemed to point to a possible revolution of our methods of electric lighting, on the other hand they must have suggested, if not for the first time, in a new and forcible way, important questions of electrical theory, and the physiological effects of rapidly alternating currents. That he should have been able unharmed to place himself in the space between two tinfoil plates connected to the terminals of his rapidly alternating machine, was to the ordinary observer in itself sufficiently startling; but that he should have been able to present a piece of iron to one of the poles of the machine, drawing a spark of several inches in length with impunity, and thereby to interpose his body as a connecting link between the machine and a long vacuum tube which glowed like a flaming sword, must have appeared to many of those most conversant with electrical phenomena truly astonishing.

Hitherto, alternating machines of great frequency and high potential have been deemed peculiarly dangerous, and not without reason. But it did not follow, of course, that with a sufficient increase of the frequency of alternation, the danger might not completely disappear. It will be of great importance to inquire in what way the immunity of the experimenter from injury is brought about. Are impulses of 20,000 reversals per second and upwards without serious effect on the nervous system of the human body, so that conduction takes place through it without any disagreeable consequences? or is the conduction effected without the nervous system being concerned at all?

The delicate network of nerves in the eye is sensitive to a certain range of frequency of electrical vibrations, and perfectly insensitive to vibrations which lie outside that range in frequency. In the same way the insensitiveness of the general nerve-system of the human body interposed between a glowing vacuum tube and the terminal of a rapidly alternating machine or transformer may begin and end at much lower limits. There is also, of course, the interesting question of the distribution of these rapidly alternating currents in the somewhat complicated conductor formed by the human body, which may have a great deal to do with the result.

It ought to be recalled here that Prof. J. J. Thomson has been working in the same field, and has obtained somewhat similar results. These were made the subject of a very interesting demonstration to the members of the Physical Society on the occasion of their visit to Cambridge in May of last year. For a long time Prof. Thomson has investigated this subject both theoretically and experimentally, and his researches have thrown much light on the *rationale* of the very striking results obtained by Mr. Tesla and himself in their closely allied but independently carried out series of experiments.

The admirable experiments of Mr. Tesla are only another instance of the way in which practical applications of science promote its progress, by enabling apparatus to be constructed on an engineering scale, and with all the security for effective action which the constructive art of the engineer furnishes so well. His simple alternating machine, running with very little clearance at a speed of about 2000 revolutions per minute, is itself a triumph of skill in design and construction, and well illustrates how desirable and even necessary it is to take advantage of all the aids to exactness, and they are many, which can be obtained from the refined machine tools and truth of design which characterize the engineering workshop of to-day. The ordinary optician of twenty years ago, with his imperfect lathes, and general utter want of power-driven appliances, his continual hand-fitting and shaping, and the absolute non-interchangeability of the parts of his instruments, has almost passed away; and even the physical laboratory has become in great measure an engineering workshop, in which are to be found Whitworth lathes and end-measuring machines adapted for the most exact work.

One point in this connection is worthy of notice. Mr. Tesla insists strongly on the essentially electrostatic nature of the phenomena illustrated by his lectures; while, on the other hand, *one* object aimed at in Prof. Thomson's experiments was to show that in a tube without electrodes luminosity could be produced by electrodynamic action alone—that is to say, in a field of electric force which is not electrostatic in the sense of admitting of the derivation of its intensity at each point from a potential function.

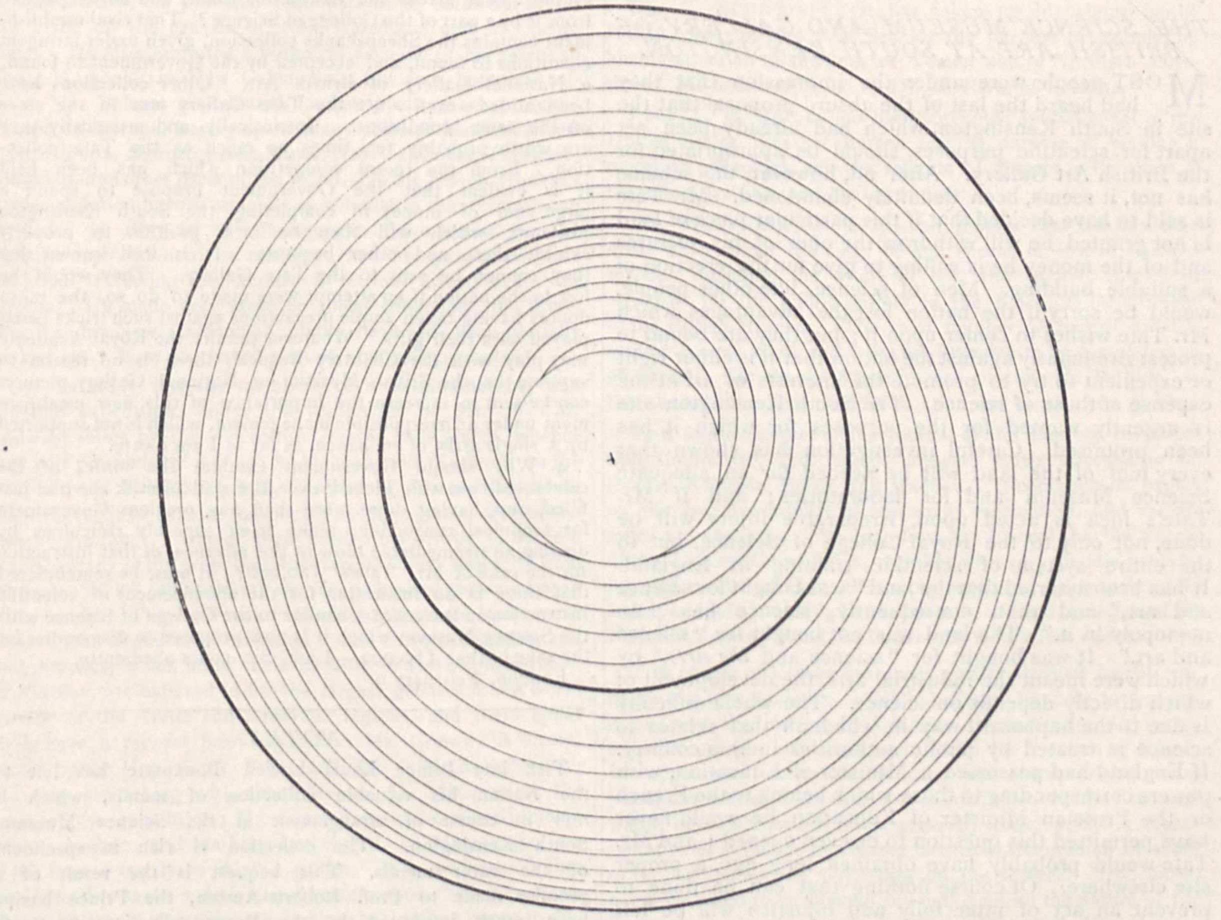
The changes produced in the distribution of electricity on neighbouring conductors will cause glow in a vacuum tube when a Holtz machine or Leyden jar is discharged; and this will in general be more or less operative. But it is not in general possible to separate the electromotive forces due to this cause from those due to electromagnetic action. Prof. Thomson has succeeded in some cases in screening off these electrostatic effects, and in producing a glow discharge in which electrostatic action could have little or no share.

The glow or flame discharges from the terminals of his induction coils, the glow discharge from the long wires stretched from the induction coil towards the roof of the hall, the glowing vacuous bulbs and phosphorescent tubes placed in the field between the parallel tin-foil plates attached to the transformer terminals are all phenomena of the highest importance; though, of course, they are only exceedingly striking and effective illustrations of experimental results already arrived at by the lecturer himself and others, and communicated in a more or less complete manner to the electrical world. The application of these, which Mr. Tesla suggests as a possible one in the future, would bring about an ideal form of electric lighting, which would transcend in luxury and convenience our present system of electric lighting by incandescent lamps as far as the latter transcends the oil lamps and tallow dips used by our near ancestors. Every drawing-room would become an electric field in a continual state of rapidly alternating stress, in which the occupants would live, experiencing no unpleasant effects whatever, while vacuous bulbs or phosphorescent globes and tubes, without care or attention, would shed a soft diffused light, of colour and intensity arranged to suit the most luxurious fancy. It would be interesting also to know whether, after all, habitual dwelling in a region of electric stress rapidly changed from one extreme of high intensity to the opposite, produced very slow physiological effects which could be traced in the improved health and longevity of the persons so dwelling, or the reverse. If such applications are made (and there does not seem to be any sufficient reason why they should not come to pass), the magnificent researches of Mr Crookes, as well as those of other investigators to whom the lecturer justly and generously acknowledged his indebtedness, will bear some practical fruit in an almost totally unexpected manner, by becoming at once available in connection with a new and beautiful development of what is at present the most progressive of the physical sciences.

It does seem that we are on the point of farther great advance into the undiscovered domain of electrical science, and it is significant that it is likely to lie along one of the routes made clearer to us by the discovery and verification of the great theory of electrical radiation. Who knows what further discoveries may be obtained before the present century has come to an end? We are advancing so rapidly that no one can declare that the record of discovery of the nineteenth century has nearly closed. One important means of further investigating electrical radiation will be that which Prof. Fitzgerald made an attempt to find—a means of maintaining for any required length of time electrical vibrations of sufficiently high frequency. Mr. Tesla's results seem to promise that this problem may perhaps be solved before very long, and many outstanding questions of the electromagnetic theory of light thereby set at rest. In many other ways his researches are certain to promote scientific discovery. To quote his own words: "The field is wide and completely unexplored, and at every step a new truth is gleaned, a novel fact observed." G.

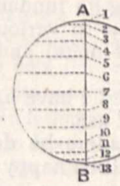
WAVE-MOTION MODEL.

AS a teacher of Physics I have always experienced considerable difficulty in giving to elementary students of Sound a clear conception of the motion of the air in organ-pipes when sounding. In Weinhold's "Physics" a method is shown in which a series of sinuous lines, drawn on a sheet of paper, exhibit this motion when drawn across a narrow slit, but the difficulty attending the drawing of these lines has, I imagine, precluded its general adoption for class purposes. It struck me that it ought to be possible to draw a series of eccentric circles upon a disk in such a way that, when rotated, the motion of the intercepted lines, as seen through a narrow radial slit, should correctly represent this motion. This, of course, is done for *progressive* waves by Crova's disk. After spending some thought upon the matter I succeeded in producing such a disk, a copy of which I inclose. It has given such satisfaction that I have been advised by several scientific friends to send a description of the method to you for publication, for the benefit of teachers and students generally.



In the following description I have given the dimensions which I myself employ in describing these disks, but they can of course be varied at will:—

A piece of stout cardboard should be taken about a foot square. A line AB, $\frac{3}{4}$ inch in length should then be drawn near the centre and a circle described about it, half of which should then be divided as shown into 12



equal parts. Perpendiculars should then be dropped upon the line AB, which is thus divided in harmonical progression in the points 1, 2, 3 . . . . 13. With the points 1, 2, 3 . . . . 13, 12, 11, 10, 9, 8, 7 successively as centres, a series of circles should then be drawn beginning with a radius of $1\frac{1}{4}$ inch, and increasing it each time by $\frac{3}{16}$ inch. The last circle therefore, described with the point 7 as centre, has a radius of $4\frac{5}{8}$ inch. The two circles described with the point 7 as centre, since they represent nodes, should be drawn rather thicker than the others to distinguish them.

The disk is now complete. It should be cut circular in shape and mounted to rotate upon a pin struck through the point 7. If it now be examined by means of a narrow radial slit extending across the marked portion of the disk, the short lines intercepted will, by their pendulum-like motions, represent the motion of the air particles in a closed organ pipe giving its first overtone. When the slit is shortened so as to show only the portion of the disk between the two nodal lines, the vibration of a rod clamped at both ends will be represented; whilst the outer half of the latter length of slit will represent similarly a closed organ pipe giving its fundamental note. In this way by restricting the slit to various parts of the disk, various vibrating rods of metal and organ-pipes can be represented.

The disks thus produced I have had very satisfactorily lithographed for students' use.

Should any of your readers be desirous of obtaining further information I shall be happy to oblige them.

F. CHESHIRE.

P.S.—In the drawing of the disk given the centre has been filled up by broken circles. As thus drawn the inner circle may with advantage be blackened over.

THE SCIENCE MUSEUM AND GALLERY OF BRITISH ART AT SOUTH KENSINGTON.

MOST people were under the impression that they had heard the last of the absurd proposal that the site in South Kensington, which had already been set apart for scientific purposes, should be appropriated for the British Art Gallery. After all, however, the scheme has not, it seems, been definitely abandoned. Mr. Tate is said to have decided that if this particular piece of land is not granted he will withdraw the offer of his pictures and of the money he is willing to give for the erection of a suitable building. Men of science, like other people, would be sorry if the nation lost the advantages which Mr. Tate wishes to confer upon it; but they are bound to protest strenuously against the notion that it is either right or expedient to try to promote the interests of art at the expense of those of science. The South Kensington site is urgently wanted for the purposes for which it has been promised. Careful investigation has shown that every foot of the land will be needed for an adequate Science Museum and for laboratories; and if Mr. Tate's idea is acted upon, irreparable injury will be done, not only to the Royal College of Science, but to the entire system of scientific training in England. It has been asserted that the land "was bought for science and art," and that, consequently, science has "no monopoly in it." The land was not bought for "science and art." It was bought for "science and *the arts*," by which were meant the industrial arts, the development of which directly depends on science. The whole difficulty is due to the haphazard way in which all that relates to science is treated by public authorities in this country. If England had possessed a Minister of Education, with powers corresponding to those which belong to the French or the Prussian Minister of Education, he would never have permitted this question to be even opened; and Mr. Tate would probably have obtained long ago a proper site elsewhere. Of course nothing that can be done to prevent an act of utter folly and injustice will be left undone in Parliament by the scientific members.

The following letter on the subject appeared in the *Pall Mall Gazette* on Wednesday, February 10:—

SIR,—Before Parliament and the public agree to the somewhat exacting terms which Mr. Tate appears to make a condition of his munificent donation, I would beg your leave to submit the following questions for their consideration:—

1. Why should he not be satisfied with the plot of ground, somewhat higher up the Exhibition Road, which is much larger than his contribution of £80,000 will cover with a decently-constructed building? The situation of that plot is in every respect better than the one he covets. It is adjacent to the East and West Galleries, which are already connected by a cross gallery. These galleries are, in the opinion of the most eminent artists in the country, the best galleries for the exhibition of pictures yet constructed in England, and in them the overflow from Mr. Tate's gallery might in future time find a home.

2. Why should the site which he asks for be cleared of the Physical Laboratory and other portions of the College of Science already housed on it to interpolate an English Luxembourg between two portions of the Science School and Science Museum, relegating the latter to the aforesaid admirable picture galleries, which then for all time can never be annexed to the Tate Gallery, or even put in connection with it? Why, in fact, should the science instruction of the country be sacrificed to this collection of pictures, which is not of sufficient value to be accepted by the National Gallery? We hear a good deal of the French Luxembourg, but would any munificent donor of modern French pictures be allowed to have a slice out of the middle of the École Polytechnique, or of the École Centrale, or of the Conservatoire des Arts et Métiers, if, peradventure, that was the Naboth's vineyard which his heart craved for?

3. Why should the Government or the public suppose that if Mr. Tate's collection of pictures were inserted like a seton into the tissue of the College of Science it would have the effect of drawing a shower of gifts and bequests away from the rival establishment across the Exhibition Road, and only separated from it by a part of the College of Science? That rival establishment contains the Sheepshanks collection, given under stringent conditions to found, and accepted by the Government to found, a National Gallery of British Art. Other collections have been added—even since the Tate Gallery was in the air—on the same conditions. Intrinsically and artistically they are worth probably ten times as much as the Tate collection. From the recent competition which has been held it is evident that the Government propose to spend a large sum of money in completing the South Kensington Museum, which will then be in a position to properly exhibit these and other bequests. It is well known that they cannot be sent to the Tate Gallery. They would be lost to the nation if an attempt were made to do so, the pious donors having taken ample precautions against such tricks being played with their gifts. Whatever pranks the Royal Academy may play with the Chantrey Bequest, there is no reason to suppose that the British Museum or National Gallery pictures can be sent to increase the importance of this new establishment under an irresponsible management, which is not supported by a single artist of eminence, as far as I am aware.

4. Why should Government emulate the antics of the celebrated cow who kicked over the pail of milk she had just filled, and, having done more than any previous Government for technical instruction, make itself superbly ridiculous by dealing an irremediable blow to the advance of that instruction for the sake of Mr. Tate's £80,000? It must be remembered that there is no institution for the advancement of scientific instruction in the country similar to the College of Science with the Science Museum which it is now proposed to dismember for the sake of that £80,000.—I am, Sir, yours obediently,

London, February 9. Y.

NOTES.

THE late Prince Louis Lucien Bonaparte has left to the Nation his valuable collection of metals, which is now in course of arrangement at the Science Museum, South Kensington. The collection is rich in specimens of the rarer metals. This bequest is the result of a promise made to Prof. Roberts-Austen, the Prince having been much interested in the Percy collection at South Kensington. The Prince's early papers, which were mainly chemical, comprised an account of a method of separating cerium from didymium; and he used to refer with pride to his having won admission to the ranks of the Legion of Honour by chemical research.

IN order to afford increased and improved accommodation for the departments of physics and mechanical and electrical engineering, the Council of University College, London, have decided to enter without delay upon a considerable extension of the College buildings. The addition to the College will form an important block opposite the east end of University Street, with an extension for some distance along the Gower Street front of the College grounds. It is to contain separate laboratories and lecture-rooms for mechanical engineering and electrical engineering, with rooms for engineering drawing, a dynamo-room, and all else that is required for an efficient school of modern engineering. This extension will enable the basement and ground-floor of the central wing of the main building, together with a new building to be erected in the inner court, to be devoted to the department of physics, which has hitherto been very imperfectly provided for in rooms that were originally intended for quite other purposes than those to which they have been applied. The position of the new physical laboratory is such that it will be as far removed as is easily possible, in the heart of London, from heavy street traffic.

THE death of the well-known botanical collector, B. Balansa, is recorded in the French journals. He died in the military hospital of Hanoi, Tongking, to which country he went on a second botanical expedition. Balansa was not merely a collector of plants; he was also a botanist, though he never published much, his principal contributions to botanical literature being on the grasses of New Caledonia and of Cochin China. He also published a botanical account of his ascent of Mount Humboldt in New Caledonia. But as a botanical collector, Mr. Balansa contributed to nearly all of the principal herbaria of Europe, having spent many years of his life collecting in Algeria, Morocco, Asia Minor, New Caledonia, Paraguay, Tongking, and other parts of the world. On Sir Joseph Hooker's recommendation he was attached as botanist to the Commission appointed in 1873 by the Paraguayan Government for the scientific exploration of its territory; and he spent three years and a half traversing the country in various directions for this purpose. He made very large botanical collections, but these, as well as his New Caledonian plants, have only been partially worked out. Kew purchased a set of about 2000 species.

ON Saturday last the members of a mountaineering and scientific expedition, under the leadership of Mr. W. M. Conway, sailed by the steamship *Ocampo* for Karachi, whence they will proceed, by way of Abbotabad and Kashmir, to the mountains of Baltistan, on the frontier of Eastern Turkistan. Their object is to explore thoroughly the high glacial area of the Karakoram range. One of their chief aims will be to make a special survey of the great Baltoro glacier, which descends from the peak "K 2" (28,265 feet), the second highest measured peak in the world. They will make scientific collections, and record observations of glacial phenomena. The Baltoro, Punmar, and Biafo glaciers, which unite their streams in the neighbourhood of Askoley, are believed to be the largest glaciers in the world outside of the Arctic and Antarctic regions, and their upper levels have never yet been explored. Mr. Conway is accompanied by the Hon. C. G. Bruce and Mr. J. H. Roundebush; and they are taking with them Mr. A. D. McCormick, the artist of the expedition; Mr. Oscar Eckenstein, a well-known Alpine climber; and Mathias Lurbriggen, of Macugnaga, one of the famous family of Alpine guides. It is understood that they intend to make a determined assault upon "K 2," or one of the loftiest of the neighbouring peaks, with a view to discovering whether the limit to which qualified mountaineers can climb has yet been attained. The expedition, it may be mentioned, has been subsidized both by the Royal Society and by the Royal Geographical Society.

A CRIMEAN Alpine Club has been formed at Odessa. The objects of the members are to explore the mountains of the Crimea, to publish scientific papers on phenomena connected with them, to protect rare species of plants and animals, to favour the development of agriculture, horticulture, and small local industries among the mountaineers, and to provide facilities for tourists, artists, and men of science who may desire to visit the region.

THE 1892 Photographic Conference will be held at the Society of Arts on Tuesday and Wednesday, March 22 and 23, under the presidency of Captain W. de W. Abney, F.R.S.

LAST week we mentioned the case of the miner Johann Latus, of Myslovitz, in Silesia, who had been asleep for over four months. The latest news about him is that he has partly recovered, and the cataleptic rigidity of the limbs, which was characteristic of his somnolent condition, has disappeared. It is curious to note that, although he has conversed with his wife, he seems quite unaware of the long stay he has made in the hospital. No feeling of pain of any sort has been experienced by him, and in fact he cannot recall any sensation during this long period. Dr. Albers, who is attending to him, hopes that he will soon completely recover. Unfortunately Latus has been threatened with inflammation of the lungs, which, view of his present weak state, might be fatal to him. He still continues to take only milk diet, having refused both meat and wine.

DR. G. SCHWEINFURTH has taken up his abode in the Italian colony on the Red Sea for the purpose of completing his investigation of the flora of Yemen and of Northern Abyssinia. He is accompanied by Dr. D. Riva, of Bologna.

PROF. L. H. BAILEY has been appointed special agent of the United States Weather Bureau for the purpose of making a report on phenology, and the relation of climate to the times of blooming, fruiting, and leafing of plants.

MR. WORTHINGTON G. SMITH reports that he has now made water-colour drawings of 492 species of British *Basidiomycetes*, including the whole of the white-spored species of *Agaricus*, for the public gallery in the Botanical Department of the British Museum. The total number of British *Basidiomycetes* is over 2000, and these are intended to be completed on 96 sheets. Closely-allied species are placed side by side, so that the salient points of differentiation can be seen at a glance.

THE fourth number of the Journal of the Leprosy Investigation Committee, just issued, presents much information on leprosy in Russia, Brazil, and Madeira. It contains also papers on the communicability of leprosy by vaccination, and various notes and abstracts. We learn from the Journal that the Report of the Leprosy Commission, together with an appendix containing the results of their laboratory work, is being printed in India, and will probably be ready for issue from the office of the National Leprosy Fund, in London, in a very few weeks.

THE people of Vienna have been greatly alarmed by the outbreak of a new epidemic, which is believed by some to be connected with the influenza. It affects the intestines, its symptoms being fever and acute colic, with the ejection of blood. Its appearance seems to indicate the absorption of some poisonous matter. At first it was attributed to the drinking-water, but this view has been generally abandoned. A representative of a Vienna newspaper has taken the opinion of some of the leading Vienna physicians on the subject. Prof. Nothnagel hesitated to pronounce any judgment on the nature of the illness, the facts not having been sufficiently studied. Prof. Drasche thought it might be "nothing else than a distinct form of influenza," and was confident that it was not due to the drinking-water. Prof. Oser was also sure that the drinking-water had nothing to do with the disease, and "did not consider that there was any indisputable evidence of its connection with influenza." Dr. Bettelheim seemed to think that there was something in common between influenza and the new malady called "catarrh of the intestines." He based his opinion on the fact that from the day when the latter made its appearance in an epidemic form cases of ordinary influenza had begun to decrease. He looked upon them both as being of an infectious nature. A chemical analyst, Dr. Jolles, said it would require three weeks to make a bacteriological inquiry into the character of the illness. A chemical analysis of the drinking-water showed it to be of normal purity.

AN appeal on behalf of the Polytechnic (Regent Street) Institute has been issued this week by Lord Reay, Lord Compton, Mr. Mundella, Sir Lyon Playfair, Dr. Gladstone, and other gentlemen, who have lately been appointed on the governing body. They have found the following condition of affairs:—Mr. Quintin Hogg has himself up to the present time paid all the deficiencies of the Institute, besides finding very large sums for constantly building and adding to the premises, amounting to in all about £150,000. Over £23,000 is contributed annually in fees, subscriptions, &c., by those who make use of the Institute, and £3500 is allowed by the City Charities Fund, but there still remains to be met a yearly deficit of £4000. The only way in which the governing body could curtail expense would be to close the Young Women's Institute and the large and numerously attended Art School. They are, of course, extremely reluctant to take this step; so they ask those who value the work done by the Polytechnic to provide a sum of £4000 per annum for three years. By that time, they trust, aid for technical education may be forthcoming from the London County Council. A donation of £500 for this year's expenses has been promised by Mr. J. Carnegie, and it may be hoped that the governing body will have the satisfaction of being able to meet the difficulty. As they point out, more students are now receiving technical education at the Polytechnic than were being so instructed in the whole of London before the institution was started; and there is not the slightest exaggeration in the statement that it would be difficult "to over-estimate the benefits which have accrued to the nation at large, and London in particular, from this branch alone of the Polytechnic work."

A COMPANY has presented to the Committee of Ways and Means in connection with the World's Fair, Chicago, a proposition which is likely to attract some attention. The company proposes to connect all the large cities of the United States by wires in such a manner that when the President presses the button for the official opening of the Exposition he will not only start in motion the machinery of the World's Fair, but will ring the fire bells and hoist the Stars and Stripes in every town in the country, and also open "the largest mechanical, electrical, and musical concert ever given on earth." According to the American journal *Electricity*, this is all to be done without cost to the Exposition management. Nothing is asked beyond the sanction of the management to the proposed idea, consent to proceed, and the assurance that a similar privilege will be given to no other person or company.

ACCORDING to a report recently published in Germany, there were, in 1889, 5260 workmen killed in accidents, and 35,392 seriously injured. These losses do not vary much from one year to another. M. Vacher, in *La Nature*, compares the figures with those of the killed and wounded at Gravelotte—one of the most murderous battles in this century—which were 4449 and 20,977. The industries furnishing most accidents are as follows, in descending order: mines, railways, quarries, subterranean works, building, breweries. All industries are arranged in 64 corporations, and it is estimated that more than 4½ millions of workpeople are insured. Wounds and fractures are the most usual form of injury, and the duration of treatment tends to increase every year, by virtue of a law which makes an allowance when incapacity for work exceeds three weeks (this was based on the observation that fractures were generally healed in three weeks). Since this law was introduced, the treatment of fractures has taken longer. There are always more accidents in winter than in summer, and on Mondays and Saturdays than on other days. Also there are twice as many accidents from 9 a.m. to noon, and from 3 to 6 p.m., than from 6 to 9 a.m., and from noon to 3 p.m. Better light in summer, and fatigue towards the end of each half-day of six hours, are supposed to explain some of these variations.

IN the February number of *Nature Notes*, Mr. Robert Morley vouches for the accuracy of a story which seems to indicate the possibility of very tender feeling in monkeys. A friend of Mr. Morley's, a native of India, was sitting in his garden, when a loud chattering announced the arrival of a large party of monkeys, who forthwith proceeded to make a meal off his fruits. Fearing the loss of his entire crop, he fetched his fowling-piece, and, to frighten them away, fired it off, as he thought, over the heads of the chattering crew. They all fled away, but he noticed, left behind upon a bough, what looked like one fallen asleep with its head resting upon its arms. As it did not move, he sent a servant up the tree, who found that it was quite dead, having been shot through the heart. He had it fetched down and buried beneath the tree; and on the morrow he saw, sitting upon the little mound, the mate of the dead monkey. It remained there for several days bewailing its loss.

AT the meeting of the French Meteorological Society on Jan. 5 M. Janssen, in his Presidential address, said that meteorology was passing through a critical and interesting period of its history; it cannot fully render the important services expected of it until it has been sufficiently cultivated for its own sake, without reference to its application to other sciences, such as agriculture, &c. He could not too strongly recommend the more general use of photography for the registration of certain phenomena. Observations in balloons, and on mountain-stations, should be utilized as much as possible, as the latter will have a considerable effect on the progress of the science. He also urged the necessity of constructing self-registering instruments, working automatically for a lengthened period, owing to the difficulty of obtaining continuous records at the highest stations. M. H. Lasne made some remarks on the subject of a communication by M. Teisserenc de Bort at a previous meeting, relating to barometric gradients. He thought that the representation of the surface isobars drawn in section in a conveniently chosen vertical plane, is of advantage from a graphical point of view, in order to show approximately the march of the phenomena. On the other hand, he was of opinion that, if calculations were introduced with a view to greater precision, there would be no longer any advantage in making use of the difference of height of the surface isobars.

GENERAL GREELY, Chief Signal Officer of the United States Army, has just issued a set of international monthly charts of mean barometric pressures and wind directions at about noon (G.M.T.) for 1882 and 1883, for a large part of the northern hemisphere. It will be remembered that this was the period at which special observations were made by the International Polar Expeditions. All the data available for the Polar regions have been used in the preparation of these charts, and they therefore contain more observations made within the Arctic Circle than any previous charts issued by the Signal Office. They show that the general features of barometric pressure in the Arctic regions are a principal minimum in July, followed by a principal maximum in November, with secondaries in January and April (or May) respectively. The author states that he has prepared, and hopes soon to publish, charts of the mean monthly pressures, as determined for the northern hemisphere from the international synchronous observations during ten successive years. He also expresses the hope that some of the meteorologists connected with the International Polar Expeditions will confirm or disprove the theory of a regular march of barometric pressure from month to month throughout the earth, and not simply to and from the oceans and interior of continents, with alternating summer and winter. The unravelling of the complex conditions produced by the march of various types of pressure from one part to another is a necessary prelude of long-time weather predictions for large areas.

THE *Mediterranean Naturalist* for January prints some good notes, by Mr. J. J. Walker, R.N., on ants' nest beetles at Gibraltar and Tangier, with especial reference to the Hisperidæ. The search for ants' nest Hister is a somewhat troublesome employment, as only about 2 or 3 per cent. of the ants' nests contain the beetle. Mr. Walker, however, thinks "it is a pretty sight, and one which compensates for a great deal of strain to the eyes, as well as to the back, to see a *Sternocœlis* or *Eretmotus* lying motionless among the hurrying crowd of ants, and then, suddenly developing an amount of leg quite surprising in so small a creature, marching off daintily on the tips of its toes (or rather tarsi) with a ludicrous resemblance, in its gait and appearance, to a tiny crab." The comparatively weak mandibles of the ants are ineffective against the hard armour and tightly packed limbs of the beetles, which devour the helpless brood with impunity. Mr. Walker has more than once taken *S. acutangulus* with a half-eaten larva in its jaws, and they are usually to be found clinging to the masses of larvæ where these lie thickest. On the other hand, he once (but once only) saw an ant take up a *S. arachnoides* in its mandibles and carry it off into a lower gallery of the nest; but this may have been done under the influence of alarm, the frightened ant seizing on the first object that came in its way.

A VALUABLE map is issued with the current number of the Proceedings of the Royal Geographical Society. It has been constructed by Mr. W. J. Turner, in accordance with instructions given by the Hon. George Curzon, who explains in a memorandum various matters connected with the work. The map, with the memorandum and an index to the positions of places, is to be bound in a handy form and published separately.

AN interesting paper on the Gran Chaco is contributed by Mr. J. Graham Kerr to the current number of the *Scottish Geographical Magazine*. Mr. Kerr visited the Gran Chaco in connection with the recent Pilcomayo Expedition. Most writers on the region have praised it in unmeasured terms; and this judgment, confined to the zone bordering the fresh-water rivers, is declared by Mr. Kerr to be perfectly just. This zone has the advantages of a beautiful climate, a magnificent deep alluvial soil, good drainage, and facility of access. Splendid forests of most valuable timber alternate with pastures of the richest quality. But the interior, and by far the larger part, of the Gran Chaco is totally different. The usual utter absence of fresh water, and the poorness of the soil and of the pastures, make the country unfit for the agriculturist or the stock-raiser, while timber is comparatively scarce. Mr. Kerr thinks that the Holywood and the *Cascarandá*, as timbers, and the *Üvira* as a textile plant, will probably be found almost the only productions of value in the interior.

THE "British Journal Photographic Almanac and Photographer's Daily Companion" for this year, edited by J. Traill Taylor, seems to have increased in bulk, and is as interesting as ever. The articles on the many and various subjects which are dealt with by the contributors are well worth perusal. The tables and the general information given in the volume are all that a photographer requires. The frontispiece, which is a likeness of William II., Emperor of Germany, is from a negative by Messrs. Russell and Sons, and is produced here on bromide paper, as an example of an average print.

MESSRS. GEORGE PHILIP AND SON have issued a valuable little book on "Technical Education in the Counties," by George J. Michell and Ernest Heber Smith. It is based on a series of articles which appeared last year in the *County Council Times*. The authors have had a large experience in teaching the classes who will be specially affected by the new instruction provided by the Technical Instruction Act. After a general chapter on national education, they deal with special agricultural requirements, night science agricultural schools, the cost of secondary and night science and agricultural schools, higher agricultural schools, and agricultural colleges and universities. Among other subjects discussed are the requirements of mining districts, manufacturing and engineering requirements, and the educational needs of girls.

THE Cambridge University Press has issued a "Catalogue of the Type Fossils in the Woodwardian Museum, Cambridge," by Henry Woods, of St. John's College. Prof. T. McKenny Hughes contributes a preface.

MESSRS. J. B. BALLIÈRE ET FILS, Paris, have issued a French translation of ten well-known essays by Prof. Huxley. The volume is entitled "Les Problèmes de la Géologie et de la Paléontologie."

THE United States National Museum has published a paper, by Prof. E. D. Cope, on the characters of some Palæozoic fishes.

CHARLES LUNN'S "Philosophy of the Voice" has been translated into German by Herr Ludwig J. Trüg. A special value is given to this translation by various additions which have been made by Mr. Lunn himself.

TWO new compounds of carbon, chlorine, and bromine are described by M. Besson in the current number of the *Comptes rendus*. There are three possible chlorobromides of carbon—CCl_3Br, CCl_2Br_2, and $CClBr_3$. The first of these compounds, CCl_3Br, was obtained some time ago by Messrs. Friedel and Silva, by heating bromine and chloroform together in sealed tubes to 170° C. M. Besson now shows that this reaction, when carried further at higher temperatures, yields all three chlorobromides, which may readily be separated by fractional distillation. The mixture of bromine and chloroform, in the proportion of two atoms of the former to each molecule of the latter, is best heated in a sealed tube first for two hours at 225°. The end of the tube is then softened in the blow-pipe flame, in order to permit of the escape of the hydrobromic acid which is evolved during the first stage of the reaction. The tube is then closed, and again heated, this time to 250°, after which it is reopened, and the pressure of gas, which is now mainly hydrochloric acid, released. The tube is finally closed, and heated to 275°, at which temperature the reaction is complete. By proceeding in this manner, the risk of the tube being fractured by the enormous pressure of the evolved hydrobromic and hydrochloric acids is minimized. The explanation of the formation of all three chlorobromides is probably as follows. The bromine first reacts with the chloroform with production of the direct substitution products, CCl_3Br and CCl_2Br_2, according to the equations

$$CHCl_3 + Br_2 = CCl_3Br + HBr,$$
$$CHCl_3 + Br_2 = CCl_2Br_2 + HCl.$$

Subsequently, at a higher temperature, the hydrobromic acid reacts upon the compound CCl_2Br_2, producing $CClBr_3$ and hydrochloric acid,

$$CCl_2Br_2 + HBr = CClBr_3 + HCl.$$

It would doubtless be more profitable to complete the whole reaction at once by heating to 250° if glass tubes were capable of withstanding the pressure, but M. Besson finds that they invariably burst if this is attempted. Upon fractionally distilling the product of the reaction, three fractions are obtained. The first, boiling at 103–105°, consists of CCl_3Br; the second, which distils constantly at 135° and usually solidifies in the receiver, consists of CCl_2Br_2; the third fraction, consisting of $CClBr_3$, boils at 160°, and rapidly solidifies as it condenses. The first chlorobromide, CCl_3Br, is a clear liquid which crystallizes when cooled to −21°. The compound CCl_2Br_2 is a solid at the ordinary temperature, crystallizing in fine needles; it melts, however, to a clear liquid at 22°, and distils without decomposition at 135°. The density of the liquid at 25° is 2·42. It is endowed with an odour recalling that of chloroform, and, like the latter liquid, volatilizes rapidly at ordinary temperatures, its vapour tension at 16° being equal to 21 millimetres of mercury. The third chlorobromide, $CClBr_3$, is readily soluble in ether, from which it crystallizes upon cooling in the form of transparent tabular crystals of specific gravity 2·71 at 15°, and which fuse at 55°. When distilled it suffers a slight amount of decomposition, a little bromine vapour being liberated. Its odour very much resembles that of carbon tetrabromide. It is very soluble in chloroform and carbon tetrachloride, but is much more difficultly soluble in alcohol.

The additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, presented by Mr. W. E. Tandy; a Black-eared Marmoset (*Hapale penicillata*) from South-East Brazil, presented by Mr. Harley M. Usill; two Herring Gulls (*Larus argentatus*), British, presented by Mr. T. A. Cotton, F.Z.S.; a Dwarf Chameleon (*Chamæleon pumilus*) from South Africa, presented by Captain J. C. Robinson; a Tabuan Parrakeet (*Pyrrhulopsis tabuan*) from the Fiji Islands, received in exchange; six Dingos (*Canis dingo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

Report of the U.S. Naval Observatory.—The Annual Report of the Superintendent of the U.S. Naval Observatory for the year ending June 30, 1891, has just been received. Prof. Hall has been using the 26-inch equatorial for observations of double stars, and his results will soon be reduced and published in a catalogue. The transit circle has been employed by Prof. Eastman in observations of the sun, moon, and planets, and stars necessary for clock and instrument corrections. Prof. Frisby has charge of the 9·6-inch equatorial, and has made a number of observations of comets, asteroids, occultations of stars by the moon, and the transit of Mercury which occurred on May 9, the first and second contacts being successfully observed. The photographs of the transit of Venus in December 1882 have been reduced and discussed, but the whole of the work in connection with the determination of the solar parallax is not yet completed. The solar eclipse of April 15, 1893, occurs under very favourable conditions, and Captain McNair hopes that every advantage will be taken of this circumstance. We note that on two nights a week the 9·6-inch equatorial is set apart for the accommodation of visitors. During the period covered by this Report 2360 persons availed themselves of this privilege.

Observations of Nebulæ and Star-Clusters.—In 1884, M. Bigourdan began to make micrometric measures of nebulæ observable at Paris, and a portion of his work, containing positions of nebulæ and star-clusters between 15h. and 16h. of right ascension, has recently been published. As an introduction, a brief account is given of the growth of the idea that nebulæ represent an important stage in the development of celestial species; and it is pointed out that measures such as those made at Paris will enable any proper motion to be determined. If successive careful measures should fail to show any proper motion, numerous observations of the motion of nebulæ in the line of sight will furnish data for the determination of the minimum distance of these bodies from the earth. M. Bigourdan next traces the gradual increase in the number of nebulæ recorded, going back to the "Almagest," in which Ptolemy mentions six. Precise observations are said to commence with Messier, and it is estimated that the co-ordinates of about 1500 nebulæ are now accurately known. At Paris the positions of nebulæ have been determined relatively to certain comparison-stars by the method usually adopted for comets; the difference *neb.*−✱ being found in right ascension by the difference in the times of transit, and in declination by micrometric measures. The instrument employed in the work has an aperture of 0·32 metres, and a focal length of 5·20 metres. The tabulated observations are made up of eighteen columns. First the N.G.C. number is given, and then the name of the discoverer and the date of observation. After this, the magnitude of the nebula is indicated. A nebula, just visible with the instrument employed, is assigned the magnitude 13·5, this number representing the faintest star that it can grasp. The majority of nebulæ observed have magnitudes comprised between 13·2 and 13·5. The state of the sky at the time of observation has, of course, been recorded, and another number is tabulated to indicate the relative ease with which the nebula could be measured. This brief outline of the Catalogue is a sufficient testimony of the care with which M. Bigourdan has done his work, so far as it goes. It is to be hoped that the publication of the completed Catalogue is not very far ahead.

Solar Observations.—Prof. Tacchini, in *Comptes rendus* for January 25, gives the following *résumé* of solar observations made at the Royal Observatory of the Roman College during the last quarter of 1891:—

1891.	Number of days of observation.	Relative frequency: of spots.	Relative frequency: of days without spots.	Relative magnitude: of spots.	Relative magnitude: of faculæ.	No. of groups per day.
October	26	15·54	0·00	54·69	85·77	4·96
November	22	12·50	0·00	61·38	51·50	3·41
December	18	8·57	0·00	42·18	35·36	2·68

A comparison of these numbers with those for the preceding quarter shows a slight diminution in the phenomena of spots and faculæ. It should, however, be remarked that on no day has the sun been free from spots, and the frequency of groups remains about the same.

The observations of solar prominences are summed up as follows:—

1891.	Number of days of observation.	Mean number.	Mean height.	Mean extension.
October	22	9·82	43″·6	1°·7
November	15	5·73	35·4	1·6
December	21	6·48	40·2	2·2

Prominences were frequently observed in September and also in October, but since this month the number has slightly diminished. The mean number for the quarter covered by this *résumé* is about the same as that of last quarter.

M. Marchand gives the results of solar observations made at Lyon Observatory during the latter half of 1891, in the current *Comptes rendus*. The proportion of spotted surface, expressed in millionths of the sun's visible hemisphere, and the surface covered by faculæ expressed in thousandths of the visible hemisphere, is stated as follows:—

	Spots.	Faculæ.		Spots.	Faculæ.
July	1696	38·2	October	1180	49·6
August	957	40·5	November	748	39·2
September	2469	51·3	December	947	50·0

The total spotted surface is thus 7999 millionths of the visible hemisphere, this being covered by 101 groups. The preceding half year's observations gave 65 groups and a surface of 3517 millionths. Spots have been more numerous in the northern than in the southern hemisphere in the ratio 69 : 32. This predominance of activity in the northern hemisphere also holds good for faculæ. The total surface covered by groups of faculæ is 268·8 thousandths of the visible hemisphere, as against 1363 thousandths in the first six months of last year. The number of groups of faculæ giving these values was 152 (July to December) and 131 (January to June).

Measures of the Nebula near Merope.—*Astronomische Nachrichten*, No. 3074, contains an account of some measures of the faint nebula discovered by Mr. Barnard close to the bright star Merope, in the Pleiades. The measures were made by Mr. S. W. Burnham with the 36-inch equatorial. The position-angle and distance found by Mr. Burnham are, 166°·3 and 36″·10 (1891·71). These values agree very well with the values 165°·8 and 36″·85 (1890·92) deduced from Mr. Barnard's observations of the differences of R.A. and Decl. between the star and the nebula. This extremely close association of a faint nebula with a bright star is most remarkable; and it will be interesting to determine, by careful measures in the future, whether the patch of nebulosity is drifting through space with Merope and the other members of the Pleiades group.

JOURNEYS IN THE PAMIRS AND ADJACENT COUNTRIES.

THIS was the subject of the paper read at the meeting of the Royal Geographical Society, on Monday, by Captain F. E. Younghusband. The author described two journeys, one in 1889 across the Kárákorum and into the Pamir, the other in 1890 to Yarkand and Kashgar, and south to the Pamirs again.

"The country," he said, "which I now wish to describe to you is that mountainous region lying to the north of Kashmir, which from the height, the vastness, and the grandeur of the mountains, seems to form the culminating point of Western Asia. When that great compression in nature took place this seems to have been the point at which the great solid crust of the earth was scrunched and crushed together to the greatest extent, and what must have formerly been level peaceful plains such as we see to the present day on either hand, in India and in Turkistan, were pressed and upheaved into these mighty mountains, the highest peaks of which are only a few hundred feet lower than Mount Everest, the loftiest point on this earth. It was amongst the peaks and passes, the glaciers and torrents of this awe-inspiring region, and anon over the plain-like valleys and by the still, quiet lakes of the Pamirs that my fate led me in the journeys which I have now come before you to describe."

Starting from Leh, in Ladak, Captain Younghusband's first objective point was Shahidula. This place is situated on the trade route to Yark and, and is 240 miles distant from Leh. This he left on September 3, to explore the country up to the Tagh-dum-bash Pamir.

The route now led up the valley of a river, on which were several patches of fine grazing, and till last year this had been well inhabited, but was now deserted on account of Kanjuti raids. The valley is known by the name of Khál Chuskún. Chuskún in Turki means resting-place, and Khál is the name of a holy man from Bokhara, who is said to have rested here many years ago. The mountains bounding the north of this valley are very bold and rugged, with fine upstanding peaks and glaciers; but the range to the south, which Hayward calls the Aktágh Range, was somewhat tame in character, with round mild summits and no glaciers. The Sokhbulák is an easy pass, and from its summit to the east could be seen the snowy range of the western Kuenlun Mountains, while to the west appeared a rocky mass of mountains culminating in three fine snowy peaks which Hayward mistook as belonging to the main Mustagh Range, but which in fact in no way approach to the height and magnificence of those mountains, and really belong to the Aghil Range, which is separated from the Mustagh Mountains by the valley of the Oprang River.

On September 11, the party crossed the remarkable depression in the range which is known as the Aghil Pass.

"From here is obtained one of the grandest views it is possible to conceive; to the south-west you look up the valley of the Oprang River, which is bounded on either side by ranges of magnificent snowy mountains, rising abruptly from either bank, and far away in the distance could be seen the end of an immense glacier flowing down from the main range of the Mustagh Mountains. This scene was even more wild and bold than I had remembered it on my former journey, the mountains rising up tier upon tier in a succession of sharp needle-like peaks bewildering the eye by their number, and then in the background lie the great ice mountains—white, cold, and relentless, defying the hardiest traveller to enter their frozen clutches. I determined, however, to venture amongst them to examine the glaciers from which the Oprang River took its rise, and leaving my escort at the foot of the Aghil Pass, set out on an exploration in that direction. The first march was easy enough, leading over the broad pebbly bed of the Oprang River. Up one of the gorges to the south we caught a magnificent view of the great peak K 2, 28,278 feet high, and we halted for the night at a spot from which a view of both K 2 and of the Gushirbrum peaks, four of which are over 26,000 feet, was visible. On the following day our difficulties really began. The first was the great glacier which we had seen from the Aghil Pass; it protruded right across the valley of the Oprang River, nearly touching the cliffs on the right bank; but fortunately the river had kept a way for itself by continually washing away the end of the glacier, which terminated in a great wall of ice 150 to 200 feet high. This glacier runs down from the Gushirbrum in the distance towering up to a height of over 26,000 feet. The passage round the end of the glacier was not unattended with danger, for the stream was swift and strong, and on my own pony I had to reconnoitre very carefully for points where it was shallow enough to cross, while there was also some fear of fragments from the great ice-wall falling down on the top of us when we were passing along close under it. After getting round this obstacle we entered a gravel plain, some three-quarters of a mile broad, and were then encountered by another glacier running across the valley of the Oprang River. This appeared to me to be one of the principal sources of the river, and I determined to ascend it. Another glacier could be seen to the south, and yet a third coming in a south-east direction, and rising apparently not very far from the Kárákorum Pass. We were, therefore, now in an ice-bound region, with glaciers in front of us, glaciers behind us, and glaciers all around us. Heavy snow-clouds too were unfortunately collecting to increase our difficulties, and I felt that we should have a hard task before us. On first looking at one of these glaciers it would appear impossible to take ponies up them, but the sides are always covered with moraine, and my experience in the exploration of the Mustagh Pass in 1887 showed that by carefully reconnoitring ahead, it was generally possible to take the ponies for a considerable distance at least up such glaciers; and as the one we had now reached seemed no worse than others, and there appeared a gap in the range which looked as if it might be a pass, I took my ponies on, and after three days' scrambling on the ice, reached the foot of the supposed pass, and started at 3.30 on the following morning to find if it was at all practicable."

Captain Younghusband was, however, obliged to return after reaching a height of 17,000 feet, and he decided to return to his camp on the Oprang River. He thus describes the glaciers from which this river takes its rise:—

"The length of this glacier is 18 miles, and its average breadth half a mile; it is fed by three smaller glaciers on the west and one on the east. At its upper part, immediately under the pass, it is a smooth undulating snow-field about a mile and a half in width. Lower down this *névé* is spilt up into crevasses, which increase in size the further down we get. Then the surface gradually breaks up into a mass of ice-domes, which lower down become sharp needle-like pinnacles of pure white ice. On each side lateral gravel moraines appear, and other glaciers join, each with its centre of white ice-peaks and its lateral moraines, and preserving each its own distinct course down the valley, until some three miles from its termination in the Oprang River, when the ice-peaks are all melted down and the glacier presents the appearance of a billowy mass of moraine, and would look like a vast collection of gravel heaps, were it not that you see, here and there, a cave or a cliff of ice, showing that the gravel forms really only a very thin coating on the surface, and that beneath is all pure solid ice. This ice is of opaque white, and not so green and transparent as other glaciers I have seen, and the snow at the head of the glacier was different from any I have seen before; for beneath the surface, or when it was formed into lumps, it was of the most lovely pale transparent blue. I must mention, too, that every flake of snow that fell in the storm was a perfect hexagonal star, most beautiful and delicate in form. The mountains on either side of the valley, especially on the eastern side, are extremely rugged and precipitous, forming little or no resting-place for the snow, which drains off immediately into the glacier below. The western range, the main Mustagh Range, was enveloped in clouds nearly the whole time, and I only occasionally caught a glimpse of some peak of stupendous height, one of them, the Gushirbrum, over 26,000 feet, and others 24,000 feet. The snowfall on these mountains must be very considerable, and it seems that this knot of lofty mountains attracts the great mass of the snow-clouds, and gets the share which ought to fall on the Kárákorum, while these latter, being lower, attract the clouds to a less degree, and are in consequence almost bare of snow."

After some further exploration of the glaciers, rivers, and passes in this wild region, Captain Younghusband returned to India by way of Kashmir. In the summer of 1890, he once more made his way northwards through Kashmir, with a companion, Mr. Macartney. They reached Yarkand on August 31.

"After a rest of two or three weeks at Yarkand," Captain Younghusband went on to say, "Macartney and I left our companions and started for a trip round the Pamirs. Approaching this interesting region from the plains of Kashgaria, one sees clearly how it has acquired the name of Bam-i-dunya, or Roof of the World. The Pamir Mountains rise apparently quite suddenly out of the plain from a height of 4000 feet above sea-level at their base to over 25,000 feet at their loftiest summits—a massive wall of rocks, snow, and ice. Mounting this wall the traveller comes on to the Bam-i-dunya, which would perhaps be better translated as the 'upper story' of the world. Houses in Turkistan are flat-roofed, and you ascend the outer wall and sit out on the roof, which thus makes an upper story, and it appears to me that it was in this sense that the Pamir region was called the Roof of the World. The name, indeed, seems singularly appropriate, for once through the gorges which lead up from the plains, one enters a region of broad open valleys separated by comparatively low ranges of mountains. These valleys are known as Pamirs—Pamir being the term applied by the natives of those parts to a particular kind of valley. In the Hindu Kush and Himalayan region the valleys as a rule are deep, narrow, and shut in. But on the Roof of the World they seem to have been choked up with the *débris* falling from the mountains on either side, which appeared to me to be older than those further south, to have been longer exposed to the wearing process, and to be more worn down—in many parts, indeed, being rounded off into mere mounds, reminding one very much of Tennyson's lines :—

> " 'The hills are shadows, and they flow
> From form to form, and nothing stands ;
> They melt like mist; the solid lands,
> Like clouds they shape themselves and go.'

The valleys have thus been filled up faster than the rainfall has been able to wash them out, and so their bottoms are sometimes as much as four or five miles broad, almost level, and of considerable height above the sea. The Tagh-dum-bash Pamir runs as low as 10,300 feet, but on the other hand, at its upper extremity the height is over 15,000 feet ; and the other Pamirs vary from twelve or thirteen to fourteen thousand feet above sea-level. That is, the bottoms of these Pamir valleys are level with the higher summits of the Alps.

"As might be expected, the climate is very severe. I have only been there in the autumn, and can therefore speak from personal experience of that season only ; but I visited them in three successive years, and have seen ice in the basin of my tent in August. I have seen the thermometer at zero (Fahrenheit) at the end of September, and 18° below (that is, 50° of frost) at the end of October. The snow on the valley bottoms does not clear away before May is well advanced. June and July and the beginning of August are said to be pleasant, though with chilly nights ; and then, what we in England might very justly call winter, but which, not to hurt the feelings of the hardy Kirghiz who inhabit these inhospitable regions all the year round, we will, for courtesy's sake, call autumn, commences."

Captain Younghusband and Mr. Macartney advanced up those long gravel desert slopes which lead out of the plains of Turkistan, and then through the lower outer ranges of hills covered with a thick deposit of mud and clay, which Captain Younghusband believes to be nothing else than the dust of the desert, which is ever present in the well-known haze of Turkistan, deposited on the mountain-sides ; then over the Kara-dawan, Kizil-dawan, and Torat Passes ; through the narrow defile known as the Tangitar, where one has to force the ponies up a deep violent stream rushing over huge boulders between precipitous rocky cliffs, in which they noticed large square holes pierced, suggesting to them that in former days this, the high road between Eastern and Western Asia, was probably improved by having a bridge over this difficult and dangerous part ; then over the Chichiklik and Koh-mamak Passes and the Tagarma Plain, till they reached the neighbourhood of Tash-kurgan, the northernmost point of Captain Younghusband's explorations in the previous year. Passing through the Little Pamir, they struck the Alichur Pamir near Chadir-tash at its eastern extremity, and from there they looked down a broad level valley, averaging four or five miles in width, to some high snowy peaks overhanging Lake Yeshil-kul at its western extremity. The range bounding this Pamir on the north is free of snow in summer, but that separating it from the Great Pamir is of considerable height, the summits are always covered with snow, and the passes across it difficult. Traces of ancient glaciers are very frequent, and the western end near Lake Yeshil-kul is choked up with their moraines, forming a sea of gravel mounds, in the hollows of which numerous lesser lakes may be seen. On the borders of Yeshil-kul, at a place called Somatash, Captain Younghusband found the fragments of a stone bearing an ancient inscription in Turki, Chinese, and Manchu. This interesting relic, as far as Captain Younghusband has been able to get the rubbings he took of it translated, refers to the expulsion of the two Khojas from Kashgar by the Chinese in 1759, and relates how they were pursued to the Badakhshan frontier.

From the Ak-su Valley the two travellers ascended the sterile valley of the Ak-baital, which at this season of the year (October) has no water in it, and visited Lake Rang-kul. "On the edge of this lake is a prominent outstanding rock, in which there is a cave with what appears to be a perpetual light burning in it. This rock is called by the natives Chiragh-tash, *i.e.* the Lamp Rock, and they account for the light by saying that it comes from the eye of a dragon which lives in the cave. This interesting rock naturally excited my curiosity. From below I could see the light quite distinctly, and it seemed to come from some phosphorescent substance. I asked the Kirghiz if any one had ever entered the cave, and they replied that no one would dare to risk the anger of the dragon. My Afghan orderly, however, had as little belief in dragons as I had, and we set off to scale the cliff together, and by dint of taking off our boots and scrambling up the rocks, very much like cats, we managed to reach the mouth of the cave, and on gaining an entrance found that the light came neither from the eye of a dragon nor from any phosphorescent substance, but from the usual source of light—the sun. The cave, in fact, extended to the other side of the rock, thus forming a hole right through it. From below, however, you cannot see this, but only the roof of the cavern, which, being covered with a lime deposit, reflects a peculiar description of light. Whether the superstitious Kirghiz will believe this or not I cannot say, but I think the probability is that they will prefer to trust to the old traditions of their forefathers rather than the wild story of a hare-brained stranger. The water of Rang-kul is salt, and the colour is a beautiful clear blue. The mountains in the vicinity are low, rounded, and uninteresting, though from the eastern end a fine view of the great snowy Tagarma Peak may be obtained."

The winter was spent in Kashgar. On July 22, 1891, Captain Younghusband left to return to India by way of the Pamirs and Gilgit.

"On reaching the Little Kara kul Lake, a piece of interesting geography, which I believe had been first noticed by Mr. Ney Elias, on his journey through these parts some years ago, presented itself. Captain Trotter, of the Forsyth mission, saw from the plains of Kashgar a stupendous peak, the height of which he found to be 25,300 feet, and the position of which he determined accurately. From Tash-kurgan or its neighbourhood he also saw a high mountain mass in the direction of the peak he had fixed from near Kashgar ; bad weather prevented his determining the position of this second peak, but he thought there was no doubt that the two were identical. Such, however, is not the case. There are two peaks, about 20 miles apart, one on either side of the Little Kara-kul Lake. That seen from Tash-kurgan is the true Tagarma Peak, and cannot be seen from Kashgar ; while that seen from Kashgar cannot be seen from Tash-kurgan. There appeared to me to be very little difference in height between the two. Both are remarkable not only for their extraordinary height, but also for their great massiveness. They are not mere peaks, but great masses of mountain, looking from the lake as if they bulged out from the neighbouring plain ; and one sees far more distinctly than is usually the case, the layers upon layers of rock which have been upturned like the leaves of a book forced upwards. It struck me too, especially from the appearance of the rocks in the neighbourhood of the northernmost peak, that these must have been upheaved far more recently than the worn-out-looking mountains in the centre of the region of the Pamirs. The appearance of these two great mountain masses rising in stately grandeur on either side of a beautiful lake of clear blue water is, as may be well imagined, a truly magnificent spectacle, and, high as they are, their rise is so gradual and even, that one feels sorely tempted to ascend their maiden summits and view the scene from the loftiest parapets of the 'Roof of the World.'"

On October 4, Captain Younghusband and a companion left the Tagh-dum-bash Pamir to explore "an interesting little corner of Central Asia, the point where the two watersheds—the one between the Indus on the south and the Oxus and Eastern Turkistan rivers on the north, and the other between the Oxus on the west and the eastern Turkistan rivers on the east—join. If any point can be called the Heart of Central Asia I should think this must be it. Here on the Oxus side of the watershed are vast snowfields and glaciers, and among these, with three of its sides formed of cliffs of ice—the terminal walls of glaciers—we found a small lake, about three-quarters of a mile in width, out of which flowed the stream which joins the Panja branch of the Oxus at Bozai-Gumbaz."

After this Captain Younghusband made his way down to Kashmir.

THE INSTITUTION OF MECHANICAL ENGINEERS.

ON Thursday and Friday evenings of last week, the 4th and 5th inst., the Institution of Mechanical Engineers held heir forty-fifth annual general meeting in the theatre of the Institution of Civil Engineers, lent for the purpose by the Council of the latter Society, according to custom.

The first business was the reading of the annual report of the Council, from which it appears that the Institution continues to prosper, both in regard to finances and membership. The accumulated surplus now amounts to about £36,000, and is increasing at the rate of over £2000 per annum. At the end of last year the number of names of all classes on the roll of membership amounted to 2077, a net gain of 134 on the previous year.

The following two papers were read and discussed:—

(1) Notes on mechanical features of the Liverpool Waterworks, and on the supply of power by pressure from the public mains, and by other means, by Joseph Parry, water engineer, Liverpool.

(2) On the disposal and utilization of blast-furnace slag, by William Hawdon, of Middlesborough.

The first paper was chiefly valuable as recording an attempt of the Liverpool Corporation, who control the water supply of the city, to establish a system of power distribution by means of the ordinary mains. The Liverpool water supply is chiefly interesting at the present time from the fact that the Vyrnwy works and connections are all but complete. When this system is in operation the Liverpool mains will carry a pressure of water obtained by a natural head, due to the source of supply being in the higher land of North Wales. At present there are in active duty, in connection with the Liverpool Water-works, some fine examples of veteran pumping-engines. There is a Cornish engine and boiler erected at the Windsor station in 1840; a crank engine made in 1837; and a fine old Cornish pumping-engine and boiler made by the celebrated firm of Harvey and Co., of Hayle, in Cornwall. The cylinder of the latter is 50 inches in diameter, with a 9-foot stroke, and is steam-jacketed. The pump is 17½ inches in diameter by 8 feet 9 inches stroke. The average boiler pressure is 35 pounds per square inch. Since this engine began its career it has lifted 18,854 million foot-tons of water. By a recent trial its duty was found to be 55·7 millions of foot-pounds per cwt. of coal. The indicated horse-power is about 86. The figures serve to show that, in spite of higher pressures and quicker piston-speeds, now so much talked of, not so much advance has been made in the economy of big engines as one might be led to suppose from the efforts that are made to introduce three and four stage compounding, and the virtues that are attributed to it. The average rate of water supply of Liverpool per head per day is about 24½ gallons, and the water is distributed on the constant service system. Mr. P. Howden's figures as to cost of various systems of power supply are valuable, but they would have been rendered still more so had he taken the further trouble of introducing a more orderly system of classification, and had he given, in one or two instances, fuller information as to the elements upon which he had based his calculations. However, we must not look our gift horse too curiously in the mouth, and any information on one of the great problems of the hour—common power supply from central stations—is to be made the most of at present. No doubt civilization has lagged behind somewhat in this respect. Power "laid on" in our houses might be as much a matter of course as the bringing of gas and water to us by automatic means; and doubtless this would do something towards solving that other great problem of the hour—and most other hours—the domestic servant problem. At present nearly all large buildings in London, and still more so in America, have a fairly large power installation in their basements. The number of steam boilers that are hidden away among the foundations of large hotels, clubs, and stacks of offices would surprise many people not familiar with these matters. All this involves some waste of room and some waste of energy. In New York a few months ago an effort was made to solve the problem of power distribution by generating steam in a gigantic battery of boilers in one central station, and running the steam pipes all over the city; so that one had only to open a valve and the steam engine could be started forthwith. The scheme was not altogether a success. After a very short time New Yorkers were disagreeably surprised by artificial geysers and mud fountains springing up in the middle of some of the most frequented thoroughfares. A great outcry was raised, and for some time it seemed as if popular indignation would compel the company to stop their work. We believe, however, that there have been improvements lately, but it does not seem probable that steam, conveyed in pipes, will be the means by which power distribution will find its solution in England. Compressed air possesses strong advocates, and in Paris the Popp system, originally devised simply for working clocks from a common centre, has proved a success. In England, however, we have the recent failure at Birmingham, where much money has been spent and many disappointments caused by an endeavour to supply compressed air for power purposes in the city, which, perhaps, of all others in the world, offers the most promising field for such an enterprise. The Hydraulic Power Company has proved a success in London, and its ramifications extend over a wider area than most people imagine; but here, we think, the enterprise finds by far its greatest outlet simply in working elevators and lifts. The gas companies are the largest distributors of power. Perhaps the keenest struggle for lighting and supplying domestic power will be between gas and electricity. The latter has the advantage, from a power point of view, that the motor is clean, compact, odourless, and comparatively noiseless. There is no denying that the gas-engine is not a pleasant neighbour. It is also difficult to start, and requires a large water supply; it smells badly, and makes a noise. On the other hand, it is far cheaper than electricity. Mr. Parry, in his paper, gives an instance of a gas-engine working a hoist in Liverpool at the cost of one-third of a penny per indicated horse-power per hour, and this we should not class as a low figure by any means; whilst Sir James Douglass stated that the charge made for the same unit of power by the Liverpool Electric Supply Company was 5*d.* per hour. There is one other source of power which is yet in its extreme infancy, but of which, we think, much will be heard before long. That is the oil-engine. It cannot be brought into the category of power distribution, however, as each motor of this kind must work on its own bottom. For country districts and isolated positions, at any rate, it offers great promise, and will assuredly take a prominent position when the mechanical details have been brought to a higher state of perfection. The chief interest in Mr. Parry's paper centres in the tables giving figures as to cost. These may be briefly summed up in the statement that when water at high pressure (700 pounds) can be bought for 5*s.* per thousand gallons, water power at average domestic pressure (50 to 70 pounds) cannot compete with it. Whether high pressure water will be able to beat electricity and gas is a problem the solution of which is hidden in the future; and doubtless all the systems mentioned have advantages peculiar to them which would give each in turn the preference under given conditions. Hydraulic distribution has a great point in its favour when the exhaust-water can be used for other purposes.

The disposal of blast-furnace slag would not appear a very interesting question to the uninitiated, but it is really a very important matter. In Great Britain the iron-masters of the country produce annually 12,000,000 tons of this all but unused material. It is the refuse of iron-smelting, and it may be added that this annual supply of waste matter absorbs, and radiates uselessly into space, heat units which require for their production 653,000 tons of coal. A very small part of this slag is applied to any useful end; by far the greater quantity of it simply cumbers the ground, or necessitates the spending of large sums in carrying it out to sea. Of course, iron cannot be made without producing slag. To smelt the ore limestone has to be used in order to separate the various impurities with which it is blended. In this way the slag is produced, and the purer metal is obtained. Mr. Hawdon has devised a machine by which he claims to have facilitated the removal and utilization of the slag. In general principle it is not altogether novel, but it possesses some features which, its inventor claims, render its working a success, whereas failure has hitherto accompanied such efforts. In the blast furnace the molten slag separates from molten iron in consequence of the difference in specific gravity of the two. When the furnace is tapped, the iron runs off to the pig-bed to be cast into the well-known form. The slag is usually run into boxes, which are mounted on wheels. The passion for bigness which in the present day characterizes nearly all engineering operations of this nature, has extended to slag handling, so that a box will sometimes hold as much as four tons of slag. When the mass is sufficiently cool to stand alone the sides of the mould are lifted off by a crane, and the bogie is drawn away to the "tip," or "slag mountain," by a locomotive. As the land covered by the "tip" is often very valuable, in some localities being worth as much as £1000 per acre, it is desirable for this reason alone that the slag should be dealt with in some other way. When the iron-works have a sea outlet, the slag is often taken away in vessels constructed for the purpose, and dropped in deep water. The difficulty here is that the big lumps, or "slag-balls," are difficult to handle. To lower them gently into the barge is too costly, and if they are shot in they are likely to start the rivetting. Hand-breaking was, therefore, had recourse to—a tedious and costly process. In order to overcome this difficulty, an ingenious plan, known as the dry core ystem, has been devised. A hollow iron casting was placed so that the slag would flow round it when run in the mould. This was done so that the slag in cooling would contract round the casting and break up into pieces small enough to be tipped into the barge without injury to the plates and rivetting. Mr. Hawdon has not found this method to be successful; but it is stated that others have followed the plan with advantage. In America a method known as "slopping" is used, and undoubtedly with success. The molten slag is run on to a surface, and a large but comparatively thin cake is so obtained. When this layer is sufficiently cool, another is formed above it, and then other layers, so that the whole forms a stratified mass, with planes of demarcation between. Such a body is broken up with comparative ease. Sometimes the slag is taken away in the molten state in "boats" which are simply tanks on wheels. It is then poured away, leaving a problem for the engineers, and perhaps the geologists, of future generations to solve. There have been other methods of dealing with slag, but these we have not space to describe. Mr. David Joy, a well-known mechanical engineer, took the matter up about twenty years ago, and spent a year or two upon the problem. Some of the devices he originated were extremely ingenious, but for reasons of a commercial nature, his efforts were not continued. There are some uses for furnace slag. It is made into bricks, it is drawn into slag-wool, it is made into cement, and is broken up for ballasting railways, pitching streams, or, when made into concrete, for harbour and breakwater works. In spite of these uses, the great bulk of the 12,000,000 tons produced each year has to be tipped to waste, and the disposal of this useless by-product is no small part of the iron-master's expense in running his works. It is to aid this that the apparatus before referred to has been devised by Mr. Hawdon. It consists mainly of two large pulleys, over which there runs an endless chain or a metal belt. The pulleys are mounted on horizontal shafts, parallel to each other, and placed in the same horizontal plane. The pulleys are driven by a steam-engine, and the chain is made to travel in this way. The latter is composed of solid bar links, joined by pins, and on it is mounted a continuous series of shallow pans or trays. At one end of the apparatus the stream of molten slag is directed into the pans, and, as the chain is moving continuously, each pan carries off a part of the material. The pans overhang, so that the metal will not spill on to the links. Between the two pulleys there is placed a large flat tank filled with water, and this is so arranged that the upper part of the endless travelling chain or belt dips into the water, the sag of the belt being sufficient for the purpose. There are guide rollers, but these are details which may be neglected in our explanation of principles. The slag flows into the trays just before they dip into the water, so that the molten metal is at once rapidly cooled. This has the effect of cracking the pieces so much that when they fall out of the trays—which they naturally do when the belt turns over the further pulley—into the barge or waggon, they are broken into convenient sized fragments. Mr. Hawdon claims that by this system a very large saving is effected in transporting slag, and a material of some commercial value is obtained, the pieces being of suitable size for railway ballast or concrete mixing. From what we hear of the apparatus it appears to do its work well so far.

The summer meeting of the Institution will be held this year at Portsmouth, on July 26 and three following days.

THE ELECTRICAL EXHIBITION.

ON Saturday evening last the Lord Mayor and the Lady Mayoress, accompanied by Mr. Sheriff Tyler, Mr. Sheriff Foster, Sir John Monckton, and many others, went to the Crystal Palace to inspect the Electrical Exhibition. After their walk round, which lasted about an hour and a half, the visitors were entertained at dinner in the large saloon off the south transept. Among the company were the Attorney-General, Sir Robert Rawlinson, Sir Frederick Abel, F.R.S., Prof. W. E. Ayrton, F.R.S., Major-General Webber, Prof. W. Crookes, F.R.S., Mr. Tesla, Mr. W. H. Preece, F.R.S., Sir James N. Douglass, F.R.S., Major-General Festing, F.R.S., Dr. Hopkinson, F.R.S., Mr. A. Siemens, Prof. Kennedy, Prof. Forbes, Prof. Robinson, Prof. Perry, Prof. Hughes, and Prof. Silvanus Thompson, F.R.S. In the unavoidable absence of the Chairman of the Crystal Palace Company, the Hon. D. J. Monson, the chair was taken by the Deputy-Chairman, Mr. G. T. Rait. After the usual loyal toasts, the Lord Mayor proposed "Success to the Exhibition." In doing so he said there was sufficient evidence to warrant him in predicting that the Exhibition would prove a very great success. He recollected how, ten years ago, the electric light occupied the minds of many people, and how at that time the light had what proved to be a very bad start. The light was then undertaken more as a speculation. This checked for a time electrical enterprise, though, in his opinion, it had done no great or permanent harm. He admitted, with some degree of shame, that in the City of London they had been very slow to move in the matter. It was possible that they might have hesitated to commit themselves to some appliance that might have been changed on the morrow. They were, however, in favour of the electric light, and the City had been handed over to the new lighting, which in a short time would be an accomplished fact.

Dr. Hopkinson, in giving "Electric Science and Industry," remarked that the reaction between these two had been very intimate.

Prof. Ayrton, President of the Institute of Electrical Engineers, who responded, said that it was impossible to imagine what progress would be made in electricity in another ten years. At present two conductors were necessary for every electric tramcar (laughter). They had anticipated his joke (renewed laughter). One conductor took the current, while the other took the current coin (laughter). It might be that in ten years street lamps would be no longer necessary, as vacuum tubes would be used for walking-sticks (laughter). The smoke plague and fog would no longer trouble us, for there would be no coal fires when we could bask in the rays of the electric field, repose in the genial warmth of an equipotential surface, and put our feet on a fender composed of horizontal lines of force (loud laughter). One suggestion he would make—that the electric light might be introduced into that room, for the warmth they had borne during the dinner had been surpassed only by the warmth of their reception by the Directors of the Crystal Palace (laughter).

Mr. R. E. Crompton, President of the Electrical Section of the London Chamber of Commerce, also responded.

Mr. E. Clark proposed "The Health of the Honorary Council and Committees of the Exhibition."

Sir F. Abel, in responding, declared that we were on the threshold of great advances in our knowledge of electricity and its applications.

Mr. W. H. Preece also responded, and congratulated the promoters of the Exhibition upon the fact that they had brought to bear upon the present position of electrical science a fierce and an impartial criticism.

Mr. Tesla acknowledged some compliments paid to him in the course of the evening.

Sir James Douglass gave "The Crystal Palace Company," and the Chairman responded.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. J. J. Lister, of St. John's College, late Assistant Superintendent of the Museum of Zoology, has been appointed Demonstrator in Animal Morphology, in place of Mr. S. F. Harmer.

Mr. Alexander Scott, of Trinity College, has been appointed

Demonstrator to Prof. Dewar. The grace for establishing the office was opposed, but carried by 76 votes to 70.

Prof. Macalister has been appointed Chairman of the Examiners for the Natural Sciences Tripos in the present year.

The Fitzwilliam Museum Syndicate report that the catalogue of the Egyptian Collection, prepared by Dr. Budge, is now ready for printing, and will forthwith be published.

SCIENTIFIC SERIALS.

The *American Meteorological Journal* for December last contains six memorial articles upon the work of the late Prof. W. Ferrel, read at a meeting of the New England Meteorological Society in October last. Prof. W. M. Davis states that Ferrel's view of the general circulation of the atmosphere is now accepted in its essential features by most meteorologists; and were it not for the silence regarding it on the part of some of the British school, it would be regarded as universally acceptable. But in Great Britain it finds little recognition; unfortunately, Prof. Davis thinks, for the advance of the science in this country. The essential part of Ferrel's theory, first stated in 1859, is that an equatorial-polar convectional circulation on a rotating earth must consist chiefly of oblique winds from a western quarter, with high velocities nearly at right angles to the gradients; and that the initial high pressure about the poles, due to low temperature, will be reversed to low pressure by the excessive centrifugal force of the whirling winds, thus leaving a belt of high pressure near the tropics. He draws a sharp contrast between the general circulation and the cyclonic circulation. Both are cyclonic, inasmuch as they whirl, but one has a cold centre, and the other a warm one.—H. Helm Clayton contributes an article on the verification of weather forecasts. Among the elements to be considered he includes (1) the kind of phenomenon, *e.g.* cloud, rain, &c.; (2) the time of occurrence; (3) the duration of the phenomenon; (4) the intensity; (5) the length of time in advance that the phenomenon is predicted. He also describes the methods of verification adopted in some countries.—Cold waves, by Dr. A. Woeikof. The object of the paper is to disprove Prof. Russell's theory that cold waves are not due chiefly to radiation from the ground, but to extreme cooling of the upper air. Dr. Woeikof shows from observations from various sources that the cold waves are certainly due to radiation, not necessarily at the place where the cold is felt, but at a distance—in the United States to the north-west, in Europe to the north-east.

SOCIETIES AND ACADEMIES.

London.

Royal Society, January 21.—"On the Mechanism of the Closure of the Larynx: a Preliminary Communication." By T. P. Anderson Stuart, M.D., Professor of Physiology, University of Sydney, Australia.

The epiglottis having been displaced from its time-honoured function of closing the larynx as a lid, the paper proceeds to show how after all the larynx *is* closed. Briefly, the closure is effected by, on the one hand, a folding up of the margins of the entrance and an obliteration of the channel of the vestibule from the entrance downwards to the level of the glottis, and, on the other hand, by the well-known movement upwards and forwards of the entire larynx against the base of the tongue—the lower part of the epiglottis intervening, but taking no active part in the process. The observations, &c., were made as follows: (1) on a man who has a large hole in the side of the neck, a result of an operation for epithelioma, through which deglutition, simple closure of the larynx, &c., can be observed proceeding in a manifestly perfectly normal manner; (2) on healthy persons examined by the laryngoscope by the author and by two professed laryngoscopists; (3) experiments on the different classes of animals; (4) the anatomy and comparative anatomy of the parts; (5) the clinical and *post-mortem* records of morbid conditions.

When simple closure is to be effected in man, the arytenoid cartilages, inclosed in the mucous membrane, (1) are rotated, so that the vocal processes (eventually) come into apposition; (2) glide forwards on the cricoid articular surface, so that the posterior broad part of their articular surface comes to rest on the cricoid; (3) approach each other, so that their inner faces are, in part at least, in contact; (4) fold forwards at the crico-arytenoid joint, so that their tips come into contact with the lower part of the epiglottis. At the same time the aryepiglottic folds become tense, pulling inwards the lateral margins of the epiglottis, and so deepening its groove to receive the tips of the arytenoids and the Santorinian cartilages. Thus the entrance assumes the form of a squat **T**-shaped fissure, its transverse limb bounded in front by the epiglottis, behind by the ary-epiglottic folds, and its vertical or antero-posterior or mesial—the more primitive—limb by the arytenoid cartilages. The head of the **T** is curved concave backwards and its stem is short. A *slight* movement of the entire larynx upwards and forwards takes place—not nearly so much as in deglutition. The epiglottis does not *actively* move, and in deglutition, for instance, the bolus is seen to glide over its laryngeal surface, its lingual surface being closely pressed against the dorsum of the tongue. But all animals are not alike, and too little account has been taken of differences in the anatomy of the parts, these carrying with them, as they do, differences in their physiology. The foregoing account applies only where, as in man, the arytenoids are long and narrow: where they are high and broad they move more bodily forwards, and where they are low and narrow, *i.e.* small, neither folding nor movement forwards would suffice to close the orifice, and there the lower part of the epiglottis is permanently bent backwards, so that the contact of the arytenoids with the front wall of the laryngeal cavity is effected with a minimum of movement of the arytenoids and the true vocal cords are, as it were, under cover of a sort of hood formed by the epiglottis. The exact behaviour of the distal portion of the epiglottis varies; so does the value of the movement upwards and forwards of the entire larynx, even in individuals of the same species. The arytenoids in their mucuous membrane thus form a valve which, when it stands backwards, closes the food-channel and drafts the air forwards into the larynx, and when it lies forwards in deglutition closes the air channel and opens the food-channel. The external thyro-arytenoid muscles with the transverse arytenoid muscle, are the agents by which the before-mentioned four movements of the arytenoid cartilages are brought about. The aryepiglottic muscles tense the edge of the aryepiglottic fold, and cross to the base of the opposite arytenoid cartilage to avert the tendency they would otherwise have to pull asunder the arytenoids' tips. As worked out in the paper, it is seen that a very large number of details in the anatomy of the larynx receive an adequate explanation by this account of the closure of the larynx, *e.g.* the detailed anatomy of the muscles just mentioned, the sacculus, the structure of the false cord, the crico-arytenoid joint, its surfaces and ligaments, the anatomy of the larynx and its cavity in the different classes of animals, the ephithelial lining the cavity, &c.

"Birds are extremely instructive in this connection. Here the vocal function is entirely removed from the larynx, so that the larynx has for its sole office the guarding of the entrance of the trachea. Inspection and experiment show the entrance to be closed by the arytenoid cartilages, or bones, and the thyro-arytenoid muscles. Since this is their function in Birds (and the same applies to Tortoises, Lizards, Reptiles, Frogs, &c.) is it not all the more likely to be at least a function in Mammals?"

The plane of the larynx at the level of the glottis corresponds to the larynx in its more primitive forms—linear when closed, lozenge-shaped when open, bounded exclusively by cartilage and muscle. In man the vocal function has been superadded: all that lies above the level of the glottis has been built on that level, and the vibrating property has been got at a physiologically cheaper rate through fibrous than through muscular tissue. For details we must refer to the paper in the Proceedings.

January 28.—"Note on some Specimens of Rock which have been exposed to High Temperatures." By Prof. T. G. Bonney, D.Sc., LL.D., F.R.S.

The first described were two specimens of the micrograpite of Threlkeld (Keswick): the effect of heating (probably to about 2000° F.) had been to melt down the felspathic and the micaceous constituents, cracking, but not materially affecting, the quartz. Next, in overburnt brick (composed mainly of disintegrated granite) from Les Talbots (Guernsey) similar effects: partial melting of larger fragments of felspar: in one case twin planes could be traced within the melted part. Thirdly, five specimens of melted basalt from Rowley Regis. Four of these were glasses (one with spherulites), the fifth exhibited skeletal crystals of felspar with a peculiar grouping, rarely and imperfectly seen in naturally-cooled basalts. With these were compared two specimens of magma-basalts, obtained by the author from the Rowley mass, which exhibited a very different structure. The author suggested that this difference might be due to the absence of water from the artificially melted rock, which might also account for the rarity of tachylites in nature.

February 4.—"On the Mechanical Stretching of Liquids: an Experimental Determination of the Volume-Extensibility of Ethyl Alcohol." By A. M. Worthington, M.A. Communicated by Prof. Poynting, F.R.S.

After adverting to the three known methods of subjecting a liquid to tension, viz. (i.) the method of the inverted barometer, (ii.) the centrifugal method devised by Osborne-Reynolds, (iii.) the method of cooling discovered in 1850 by Berthelot, and pointing out that the first two afford means of measuring stress but not strain, while the third gives a measure of strain but not stress, the author proceeds to describe the manner in which he had used the method of Berthelot in combination with a new mode of determining the stress, and had succeeded in obtaining simultaneous measures of tensile stress and strain for ethyl alcohol up to a tension of more than 17 atmospheres, or 255 pounds per square inch.

The liquid, deprived of air by prolonged boiling, is sealed in a strong glass vessel, which it almost fills at a particular temperature, the residual space being occupied only by vapour. On raising the temperature, the liquid expands and fills the whole. On now lowering the temperature, the liquid is prevented from contracting by its adhesion to the walls of the vessels, and remains distended, still filling the whole and exerting an inward pull on the walls of the vessel. The tension exerted is measured by means of the change in capacity of the ellipsoidal bulb of a thermometer sealed into the vessel and called the "tonometer." This bulb becomes slightly more spherical, and therefore more capacious, under the pull of the liquid, and the mercury in the tonometer-stem falls. The tension corresponding to the fall is previously determined from observation of the rise produced by an equal pressure applied over the same surface.

The liquid is caused at any desired instant to let go its hold and spring back to the unstretched volume corresponding to its temperature and to its saturated vapour pressure, by heating for a moment, by means of an electric current, a fine platinum wire passing transversely through the capillary tube that forms part of the vessel. The space left vacant in the tube represents the *apparent* extension uncorrected for the yielding of the glass vessel.

The measures obtained show that, within the limits of observational error, the stress and this apparent strain are proportional up to the highest tension reached (17 atmospheres); but, since the small yielding of the nearly rigid glass vessel must itself be proportional to the stress, it follows that the stress and absolute strain are proportional.

By subjecting the liquid to a pressure of twelve atmospheres *in the same vessel*, it was found that the apparent compressibility was the same as the apparent extensibility, whence it is deduced that between pressures of + 12 and − 17 atmospheres the absolute coefficient of elasticity is, within the limits of observational error, constant. Its actual value is best obtained by observations of compressibility.

The paper concludes with a description and explanation of a peculiar phenomenon of adhesion between two solids in contact when immersed in a liquid that is subjected to tension.

Physical Society, January 22.—Prof. O. J. Lodge, F.R.S., Vice-President, in the chair.—Prof. G. F. Fitzgerald, F.R.S., read a paper on the driving of electromagnetic vibrations by electromagnetic and electrostatic engines. The author pointed out that as the electromagnetic vibrations set up by Leyden jar or condenser discharges die out very rapidly, it was very desirable to obtain some means whereby the vibrations could be maintained continuously. Comparing such vibrations with those of sound, he said the jar discharges were analogous to the transient sound produced by suddenly taking a cork out of a bottle; what was now required was to obtain a continuous electromagnetic vibration analogous to the sound produced by blowing across the top of a bottle-neck. In other words, some form of electric whistle or organ-pipe was required. These considerations led him to try whether electromagnetic vibrations could be maintained by using a discharging circuit part of which was divided into two branches, and placing between these branches a secondary circuit turned to respond to the primary discharge. This did not prove successful, on account of there being nothing analogous to the eddies produced near an organ-pipe slit. The analogy could, he thought, be made more complete by utilizing the magnetic force of the secondary to direct the primary current first into one of the two branches and then into the other. If spark gaps be put between two adjacent ends of the branches and the main wire, then the magnetic effect of the secondary current should cause the spark to take the two possible paths alternately. Electrically-driven tuning-forks and vibrating spirals were cases in which magnetic forces set up vibrations, but here the frequency depended on the properties of matter, and not on electrical resonance. The frequency of delicate reeds could, however, be controlled by resonance cavities with which they were connected, and he saw no reason why the same action could not be imitated electromagnetically, using an electric spark as the reed. Referring to the properties of iron in connection with electromagnetic vibrations, he pointed out that a prism of steel 1 millimetre long had a period of longitudinal vibration of about one-millionth of a second, and, as this was comparable with the rates of electromagnetic vibrations, the immense damping effect which iron had on such vibrations might be due to the setting up of sound vibrations in the material. Other methods of driving electromagnetic vibrations had suggested themselves in the shape of series dynamos or alternators. The polarity of a series dynamo driving a magnetic motor would, under certain circumstances, reverse periodically, and thus set up an oscillatory current in the circuit. Similar effects can be got from series dynamos charging cells or condensers. In an experiment made two weeks before, with Planté cells and a Gramme dynamo, reversals occurred every fifteen seconds. Greater frequencies might be expected with condensers. The latter case he had worked out theoretically. He had also tried experiments with Leyden jars and a dynamo, but got no result. This might have been expected, for the calculated frequency was such as would prevent the currents and the magnetism penetrating more than skin deep. Calling the quantity of electricity on the condenser Q, the differential equation for a dynamo of inductance L, and resistance r, and a condenser of capacity x is

$$\mathrm{L}\ddot{\mathrm{Q}} + r\dot{\mathrm{Q}} + \frac{\mathrm{Q}}{x} = \dot{\mathrm{L}}\dot{\mathrm{Q}},$$

or

$$\mathrm{L}\ddot{\mathrm{Q}} + (r - \dot{\mathrm{L}})\dot{\mathrm{Q}} + \frac{\mathrm{Q}}{x} = 0.$$

If $\dot{\mathrm{L}}$ be = o, the solution of the equation is

$$\mathrm{Q} = \mathrm{Q}_0 \epsilon^{-\frac{r}{\mathrm{L}}t} \cos 2\pi \frac{t}{\mathrm{T}},$$

and the rate of degradation of amplitude depends on the factor

$$\epsilon^{-\frac{r}{\mathrm{L}}t}.$$

If, however, L be greater than r, the exponent of ϵ becomes +, and hence Q would go on increasing until limited by the saturation of the iron or the increased resistance of the conductors due to heating. A dynamo without iron, provided one could be made to run fast enough to send a current through itself, would be likely to give the desired effect. The author thought that by making such a dynamo large enough and its armature very long, it would be possible to get a frequency of about one million. Electrostatic machines seem, however, to be more promising driving agents. Like series dynamos, their polarity depends on the initial charge, and can be easily reversed. Hitherto such machines have been inefficient mainly on account of the sparking in them, but Maxwell had shown how this could be obviated. There was the same kind of difference between electromagnetic and electrostatic machines as between Hero's engine and the modern pressure engine. Like modern engines electrostatic machines worked by varying capacity, but the effect of this variation in electrostatic machines was only to vary the frequency and not the rate of degradation. From the fact that electrostatic multipliers could be driven by alternating currents, he thought they might be made to drive alternating currents. If magnetic currents could be obtained, then electrostatic engines would easily be produced. In conclusion, the author described a modified electrostatic multiplier which he beli ved offered a feasible solution of the problem. In this machine the collectors were supposed joined to the ends of the vibrating circuit, and would therefore become + and − alternately. Inductors and brushes were to be so arranged that an insulating cylinder turning between them should have many + and − charges distributed alternately round its periphery. By suitable adjustment these charges could be collected at the proper instants so as to keep up the vibration.—The chairman, Prof. Lodge, said the paper was very suggestive and full of interesting points. The subject of electromagnetic vibrations was attracting great attention in America in connection with the manufacture of light. Hertz's oscillations die out too soon to be satisfactory, for their duration rarely exceeds a thousandth part of the interval between consecutive discharges. The theory of dynamos charging condensers he considered extremely interesting, and thought the fact that the damping factor could be changed in sign must have tremendous consequences.—Dr. W. E. Sumpner asked a question about a method of doubling frequency of alternation recently described by Mr. Trouton, in which the armature of one alternator excites the fields of a similar machine. Mr. Trouton had said that after once doubling the frequency it was not possible to go on doing so. He (Dr. Sumpner) thought that by adding other machines the frequency could be still further increased, and gave a proof of the fact. In reply, Prof. Fitzgerald said that adding another machine increased the frequency by a given amount and did not double the preceding one. Hence to increase the frequency a thousand-fold, a thousand machines would be required, and on this account Mr. Trouton considered it impracticable. Prof. S. P. Thompson thought the paper very suggestive, and the acoustic analogies very interesting. Melde's apparatus was an instance of doubling or halving a frequency. On reading the title of the paper, he had expected hearing of a method of maintaining electromagnetic vibrations by giving occasional impulses in some such way as that in which a tuning-fork could be kept vibrating by allowing the hammer of a trembling bell to knock against it. There was another method of intensifying electric oscillations which he had only seen mentioned in a patent specification by Sir W. Siemens, who suggested using a series dynamo with a telegraph cable to augment the signalling currents. On the subject of ironless dynamos he (Prof. Thompson) desired further information. Some years ago he had made calculations and found the speed at which they would require to run was so enormous as to be beyond the range of engineering possibility. Mr. C. V. Boys, referring to the author's suggestion of using an electric spark with alternate paths to maintain vibration, said that he had tried whether an oscillatory spark was displaced by a magnetic field, but the displacement, even when photographed by a revolving mirror, was barely appreciable. Prof. Perry asked for an explanation of the term "skin-deep magnetism." He was not previously aware that Sir W. Siemens had described a method of improving cable signalling by using a series dynamo. He himself had patented a somewhat similar arrangement. He had also made a dynamo without iron, but had not got it to work. In reply to Prof. Perry the author of the paper said that in electromagnetic vibrations the magnetic force alternates so rapidly that it could not penetrate far into the field magnet of a dynamo before it is reversed; hence the magnetism would only be skin-deep. Dr. Burton suggested that a commutator with many segments, something like that used by Mr. Gordon in his researches on specific inductive capacity, might possibly be employed for producing high frequencies.—A communication on supplementary colours, by Prof. S. P. Thompson, F.R.S., was postponed.

Entomological Society, January 27.—The fifty-ninth annual meeting, which had been adjourned from the 20th inst. on account of the death of H.R.H. the Duke of Clarence.—Mr. F. DuCane Godman, F.R.S., President, in the chair.—An abstract of the Treasurer's accounts, showing a good balance in the Society's favour, having been read by one of the Auditors, the Secretary, Mr. H. Goss, read the Report of the Council. It was then announced that the following gentlemen had been elected as Officers and Council for 1892:—President: Mr. Frederick DuCane Godman, F.R.S. Treasurer: Mr. Robert McLachlan, F.R.S. Secretaries: Mr. Herbert Goss and the Rev. Canon Fowler. Librarian: Mr. George C. Champion. And as other Members of the Council: Mr. C. G. Barrett, Mr. Herbert Druce, Captain Henry J. Elwes, Prof. Raphael Meldola, F.R.S., Mr. Edward B. Poulton, F.R.S., Dr. David Sharp, F.R.S., Colonel Charles Swinhoe, and the Right Hon. Lord Walsingham, F.R.S. It was also announced that the President would appoint Captain Elwes, Dr. Sharp, and Lord Walsingham, Vice-Presidents for the session 1892-93.—The President then delivered an address. After alluding to the vast number of species of insects, and to the recent calculations of Dr. Sharp and Lord Walsingham as to the probable number of them as yet undescribed, he referred to the difficulty experienced in preparing a monograph of the fauna of even a comparatively small part of the world, *e.g.* Mexico and Central America, and certain small islands in the West Indian Archipelago, upon which he, with a large number of competent assistants, had been engaged for many years. The examination of the collections recently made in St. Vincent, alone, had obliged him to search the whole of Europe and North America for specialists; and similar collections from Grenada were still untouched in consequence of the number of workers being unequal to the demands upon their time. He observed that the extent of the subject of entomology was so vast that nothing but a systematic and continuous effort to amass collections, work them out, and preserve them, could place us in a position to proceed safely with the larger questions which followed the initial step of naming species: and it would only be by the steady effort of our Museum officials, not only to work at the subject themselves, but to enlist the aid of every available outside worker, that substantial progress could be made. The President concluded by referring to the losses by death during the year of several Fellows of the Society and other entomologists, special mention being made of M. André, the Duke of Devonshire, Mr. F. Grut, Mr. E. W. Janson, Prof. Felipe Poey, Sir William Macleay, Mr. H. Edwards, Mr. Robert Gillo, and Dr. J. M. J. Af Tengström.

Geological Society, January 27.—Dr. W. T. Blanford, F.R.S., Vice-President, in the chair.—The following communications were read:—On the hornblende-schists, gneisses, and other crystalline rocks of Sark, by the Rev. Edwin Hill and Prof. T. G. Bonney, F.R.S. The authors refer to Mr. Hill's paper, published in 1887, for a general description of the island. They were led to examine Sark again in the hope that its rocks might afford some clue to the genesis of the hornblende-schist of the Lizard. They describe the structure, macroscopic and microscopic, of the various foliated rocks. These are:—(*a*) The basement gneiss, a slightly foliated, somewhat granitoid rock, probably of igneous origin, but with some abnormal environment, and possibly intrusive into, instead of older than the rock which succeeds it. (*b*) The hornblende-schists, almost identical with those of the Lizard, but in one case yet more distinctly banded. (*c*) Banded gneisses, sometimes rather fine-grained, variably banded; quartzofelspathic layers alternating with those rich in biotite or occasionally hornblende. Some of these gneisses resemble the "granulitic group" of the Lizard; others recall certain of the less coarse, well-banded gneisses of Scotland, *e.g.* south of Aberdeen. Sometimes they are much "gnarled" by subsequent earth-movements, by which, however, as a rule, the crystalline rocks of the island do not appear to have been very seriously affected. (*d*) A very remarkable group of local occurrence which exhibits great variety. In some places large masses of a dark green hornblende-rock are broken up and traversed by a pale red vein-granite or aplite. The former rock is drawn out into irregular lenticles, elongated lumps, and finally streaks, and has been melted down locally into the aplite. This then becomes a well-banded biotite gneiss, which macroscopically and microscopically agrees with types which are common among the Archæan rocks. Sark therefore presents an example of the genesis of such a gneiss, and the authors are of opinion that probably all the above-named rocks are of igneous origin, but became solid ultimately under somewhat abnormal conditions, to which the peculiar structures (which distinguish them from ordinary igneous rocks) are due. They attribute the banding to the effect of fluxional movements, anterior to final consolidation, in a mass to some extent heterogeneous. This hypothesis they consider may be applied to all gneisses or schists which exhibit similar structures—that is, to a considerable number (but by no means all) of the Archæan rocks. The second part of the paper consists of notes on some of the dykes and obviously intrusive igneous rocks of the island. Among these are four (new) dykes of "mica-trap," one of which exhibits a very remarkable "pisolitic" structure. The variety of picrite described by Prof. Bonney in 1889 (from a boulder in Port du Moulin) has also been discovered *in situ*. The reading of this paper was followed by a discussion, in which Major-General McMahon, Prof. Judd, Mr. Hudleston, Mr. Barrow, the Rev. Edwin Hill, and Prof. Bonney took part.—On the plutonic rocks of Garabal Hill and Meall Breac, by J. R. Dakyns and J. J. H. Teall, F.R.S. (Communicated by permission of the Director-General of the Geological Survey.) The plutonic rocks described occur in a complex forming a belt of high ground south-west of Inverarnan. They vary considerably in composition, and though gradual passages are sometimes found between more or less acid rocks, at other times the junction is sharp. The more acid are always found to cut through the less acid when the two rocks are found in juxtaposition, and fragments occurring in a rock are less acid than the rock itself. Though thus shown to be of different ages, they must evidently be referred to one geological period. The first rocks to be formed were peridotites; then followed diorite, tonalite, granite, and eurite in order of increasing acidity. The specific gravities, colours, and textures of the rocks are considered, and a detailed account of the constituent minerals given. The essential minerals are arranged in the following order, based on their general distribution in the different types of rock: olivine, pyroxene, hornblende, biotite, plagioclase, orthoclase and quartz, microcline. The following is the order in which the principal constituents commenced to form in the rocks: iron-ores, olivine, pyroxene, hornblende, biotite, plagioclase, orthoclase, microcline, and quartz. The chemical composition of the rocks is discussed, data being furnished by a series of analyses made by Mr. J. H. Player, and a diagrammatic representation of the molecular relations of the different bases and silica is given. The relations between mineralogical composition, chemical composition, and geological age are then considered; and the following conclusions are reached:—(1) That the various rocks have resulted from the differentiation of an originally homogeneous magma. (2) That the chronological sequence from peridotite to eurite is connected with the order of formation of minerals in igneous magmas. The paper was discussed by Dr. Hatch, Prof. Bonney, and Mr. Barrow.—North Italian Bryozoa; Part II. Cyclostomata, by Arthur Wm. Waters.

PARIS.

Academy of Sciences, February 1.—M. D'Abbadie in the chair.—Note on a structure placed on the summit of Mont Blanc, by M. J. Janssen. It will be remembered that, after failing to reach the rock through the snow on the top of Mont Blanc, M. Janssen, last October, made some observations in a temporary hut for the purpose of testing whether it was displaced appreciably by the movement of the snow. The observations failed to indicate any movement. On January 2 the hut was visited by M. Dunod, and some observations made in it at M. Janssen's request show that no change of place has occurred during this interval of four months.—Observations of solar spots and faculæ made with the Brunner equatorial (0·16 metre aperture) of Lyon Observatory during the latter half of 1891, by M. Em. Marchand. (See Our Astronomical Column.)—Temperate regions; local conditions of persistency of atmospheric currents; derived currents; origin and translation of certain cyclonic movements, by M. Marcel Brillouin.—On an extension of Sturm's theorem, by M. E. Phragmén.—On Laplace and Lavoisier's apparatus for measuring the linear expansion of solids, by M. E. Grimaux. The author has come into the possession of some copper-plates drawn by Lavoisier in illustration of his method of determining the coefficient of linear expansion. Pulls have been obtained from these plates and presented to the Academy.—On the compressibility of saline solutions, by M. Henri Gilbault.—On electro-capillary phenomena, by M. Gouy.—On the optical determination of high temperatures, by M. H. Le Chatelier. Some experiments have been made with the idea of measuring high temperatures by determining the intensity of the radiations emitted by a pyrometer of platinum, or clay, or other material, when compared with the light of a standard lamp. The results obtained indicate that the method is a good one. The principal difficulties, of course, depend upon the fact that the radiations emitted by an incandescent body are affected by conditions other than temperature. M. Le Chatelier, however, seems to have satisfactorily overcome these difficulties.—On achromatism, by M. A. Broca.—Barium and strontium nitrides, by M. Maquenne. These nitrides are formed by the direct action of nitrogen at a red heat upon the metals obtained from amalgams formed by electrolysis. The analyses given prove their composition to be represented by N_2Ba_3 and N_2Sr_3 respectively. They yield ammonia on treatment with water, and may be viewed as metallic ammonias. Barium nitride does not give ethyl bases when treated with alcohol. It reacts energetically at a red heat with carbon monoxide, producing barium cyanide and oxide. Strontium nitride similarly yields only a trace of strontium cyanide, the chief products being the oxide, carbonate, and carbon.—Carbon chlorobromides, by M. A. Besson. (See Notes.)—Action of metals on salts dissolved in organic liquids, by M. Raoul Varet. Certain metals, able to precipitate others from their salts dissolved in water, lose this property when certain organic liquids are used as solvents. This difference of action is due somewhat to the water and somewhat to the formation of molecular compounds formed by the union of the products present.—On monosodium mannite, by M. de Forcrand.—Transformation of sulphanilic into sulphanilocarbamic acid in the animal economy, by M. J. Ville.—Chemical study of the chlorophyll bodies of the pericarp of the grape, by M. A. Etard.—Researches on the adherence to the leaves of plants, and notably to the leaves of the potato, of copper compounds used to prevent their diseases, by M. Aimé Girard.—Development of the *organe vibratile* of Composite Ascidiæ, by M. A. Pizon.—On the locust (*Schistocerca peregrina*, Oliv.) and its changes of colour; *rôle* of the pigments in the phenomena of histolysis and histogenesis which accompany the metamorphosis, by M. Kunckel d'Herculais.—On the commencement and extinction of cambial activity in trees, by M. Emile Mer.—Absolute surfaces and relative divisions of the earth occupied by the principal geological groups, by General Alexis de Tillo. The author states the relative surfaces, of each of the present continents, which existed in different geological periods.—Investigation of the nature of the waters and mud of Lake Annecy, by M. L. Duparc.

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