THURSDAY, MARCH 8, 1894.

ELECTROMAGNETISM AND DYNAMO CONSTRUCTION.

A Text-Book on Electromagnetism and the Construction of Dynamos. By Dugald C. Jackson, B.S., C.E., Professor of Electrical Engineering in the University of Wisconsin, &c. Vol. I. (New York and London: Macmillan and Co., 1893.)

IN this work an excellent attempt is made to present the elements of a very important subject in small compass and in a clear and readable form, without any sacrifice of accuracy. The present volume is only the first instalment of the complete treatise promised by the author, but it contains in nine chapters, covering some 280 pages, a fairly comprehensive survey of the elements of electromagnetism, the magnetic properties of iron, magnetic circuits and characteristic curves of dynamos, a discussion of efficiencies, and the action of multipolar dynamos.

The primary definitions and statements regarding units, which are always a good test of the competency of at least the theoretical treatment in a book like the present, are generally clear and accurate. The author begins by discussing lines of force, and on p. 2 gives the needful caution that such lines "have no material existence, but are merely hypothetical." It might have been added here, perhaps, that this notion of lines of force is a concept corresponding to a state of the field produced by the presence of the magnetic distribution, that is to say that there is some kind of "displacement or motion of the medium" perfectly real though not material, the direction and amount of which is typified by the grouping of the lines of force.

On the same page it is stated that "when the lines of force in a magnetic field are parallel and of equal number per square centimetre a magnet pole will experience the same force at all points of the field, and the field is said to be uniform." This is, of course, quite correct; but it ought to be noticed that if the lines of force are parallel throughout any finite portion of the field, they must be of equal number per square centimetre, and *vice versâ*.

The usual definitions of $\mathbf{B}$ and $\mathbf{H}$ are given on p. 5, and we do not criticise in any adverse sense the author's procedure in so doing. But we cannot help thinking that it is much more conducive to clearness to give to each medium, whatever it is, a magnetic inductivity, and to consider this as a physical quantity depending on the medium. Thus, denoting the inductivity by μ, we should have the relation $\mathbf{B}=\mu\mathbf{H}$. Then if the inductivity of a standard medium be μ_0 we should have, for the same $\mathbf{H}$, $\mathbf{B}_0=\mu_0\mathbf{H}$. The ratio $\mathbf{B}/\mathbf{B}_0$ or μ/μ_0 is then properly the *permeability* of the former medium, and might be denoted by ϖ. This, it seems to us, would be much more in accordance with Lord Kelvin's original presentation of the matter. The permeability ϖ would be in all circumstances a mere ratio, and therefore of zero dimensions; while the confusion caused by at one time regarding μ as a mere number, and at another as a quantity having certain dimensions (for example, the dimensions of the reciprocal of the square of a velocity), would be entirely avoided. This procedure was recommended some time ago by Heaviside, and there can be no question of the desirability of its adoption. Instead of the equation

$$\mu = 1 + 4\pi\kappa$$

we should have

$$\mu = \mu_0 (1 + 4\pi\kappa)$$

where κ is the magnetic susceptibility, also a pure number. If, as Heaviside strongly advocates, "rational" units be adopted, the 4π must be omitted in these formulæ.

The ordinary mode of dealing with the subject begins by making $\mathbf{B}$ a quantity of the same dimensions as $\mathbf{H}$, and later when the energy of the electromagnetic field is discussed the definition of $\mathbf{B}$ is virtually altered, so that $\mathbf{BH}/8\pi$ becomes the energy per unit volume of the medium, and $\mathbf{B}$ has *not* the same dimensions as $\mathbf{H}$. This change may be explained, but it constitutes a sore difficulty to the student.

In the present case, however, the matter is not so important, as for the dynamo application it is sufficient to regard the relation as that which holds when μ_0 is put equal to 1. There is, however, essentially the same kind of difference between μ and ϖ that there is between density and specific gravity. The former depends on the units adopted, the latter does not.

A very good account is given in chapter iii. of the magnetic properties of iron. The more important recent researches on this subject are summarised, and the results illustrated by curves. The author seems, however, to have missed, or at any rate has not brought out, the point of Dr. Hopkinson's divided bar method, which was to test the total magnetic induction in the bar after certain specified series of changes of magnetic force had been applied. This object would not be attained by having the bar undivided and the coil fixed, and simply reversing the magnetising current, as Mr. Jackson suggests.

The description in this connection of a ballistic galvanometer as "a galvanometer with a rather heavy needle, and therefore a considerable time of vibration," has the merit of brevity, but is curiously inaccurate. It is no doubt an off-hand careless statement which has escaped correction in proof, but it may mislead a reader into supposing that weight of needle was in itself an advantage in such an instrument.

Hysteresis is adequately discussed in this chapter, and Steinmetz's formula for the energy dissipated in a cycle as depending on the quality of the iron and the number of cycles per minute is exemplified by numerical values found by experiment for different kinds of iron. Here we notice the phrases "watts of energy," "energy in watts," improperly used for "joules of energy," "energy in joules."

With regard to the discussion of energy-losses by hysteresis, it is worth remarking that no assertion can be made as to the disposal of the energy given to the medium (or taken from it) in an unclosed cycle. The ordinary diagram and mode of discussing it easily shows that at certain parts of the cycle more energy is given to

the medium, at others less, than is accounted for by the increase in electrokinetic energy, and that similarly when energy is being returned from the medium more or less is received than disappears from the electrokinetic energy of the field. It seems not impossible that these energy differences may be related to the cyclic changes of dimensions of a specimen of iron, which it has been shown recently by Mr. Nagaoka (*Phil. Mag.* Jan. 1894) accompany the cycles of magnetisation.

In chapter iv. we have a business-like discussion of what the author calls the establishment of electric pressures, in which the building up of a nearly uniform current by the commutation of successive sinusoidal currents in the different sections of the armature is described in the usual manner, but clearly and without undue elaboration. The winding of Gramme and Siemens armatures is dealt with in the same chapter, which ends with some numerical calculations of armature constants, and the heating caused by the Joulean dissipation of energy in the coils.

Hopkinson's method of studying dynamo construction by means of the idea of the magnetic circuit, in conjunction with his brilliant invention of dynamo characteristic curves, and the valuable practical results which he and others have obtained by this mode of investigation, have gone far to clear up the whole subject of the designing of steady-current machines. Prof. Jackson has done well to devote a considerable amount of space to this part of the subject; in fact, taking in the topics of regulation and connecting dynamos, it occupies no less than half the present volume. Opinions will no doubt differ as to the practical value of a good deal in this chapter, but the selection made seems satisfactorily dealt with.

Short chapters on efficiencies and multipolar dynamos conclude the volume. A second is promised on alternating current and arc lighting machinery.

As it is the object of the author only to present fundamental principles, and he very rightly holds that the electrical student should study typical dynamos mainly in the workshop or generating station, he has not burdened his pages with cuts of actual machines of different kinds. There the student who has had a sound course of instruction such as this book represents, based upon previous knowledge of certain cognate subjects, and satisfactory divergences into others, will be able to read to advantage what is essential of the more elaborate works of reference on dynamo machinery.

A small incidental advantage is the absence of those embarrassing folding plates, which cannot be avoided in works of the latter kind, and which, instead of being printed on cloth-backed sheets, arranged to fold always at the same place, are made of the most exasperatingly brittle and frail material.

The book is excellently printed in good, bold type, and reflects credit on the Norwood Press, Boston. There is less than we have seen in some other cases of that disagreeable glare of regularly reflected light from the hot-pressed paper, which renders many American books, notwithstanding their often excellent typography, so difficult to read with comfort.

A. GRAY.

INTERNAL COMBUSTION MOTORS.

A Text-Book on Gas, Oil, and Air Engines. By Bryan Donkin, Jun., M.Inst.C.E. (London: Charles Griffin and Co., Ltd., 1894.)

AS the results of recent researches on internal combustion motors are usually only to be found in the proceedings of our technical societies and institutions, we greet the present volume with pleasure. The gas engine in its present form has attained a lasting success, and this is due principally to the labours of Messrs. Crossley Bros., of Manchester, a history of that firm being really a record of the advance of the gas engine from its early stages to its present high state of development. The manifold advantages of a gas engine over a steam engine are evident, particularly when the power is required intermittently; moreover, for electric lighting, this type of motor is invaluable for small powers, being started at a few minutes' notice. For larger powers where town gas would be expensive, the addition of a Dawson gas plant renders it far more economical in fuel consumption than any steam engine, and with proper supervision the cost of repairs can be maintained at a low figure. Once started, a gas engine can be allowed to run for several hours unattended, thus reducing the cost of skilled attention to a minimum.

Experiments are now in progress with the object of reducing the consumption of gas in the Crossley Otto engine, and the following results show the progress made in this direction. A 14-h.p. nominal engine has recently been tested, and gave a brake horse-power of 39·91, and used 16·487 cubic of gas per b.h.p. per hour. These results are far in advance of the older engines, and show there are still means of improving what is already a wonderfully economical motor.

Mr. Donkin's work is divided into three parts, treating respectively of gas, air, and oil engines. Part i., on gas engines, is divided into two sections, the first dealing with the early history of these motors, and the second with modern gas engines. The subject of gas engines occupies more than half the book, and has been treated in a careful and very complete manner; most known engines are described and illustrated, and indicator diagrams are shown in many cases, thus rendering the descriptions very complete. Although the Atkinson engine has not come in for very general use, it is an excellent example of a type giving an impulse every revolution, using one cylinder, whereas the Crossley engine gives an impulse every two revolutions. Another engine of a similar type is that designed by Prof. Rowden, and although it is not described in this work, or elsewhere, yet the consumption of gas is very low per brake horse-power, and owing to the complete expansion of the heated gases the water jacket round the cylinder is not so necessary.

Part ii. of the volume under review deals with petroleum engines, a class of motor now rapidly coming to the front, and used in places where gas is not available. If Messrs. Crossley Bros. can claim the honour of having made the gas engine a practical working success, Messrs. Priestman can claim the same honourable position as regards the oil engine. Like all new machines it is more or less complicated, and recent engines made by other firms

are decidedly more simple. Here again we find Messrs. Crossley Bros. to the fore with an engine designed on the lines of their Otto gas engine, and certainly working economically and without trouble.

Part iii. deals with air engines, a subject which has occupied the minds of engineers for many years, and one which appears to baffle their best designs and schemes. These motors deal with low working pressures, and are necessarily bulky for their power. In the Ericsson engine, for instance, the pressure was only 3 lbs. per square inch.

The author says in the preface that, "in both oil and gas engines, about 40 per cent. of all the heat received now goes off in the exhaust gases, and about 35 per cent. in the jacket water." This is nothing new, and the remedy lies in the better expansion of the heated gases. This with the Crossley engine is difficult, but with Prof. Rowden's engine very complete expansion is obtained, and consequently a low pressure at exhaust and a far cooler cylinder. Of course this end is obtained by sacrificing simplicity of design and working parts; at the same time it is questionable whether it would not be worth while experimenting in this direction, considering the great saving to be obtained by more complete expansion. The question of compounding gas engines has not been overlooked, more than one having been constructed; but difficulties have arisen in connection with the valves, and these have only partly been overcome. The difficulty of making a valve to continually pass hot gases is enormous. Yet this is evidently the direction in which economy is to be found, and its solution is merely a question of time.

Another point of importance in the economy of the gas engine is the question of accuracy of manufacture; a badly made gas engine is sure to be a constant trouble, and as many now on the market are bad copies of the Crossley engine without its accuracy and finish, one is not surprised to occasionally hear of failures of this class of motor.

This volume contains a very complete and accurate record of all that has hitherto been done in the design of internal combustion motors. The information has been well brought together, and the illustrations are exceptionally good. The author is to be congratulated on the completion of an excellent book on a subject very little understood by general engineers. N. J. LOCKYER.

PHYSIOLOGY FOR SCIENCE SCHOOLS.

Human Physiology. By John Thornton, M.A. (London: Longmans, Green and Co., 1894.)

THE book before us belongs to a class which requires some apology for its existence. This particular work has been prepared for lay students intending to present themselves for the second or advanced stage of the Science and Art Department. It aims at being something more than a mere cram book, and in justification of this aim it professes "to furnish precise and accurate information on such parts of histology and anatomy as are required, as well as to give a reasoned account of the physiological processes of the human body." For all this, however, the book belongs to a class to which exception may justly be taken. The writer appears to have depended almost entirely upon the existence of descriptive physiological works for his material. The result is that the book represents simply a compilation of physiological facts, and in no sense can it be described as a guide to physiological practice. The South Kensington examinations, both elementary and advanced, attempt, as far as their opportunities permit, to test the practical acquaintance of a candidate with the subject in which he presents himself for examination. This is very frequently found to be non-existent, and most usually the reason of this is that the teacher himself is not in a position to act as an instructor in the practical work of a subject he professes to teach. There exists a large number of books which give the minimum of the required amount of physiological fact necessary to impart to his pupils, and upon these alone he usually depends. This class of books gives the teacher no information as to the best way to demonstrate practically the facts he teaches, for the reason generally that the writers themselves are unacquainted with the methods. These books are the class which we would wish to see abolished from our elementary science schools; they are necessarily unreliable, and they always tempt the teacher who uses them to depend upon a wholly artificial knowledge of little practical value whatever. What advantage is it to a student to know that if fibrin be "placed in gastric juice and the mixture kept at a temperature of about 40° C. . . . in about an hour the fibrin will be in great part dissolved"? By itself this is simply a naked fact (though stated in the way the writer puts it, it can hardly be called a fact). The whole process could be shown the student in the most simple way on the lecture table, and unless he actually sees the change produced by the gastric juice, he can, as a rule, have but an imperfect idea of what really occurs.

All these books that aim at being guides to elementary science teaching should have so much simple instruction as to the methods to be adopted to actually show the different processes described, as can be done, having regard to the opportunities of an elementary science school. In physiology a very considerable knowledge can be imparted simply by demonstration, and to ignore this and depend simply upon oral description is to teach physiology in a way that, we are glad to say, is rapidly becoming obsolete. If this volume were supplemented with practical demonstration, it might serve a useful purpose. But the divorce from practical acquaintance with the subject is frequently emphasised. In referring to coagulation, the writer says that "by adding to plasma about 14 per cent. of a saturated solution of sodium chloride a white flaky sticky precipitate of fibrinogen is thrown down." The author intends to be precise, but there is a considerable difference between the statement above and the actual fact, viz. that solid sodium chloride should be added so that it becomes dissolved to the extent of 14 per cent. Later, in treating of the absorption of food, the author commits himself to the following statement: "We know of a physical process called *filtration*, by which is meant the passage of fluids through the pores of a membrane under pressure. Substances that may be obtained in the form of crystals, or

crystalloids, as they are termed, filter easily when in solution. Glue-like substances, or colloids, as they are termed, filter with difficulty." Statements like these are calculated to mislead a student as to the differences between simple filtration and dialysis.

On the whole the book gives a large amount of information in a very small compass, and this is, speaking generally, accurate. One of the best features is the wealth of illustration, selected from well-known text-books, which it possesses. J. S. EDKINS.

OUR BOOK SHELF.

Light: an Elementary Text-book, Theoretical and Practical, for Colleges and Schools. By R. T. Glazebrook, M.A., F.R.S. (Cambridge: University Press, 1894.)

THE best foundation upon which a student of science can build is elementary physics, for the necessity of accurate observation and correct reasoning is impressed upon him from the very beginning. Mere book-work has no value in training the mind in this direction: lectures illustrated with experiments may lead to the desired end if the teacher take care that the inferences to be drawn from the experimentation are quite clear; but best of all methods, by far, is to let the student perform the experiments himself, to mark the result, and then reason out the explanation. The advantages to be derived from such practical work are incalculable, yet the small number of physical laboratories in our schools and colleges at the present time shows that its importance has not been fully recognised. There are, however, signs of improvement. Judging from the increasing number of books dealing more or less with practical physics, interest in that subject is developing. Mr. Glazebrook's two volumes, that on "Heat," recently noticed in these columns, and the one now before us, help to extend the practical method of teaching. Believing with most scientific educationalists that courses of practical instruction are necessary to the proper understanding of fundamental principles, Mr. Glazebrook gives, in the volume under review, clear descriptions of experiments, the explanations of the theory underlying the work, and the deductions to be made from the results. The theoretical portion of the book could very well form the subject of short lectures preceding the laboratory work, in which the principles expounded at such times could be experimentally tested. The book abounds with diagrams of the kind that appertain to treatises on light. To the artistic mind these figures lack beauty, but they possess the qualification of clearness; and that is sufficient to commend them to the student of optics. Teachers who require a book on light, suitable for the class-room and the laboratory, would do well to adopt Mr. Glazebrook's work.

Beni Hasan. Part ii. By P. E. Newberry. With appendix, plans, and measurements of the Tombs, by G. W. Fraser. (London: Kegan Paul, 1893.)

SOME two or three months ago we called the attention of readers of NATURE to the first part of Mr. Newberry's work on the rock-hewn XIIth dynasty tombs at Beni Hasan in Upper Egypt, and we have now the pleasure to record the appearance of the second and concluding portion of this valuable book. We have already described the general scope of the publication, and the plan upon which it has been carried out, and it therefore only remains for us to state the contents of the part before us. Employing the same method of arrangement, Mr. Newberry describes tombs Nos. 15-39, and he gives lists of all the members of the households of the Egyptian noblemen who were buried at Beni Hasan; the general remarks which he makes upon them are interesting and to the point. Too much praise cannot be given to the thirty-seven plates which illustrate the text, for they give the reader an accurate idea of the general appearance of the scenes painted upon the walls of the tombs. Mr. G. W. Fraser's "Report" (pp. 71-85) is also a very useful addition to the book, and the copies of Greek and Coptic *graffiti* on pp. 65-68 will be welcome for several reasons. We are glad to see that the system of transliteration of Egyptian texts has been much modified, especially as the non-expert will now be able to gain some idea of its meaning and use. It is a great pity, however, that the system as represented in Dr. Birch's "Egyptian Texts" was not wholly adopted.

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.*]

Great Auk's Egg.

IN your last issue (p. 412), I observe a letter from Prof. Newton, in which he gives his version of the history of the egg of this extinct bird, which was recently sold by auction for £315. There is no doubt that the egg was brought to this country by Yarrell, who purchased it in France some time before 1838, in which year it was figured by Hewitson in his well-known work on birds' eggs. But the question is, whereabouts in France did he find it? Prof. Newton, who well remembers it in the collection of Yarrell, says: "He told me, as he told others of his friends, that he bought it *in Paris*, in a little curiosity shop of mean appearance," and that he paid two francs for it. He adds that the only "variant" of this story deserving of consideration, is to the effect that the price was five instead of two francs. If this were the only "variant," it would not be worth further discussion. But there is a very different story told of it in Mr. Symington Grieve's important work on "The Great Auk, its history, archæology, and remains," published in 1885. At p. 105 of this volume, Mr. Grieve writes of this very egg:—

"The following curious story, which is well-known to ornithologists, is so remarkable that we repeat it, and give a copy of Mr. R. Champley's original note, dated June 1, 1860: Mr. Bond [who became the purchaser of the egg in question upon Yarrell's death] says to R. C.—Yarrell told him that, walking near a village *near Boulogne*, he met a fishwoman having some guillemot's eggs. He asked her if she had any more; she said she had at her house. He went, when he saw hanging over the chimney-piece four wild swans' [eggs], with a great auk's [egg] hanging in the centre. She asked two francs each for them. He bought the auk's, and two swans'. She said her husband brought it from the fisheries. The great auk's egg sold at Stevens's sale to Mr. Gardner for £21, [and was] sold again by him to Mr. Bond for £26. Copied by R. Champley at Mr. Bond's, by whom the history was told."

Here then we have an important "variant" of Prof. Newton's version; and as it was taken down in writing in 1860, within four years of Yarrell's death, from the lips of the the late Mr. Bond, who had it from Yarrell himself, it seems to me that it ought not to be passed over in silence. At any rate, it affords some justification to the writers referred to by Prof. Newton (see the *Times* of February 23), who, commenting upon the recent remarkable sale, have naturally repeated the only history they could find of this egg, namely, that published in the latest book on the subject.

J. E. HARTING.

On M. Mercadier's Test of the Relative Validity of the Electrostatic and Electromagnetic Systems of Dimensions.

IN connection with the clear exposition of the true dimensions of electrical units given by Prof. Kücker in NATURE of the 22nd ult. it is well to bear in mind that Maxwell *long before the publi-*

cation of his book, namely, in the first report to the British Association on electrical standards (see report of the Newcastle meeting of the Association in 1863, p. 160) called attention, in a "Note on the Table of Dimensions," to the provisional character of the electrostatic and electromagnetic series recommended by the committee, and since widely adopted.

He there points out that "if we take into account the coefficient of magnetic induction of the medium in which we work," this quantity, μ, will enter into the dimensional equations; and he gives an illustration of this under a particular hypothesis. The whole note is worthy of very careful attention.

This pregnant note, so far as my memory serves me, was omitted from the reprint, by Prof. Fleeming Jenkin, of the British Association reports on electrical standards, and may now be easily overlooked. It seems, therefore, well to call attention to it. G. JOHNSTONE STONEY.

8 Upper Hornsey Rise, N., February 26.

Experiments in Elementary Physics.

I NOTICE on p. 379 a description of a new form of Boyle's tube used by Dr. J. Joly. The following, which I have now used for about six or seven years, I have found very convenient for school use, where it is a disadvantage to have much pouring to or fro of mercury.

A piece of Sprengel tube about 1 m. long is fastened along a metre scale, one end having been previously closed. The metre scale is then mounted so as to be capable of rotating about a horizontal axis, and a thread of mercury about 30 cm. long is introduced into the tube so as to leave an air space 20 to 30 cm. long at the closed end. The volume of air is read off along the scale, and the pressure varied by rotating the tube about its axis, and measuring the vertical height of the mercury column. By this means pressures greater or less than one atmosphere can be easily obtained, and the product v.p. shown to be constant with considerable accuracy if ordinary precautions are taken.

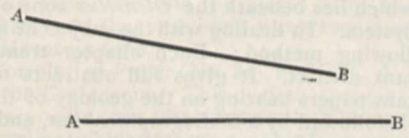
To show that when the volume is constant the pressure of a gas varies with the absolute temperature, I use a vertical tube about 40 cms. long, surrounded in the upper part by a water jacket. The upper end is closed, and the lower connected by stout rubber tubing to a long tube fixed to a wooden arm—the end of this arm nearest to the vertical tube being hinged to the base board. The two tubes are filled with mercury, so that it rises to a certain mark on the vertical tube, and nearly fills the long tube when the surfaces are about the same level. The air in the vertical tube is heated by passing steam into the water in the jacket, and when the desired temperature is reached, the wooden arm with its tube is raised till the air resumes its former volume. The pressure is then the height of barometer + diff. in height of the two mercury surfaces.

A method of illustrating magnetic lines of force, which I have found useful, is to thrust a magnetised knitting-needle through a cork so that it can float vertically in a large vessel of water. If now a magnet is supported just above the water surface, the needle moves along a line of force. The lines due to two or more magnets may easily be traced out on this plan.

Blairlodge School, Stirlingshire. W. RHEAM.

Spectacles for Double Vision.

MANY years ago, on recovering consciousness twelve hours after a railway accident in which my jaw was broken, I saw everything double in this position:—



The image seen by one eye was lifted above that seen by the other to the extent of about one-eighth the distance of the object, and was shifted a little to one side, while the two images were inclined to each other at an angle of about twelve degrees. This double vision still continues. It produced little inconvenience until I had to use spectacles for reading and writing; but the forcible bringing of the two images together then injured one eye so much that it soon became of little use. I found that to use one eye alone was equally bad; a white fog seemed to rise before the one not in use, and it speedily became almost blind. A five weeks' sea voyage, where I had nothing to read, improved the weak eye wonderfully. After consulting some of the best oculists and opticians, I got a pair of spectacles made with prismatic lenses, which brought the centres of the two images together, but left them still inclined at the same angle. Rotating these lenses simply shifts the images parallel to themselves. After two years' use the spectacles had produced a beneficial effect; but the improvement stopped half-way—like the half-remedy.

Fortunately, I met Mr. C. Vernon Boys, F.R.S., of South Kensington, explained my difficulty, and he at once pointed out the remedy, as follows:—A pair of right-angled prisms are placed in the form of a rhombus, and a small distance apart. When one is turned relatively to the other about the common visual axis, the image is turned through double the angle. When one is turned relatively to the other about a direction perpendicular to that axis in a horizontal plane, if the greater face of the prism is horizontal the image is raised or lowered. If the two prisms are turned together about the common visual axis, the image is shifted to the right or left. The images seen by the two eyes can thus be made to coincide exactly in every respect.

I have had a pair of prisms mounted in this fashion on common spectacles in front of the stronger eye. The prisms have facets only seven-sixteenths of an inch square; they are very light, and although small, yet give a sufficient field of view. There being now absolutely no strain on the weak eye in reading or writing, I have no doubt an improvement will soon set in.

I think this information should be disseminated among oculists and opticians, as the contrivance might be useful to others similarly afflicted. T. I. DEWAR.

Recent Local Rising of Land in the North-west of Europe.

DURING January of 1894 the local papers of Sweden, Norway, and Finland reported the occurrence of underground shocks or tremblings of the ground, accompanied with noises. The zone seems to be east and west on about 60° of latitude, from about Drammen in Norway across Sweden to Hangö on the southern part of Finland.

In Norway shocks were felt at the beginning of this year in several places. On the night of January 2, tremblings of the ground were felt at Navnaa, in Grue (lat. 60° 28′), and at several places in Solör, throughout the whole night and also on the following night. Loose things in the houses were much shaken, and an examination of the earth surface showed cracks about 2 cm. wide in several places.

On the night of January 3, three strong shocks were felt at Lower Eker in Mjöndalen (lat. 59° 38′). The last one shook the houses and all loose things.

In Sweden, on the night of January 3, a shock and underground noise was heard at Hedemora (lat. 60° 20′), and lasted two seconds. A shock was also felt at Mora in Dalarne (lat. 61°), and a crack in the ground, 2 cm. wide and one kilometre long, was found to have resulted from it. On January 24 a shock was felt in Dalarne at Stora Tuna (lat. 60° 27′). It lasted only two seconds. The same trembling was also felt at Uddnäs (about thirty English miles to the west from Tuna).

An underground noise, not very strong, was heard at Finspong (lat. 58° 40′). It lasted one and a half minutes.

A strong underground shock was felt on February 1 at Wilhelmsberg in Asker (lat. 59° 35′). It appeared to pass from north-west to south-east, and gave rise to a sound like thunder in the Iron mine department, and was felt at a distance of two miles from this place.

In the town of Ekenäs (lat. 60°), in the south-west corner of Finland, underground shocks were felt on the evening of January 2, and repeated until 2 o'clock in the morning. The shock was felt strongest in an open field to the west of the town, where three cracks in the ground were visible; one of these rents had a length of 240 feet, and crossing this was another running west, and of 400 feet length. Some people believed that the ground was raised. The following day two more shocks were felt, but they were not so strong as the preceding ones.

Stockholm, February 18. C. A. LINDVALL.

Apogamy in *Pteris serrulata* (L. fil.) var. *cristata*.

CASES of apogamy are so rare and so intrinsically interesting, that it may be worth the while to record at once the following fact:—

About a fortnight ago, while preparing prothallia for imbedding in paraffin, my attention was called by a student to a specimen obtained from a pot containing a fine plant of *Pteris serrulata cristata*.

The prothallium was of somewhat unusual form, perfectly destitute of archegonia and antheridia, but yet had midway between base and apex a peculiar protuberance. This I suspected to be a young sporophyte apogamously developed.

The prothallium was imbedded in the usual way, and yesterday it was cut into a series of sections. These demonstrate conclusively, I think, that the prothallium was apogamous, for while there is no trace of an archegonium, I find, in the first place, *a row of scalariform tracheides*, and in the second place—except over a limited area, where I believe the apex of the root has been separated off by the appearance of a conical split—there is *no sharp distinction between the cells of the sporophyte and gametophyte*.

It should be added that my examination of the sections was necessarily a hurried one, and that at present it is impossible to be *certain* that the prothallium was developed from a spore of *P. serrulata cristata*. The ferns of the garden and house where the prothallium grew, however, included no known apogamous forms.

It is not unlikely that I may be unable to follow the matter further, and this must be my excuse for making public, without further investigation, this interesting fact. A. H. TROW.

University College of South Wales and
Monmouthshire, February 27.

Fireballs.

THE large meteor of February 21 last, mentioned in NATURE of March 1 (p. 419), was also observed by me at Bristol. The time was noted at 7h. 18m., and the meteor was estimated as bright as Jupiter, but its light was much dimmed by the fog, low on the northern horizon, where it appeared. Its direction of flight was not well determined, the path being short and rapidly traversed in a place barren of visible stars, but it was roughly recorded as from 252° + 53° to 253½° + 49°. Comparing it with the description by Mr. Greig at Dundee, and with notes from North Lincolnshire and other places, it seems the meteor disappeared at a height of about thirty miles over Bolton, Lancashire; but the place and height of its first appearance are not satisfactorily indicated. The probable radiant is in Ursa Major. A good observation from Ireland, or the north-west part of England, would be very useful in assigning the precise path.

A fine example of a fireball, visible in sunshine, was afforded by the meteor of February 8, 0h. 28m. p.m., which appears to have been very widely observed in this country. Its real path was from a point above the Irish Sea, west of Southport, where its approximate elevation was seventy-five or eighty miles, and from thence it passed rapidly over Lancashire into Yorkshire, finally disappearing near Leeds at a height of twenty miles, or possibly less. Its radiant point was in Hercules, and the direction of its motion from west by south to east by north. This daylight fireball may have had its origin in the same system as that which supplied the brilliant fireball seen in the evening twilight of February 7, 1863, the radiant of which was about 270° + 35°.

Bristol, March 4. W. F. DENNING.

Astronomy in Poetry.

À propos of the subject of "Astronomy in Poetry," permit me to quote one verse from "The Faërie Queene" of Spenser:—

> Yet all these were, when no man did them know,
> Yet have from wisest ages hidden beene:
> And later times thinges more unknowne shall show.
> Why then should witlesse man so much misweene,
> That nothing is but that which he hath seene?
> What if within the Moones fayre shining spheare,
> What if in every other starre unseene
> Of other worlds he happily should heare,
> He wonder would much more: yet such to some appeare.

I have followed the spelling and the punctuation of the text of the "Globe" edition (1879).

Kendal, Westmorland. G. W. MURDOCH.

RECENT PUBLICATIONS OF THE AMERICAN GEOLOGICAL SURVEY.

TO initiate and to be left behind—that seems to be the fate of England in the latter half of the nineteenth century. In science, at any rate, it is too often so. A sight of the volumes—fourteen in number, the earliest dated in 1891—with which our table is loaded, a glance at those which are already ranged upon our shelves, indicate that this is emphatically true of the work of the Geological Survey. We mean no reproach to British men of science or to the British surveyors. The State despises the one and starves the other; and the "people love to have it so"; for what care they for learning or research, unless it will obviously put money into the pocket? But this is a large question, and our space will not suffice even for an adequate notice of the volumes before us. These consist of one bound octavo volume on the mineral resources of the United States (the eighth of a series), nine paper-covered numbers of the *Bulletin*, slightly larger in size, ranging from thirty to five hundred and fifty pages; two volumes, still larger, of the Annual Report (eleventh), and yet two volumes of Monographs of quarto size.

Passing by the first as of commercial rather than of scientific interest, we come to the *Bulletin*. Four of the numbers, smaller than the others, though they make up to full 220 pages, have little in common. No. 90 is a report of work done in the Division of Chemistry and Physics, mainly during the years 1890–91. It contains several studies and analyses of special minerals, including a research on certain micas, vermiculites and chlorites, and a note on the colloidal sulphides of gold, in which it is suggested that the separation of free gold in the upper strata of the earth's crust may have been effected by the action of sulphuretted hydrogen on chloride of gold, at no very great depth, though at one less than that at which pyrites is formed. The report concludes with a number of analyses of miscellaneous rock specimens. No. 91 is a "Record of North American Geology for 1890," a very useful bibliography of papers, &c., classified not only under names of authors, but also under subjects. No. 93 is a pamphlet by Mr. S. H. Scudder, on "Some insects of special interest, chiefly from Colorado," and No. 94, which is about the same length, is by Mr. E. S. Holden, on "Earthquakes in California in 1890 and 1891."

The larger volumes of the *Bulletin* are all "Correlation Papers," or memoirs written on some one geological period, by a specially qualified author, "for the purpose of summarising existing knowledge with reference to the geologic formations of North America, and especially of the United States; of discussing the correlation of formations found in different parts of the country with one another and with formations in other countries; and of discussing the principles of geological correlation in the light of American phenomena." Of these four memoirs the largest (No. 86), written by Prof. C. R. van Hise, deals with the "Archæan and Algonkian" systems.

By these names the author designates the vast mass of rocks which lies beneath the *Olenellus* zone of the Cambrian system. In dealing with the subject he has adopted the following method:—Each chapter treats of some important district. It gives full abstracts of the more important papers bearing on the geology of that district, which is followed by a bibliographical list, and concluded by a summary of the results. More than four hundred pages are thus occupied, and the work is ended by a long chapter (about eighty pages) on "general successions and discussion of principles."

The author employs the term Algonkian for "the pre-Olenellus clastics and their equivalent crystallines," and Archæan for the completely crystalline rocks below

them. The latter system, accordingly, "has no limit downward. It is the oldest system, and surely includes, if such rocks exist, all of the original crust of the earth." The upward limit also is not easily defined, but "it is frequently easy in the field to say, with a great degree of probability, what rocks are Archæan and what post-Archæan." Thus the former system includes the original Huronian of Logan, which the author inclines to think separable into two divisions, the lower of which comes nearer than the upper to assuming a crystalline character. It also covers the Animikie and the Keweenawan of Irving; in short, a vast group of rocks which are generally clastic in origin, and seldom more than sub-crystalline in character, in certain of which undoubted traces of life—though very rarely—have been found. The origin of the Archæan system is considered to be a problem yet unsolved. Its rocks are highly crystalline, and if any have been formerly sediments all traces of a clastic origin have been completely lost. It certainly constitutes a complex, probably to no small part of igneous origin, and the author evidently inclines to the view "that this earliest crystalline complex was produced under conditions differing from those of the rocks of any subsequent period." He would employ the term Laurentian in a more restricted sense than that in which it was used by Logan for the gneissoid part of the Archæan, while he dismisses most of the six pre-Cambrian rock systems of the late Sterry Hunt and his school as hypothetical existences to which the atmosphere of the laboratory was more congenial than the air of the field.

In a subject so difficult as these pre-Cambrian rocks, where so many things are yet unsettled, Prof. van Hise cannot expect to satisfy all readers. Speaking for ourselves, we think he is disposed to attribute too much potency to dynamic metamorphism—an agency which is being rather "boomed" at the present time—and to admit on too slight evidence that in "Silurian, Devonian, and even later times, completely crystalline schists have been produced over large areas"; for in the past this assertion has been so often made, and so often proved to be erroneous, that on the principle, "once bit twice shy," we are disposed to be a little sceptical. But whether we accept or whether we demur to the author's conclusion, we gladly welcome his volume as a contribution to the history of the pre-Cambrian rocks which will be invaluable to students, and is full of sagacious criticism and suggestive remarks.

The next Correlation Paper (No. 85), written by Mr. I. C. Russell, deals with the Newark system, which occupies a series of rather elongated outcrops in the Eastern States, and runs along the shore of the Bay of Fundy. The fragmental rocks of this system, which includes the well-known New Red Sandstone of Connecticut, vary from coarse to fine; a few thin seams of coal and limestone are also present. Dykes and sheets of basalt, &c. occur in almost every area. The system is limited by an unconformity, both above and below, and is not easily correlated precisely with those of Europe, but the reptiles, amphibia, and crustacea correspond generally with those of the Keuper, the fishes with the Mesozoic rather than with the Palæozoic, and the plants with the Upper Trias or Rhætic, so that it evidently represents an early portion of Mesozoic time.

A third Correlation Paper (No. 82), by Mr. C. A. White, deals with the Cretaceous. This system occupies in the interior a very wide zone (the southern half being the less uniform in outline) which extends roughly from latitude 28° to 60°. Further north are some outlying patches; near the Pacific coast is a long string of the same, and in the Southern States east of the Mississippi a crescentic area. The rocks, especially in the Interior Basin, have been affected in many places by great displacements both during and after Cretaceous times, but though over a large part of this region they have been elevated from about one to five thousand feet above the sea, they generally lie almost horizontally; these displacements are more frequent in the Lower than in the Upper Cretaceous. Also much volcanic material was extruded during this period as well as after its close. In the Interior Basin marine deposits alternate with freshwater, but the latter predominate, showing that the land was more often above than below sea level.

The Eocene forms the subject of another Correlation Paper (*Bulletin* No. 83), by Dr. W. B. Clark. The rocks of this period occur in the same regions as the Cretaceous, but occupy much less extensive areas in the western half of the continent, while they are more largely developed in the south-east, extending from the Mexican frontier to New Jersey State. The last, as is well known, are marine, and comparable with the deposits on the other side of the Atlantic, but the correlation of the various groups of the Interior Basin, including the transitional Laramie deposits, is very difficult, probably because the flora and fauna of these inland waters, as they were changing from brackish to fresh, present so few points of comparison with other regions. Still, Dr. Clark's clear summary of the main results of investigation, and of the succession of the strata, will be very helpful to the student.

The last *Bulletin* before us (No. 84), by Messrs. W. H. Dall and G. D. Harris, describes the Neocene. This term is supposed to include the Tertiaries other than Eocene. We have not troubled to inquire to whom belongs the honour of its paternity. If it does not mean New-new, then words respectively more applicable to persons and things are combined. Perhaps the one half was intended to apply to the animals, the other to the rocks; or perhaps—what is more usual with geologists—nobody troubled himself to think whether the term was sense or nonsense. The memoir, however, is full of valuable and interesting information, for it deals with the final shaping of the American continent and the development of its fauna; but with this bare mention we must be satisfied.

Of the two volumes of Monographs, one (No. xvii.) has a melancholy interest, for it is the last work of "the Nestor of American palæobotanists," Leo Lesquereux, left barely complete at his death. The memoir on the "Flora of the Dakota Group" has been edited by Prof. F. H. Knowlton. The Dakota group appears to correspond more closely with the Cenomanian of Europe; thus its plants have an exceptional interest, since they "pertain to an epoch in which, by the appearance of the dicotyledons, the character of the flora of the globe has been modified as by a new creation. The cause or reason of this marked change remains still unexplained." The flora described by Prof. Lesquereux consists of 460 species, of which 429 are dicotyledons. Sixty-six plates illustrate their remains, and the volume concludes with an analysis of the results of the investigation, which is of interest to more than palæobotanists. We must, however, restrict ourselves to stating Prof. Lesquereux's conclusion: that the flora of North America is not the result of migration in past geological times, but an indigenous one. All the plants of the American Cenomanian (except those of Ficus and the Cycads) might still find a congenial climate in the United States between latitudes 30° and 40°—that is to say, in localities at most a very few degrees (perhaps five) further to the south. Since the Cenomanian epoch the land surface between the Rocky Mountains and the Alleghanies has suffered no physical change of importance, for the general absence of drift deposits from these vast plains indicates that they were not greatly affected even by the glacial epoch. "The result has been a prolonged uniformity of climate and, of course, the preservation of the original types of the flora, subjected to some modification of their original

characters, without destroying them or forcing their removal by the introduction of strange or exotic forms."

The second volume of the Monographs (No. xviii.) describes the Gastropoda and Cephalopoda of the New Jersey Marls and accompanying beds; the Lamellibranchiata and Brachiopoda having been already the subject of a memoir (No. ix.). These deposits are generally glauconitic; the fossils are casts, often ill-preserved, so that the determination of them has been not seldom attended by great difficulties; they bear a superficial resemblance to those from the Cambridge Greensand of England, and the rock contains a certain proportion of phosphate of lime, though these casts do not appear to be, strictly speaking, phosphatised. The Marls, as is well known, are mostly Cretaceous in age, no part representing the Neocomian, but the uppermost beds are referred to the Eocene. Beneath the last are indications of a very slight break: so that systems which in our own country and the adjacent parts of Europe are separated by a wide gap, in this region are practically continuous. The beds—which may possibly be Neocomian—beneath the Marls, called the Raritan clays, are brackish or even fresh water in origin; the Marls themselves are marine, but shallow water deposits. The Cretaceous members contain the usual cephalopods, which come chiefly from the lower Marls, as indeed do most of the other fossils. Among these are seven species of Ammonites, four of Scaphites, and three of Baculites; Turrilites, Heteroceras, Ptychoceras, and Belemnitella are each represented by one species. None, however, appear to be individually common, and most are rare. The Eocene contains one Nautilus and one Aturia. The Gastropoda are fairly numerous, 136 in the Cretaceous and 52 in the Eocene. As the former volume showed, the Lamellibranchiata are more strongly represented in the Cretaceous than in the Eocene, and in the former deposit dominate over the Gastropoda; the Brachiopoda are in neither numerous. The illustrations in this volume exceed fifty plates.

The eleventh annual report is in two parts. The first, after the usual official matter, contains two lengthy memoirs; the first, almost a volume in itself, by Mr. W. J. McGee, entitled the "Pleistocene History of North-Eastern Iowa," the second, by Mr. A. J. Phinney, on the "Natural Gas Field of Indiana," with an introduction by the former author. In the "Pleistocene History" Mr. McGee gives a very full and interesting account of the drifts of a large area of Iowa, with maps illustrative of the conclusions which he considers them to justify. The region appears to have been twice invaded by ice, the earlier glaciation being "the longer and the more energetic." Glacial striæ, however, are very rarely found, in consequence, probably, of the incoherence of the rock masses to this region. As memorials of these invasions of the ice-sheet, an upper and lower till can generally be distinguished; and the latter sometimes shows crumplings, interpreted as memorials of the pressure of the second ice-sheet; between these tills a kind of "forest-bed" is frequently to be found. By each advance of the ice-sheet, rivers were dammed and great lakes formed on its margin, in the waters of which materials were deposited from the ice and from other sources, much of this being a stiff clay, locally named "gumbo." During the first invasion the land sank; perhaps sufficiently to allow of an invasion of the sea. A similar but less extensive subsidence took place in consequence of the second invasion. These depressions aided in the formation of the lakes. A summary this, necessarily very imperfect, but it may suffice to indicate the general conclusions at which the author has arrived.

The second memoir contains a vast amount of information concerning the natural gas and oil wells of Indiana, and is prefaced by a general sketch of the distribution of bituminous deposits. The commercially valuable bitumens occur (not in America only) in the Lower Silurian rocks, and continue to comparatively recent times, but the most important are found in the Silurian and Devonian systems, and in the Tertiary series. In the first the products are chiefly gas; in the second both are found, petroleum probably predominating; while in the third nearly all the known forms occur.

The second part of the report deals exclusively with irrigation. Maps and details of the arid region of the United States are given, from which it appears that this extends from their northern frontier to the 32nd parallel of latitude, and from the eastern slopes of the Sierra Nevada approximately to the 100th parallel of longitude, thus including the great Inland Basin and the Rocky Mountains. On the ranges, however, there is a considerable amount of precipitation. As stated by Major Powell, in evidence before a Committee of Congress, the rainfall on the mountains may vary from 25 to 60 inches per annum, while in the valleys below it is generally less than 15, and sometimes even as small as 3 inches.

These publications, as this imperfect sketch may indicate, are full of varied and valuable information, and are richly illustrated with maps, plates, and woodcuts. If we might venture on a general criticism, it would be that the authors not seldom exhibit a tendency to "spread themselves" too much, to be over-diffuse in style, and to enter upon general disquisitions, which, however interesting, are a little out of place in official publications. Space also seems occasionally to be wasted in giving information which would be more appropriate in a text-book of geology. As the volumes are primarily designed for the people of the United States, the authors may be presumed to know best the desires of their own public, but this redundancy is sometimes a little wearisome to outsiders. Possibly the recent reduction of the vote for the support of the Survey, which we trust will not be permanent, may be intended as an expression of this feeling. Very probably some economies might be effected, but it will be an ill day for this branch of science if the work of the Geological Survey of the United States is seriously cramped.

T. G. BONNEY.

MEASUREMENTS OF LOW VAPOUR PRESSURES.

THE two well-known methods of measuring vapour pressures are the statical and the dynamical. In the former the pressure exerted by a vapour is measured when the substance is kept at a given temperature, while in the latter the temperature is ascertained at which the liquid boils when under a given pressure. The present volume is mainly concerned with the description of, and the results obtained by, a dynamical method of estimating very low pressures for mixed as well as for pure substances; the pressure range extending, in general, from about zero to a maximum which is below 70 mm.

Before proceeding to the description of this method, the author seeks to clear away certain discrepancies which have been recorded regarding the results of vapour pressure observations as given by the statical and dynamical methods. Dynamical observations on the fatty acids, published by himself in 1885, differed considerably at low pressures from those obtained by Landolt in 1868 from statical measurements. From the fact that the differences varied regularly with the chemical nature of the acids, it appeared possible that at very low pressures the two methods led to different results. A historical summary of work on this subject is

[1] "Studien über Dampfspannkraftsmessungen." In Gemeinschaft mit Paul Schrœter und andern Mitarbeitern von Georg W. A. Kahlbaum. Basel: Benno Schwabe, 1893.)

given, which serves to show that whereas Dalton and Magnus definitely asserted that such a difference existed, Regnault, on the other hand, although he held it to be theoretically possible, found that it could not be detected in the case of pure substances. Regnault's observations, however, were not made at very low pressures, and his observations on water seemed to indicate that in this region a difference really existed. To test this point, the author carries out dynamical observations on water and mercury at pressures below 60 mm., and ascertains that they are in perfect accord with published statical observations. He next repeats Landolt's statical observations on the fatty acids, taking elaborate precautions to introduce dry and air-free substances into the barometer tube, and obtains results agreeing with those given in 1885 by the dynamical method. Landolt's results are thus held to be inaccurate, the presence of moisture in the liquids used being regarded as the disturbing factor. This assumption is shown by Konowalow's observations to explain why the differences varied, as already indicated, with the chemical nature of the acids.

It is therefore concluded that statical and dynamical methods give the same results even at the lowest pressures. This could hardly be otherwise, however, from the fact that in the dynamical method employed a current of air bubbles is allowed to pass continually through the liquid, ample free surface being thus allowed for evaporation.

As the dynamical method is the more easily carried out, and as the results obtained by it are affected to a much less extent by traces of moisture, &c., than those given by the statical method, it is adopted for the examination of pure and mixed substances. The apparatus here employed consists of a Beckmann's boiling-point flask which is connected up with a large air reservoir fitted with a manometer. The reservoir may be exhausted either by a water pump or by an automatic mercury pump. The liquid is made to boil in the flask, which, as usual, contains glass beads, and a current of air-bubbles is allowed to pass through the liquid. The thermometer is immersed in the liquid, preliminary observations with a pure substance having shown that the same results were thus obtained as when the thermometer was suspended in the vapour. On account of the high efficiency of the mercury pump, observations could be taken when the liquid was boiling into almost a perfect vacuum.

The substances operated upon are the first ten normal fatty acids, the first three iso-acids and monochloracetic acid, together with mixtures of the acids themselves, and of formic acid and acetic acid, with varying amounts of water. Excellent drawings of the apparatus used, including the various pumps employed, mercury joints, &c., and curves representing the results obtained, in which 1 c.m. corresponds with 1 mm. and 1° are supplied separately along with the volume. The graphical representation of the results, and indeed the whole contents of the book, indicate that the research has been carried out with the greatest care.

As the numbers obtained are to be discussed and compared with those of other observers in a second volume, which has not yet appeared, it is perhaps out of place to say much by way of criticism at this stage. It is to be hoped, however, that in vol. ii. Ramsay and Young's work will be more fully considered, for in the present volume, especially when dealing with the identity of the values given by statical and dynamical methods, it receives anything but its fair share of recognition.

J. W. RODGER.

NOTES.

AT the coming meeting of the British Association, which will be held at Oxford, under the Presidency of Lord Salisbury, Prof. A. W. Rücker will preside in Section A (Mathematics and Physics); Prof. H. B. Dixon in Section B (Chemistry); Mr. L. Fletcher in Section C (Geology); Prof. Bayley Balfour in Section D (Biology); Captain Wharton in Section E (Geography); Prof. Bastable in Section F (Economic Science and Statistics); Prof. Kennedy in Section G (Mechanical Science); Sir W. H. Flower in Section H (Anthropology); and Prof. Schäfer in the new Section I (Physiology). The evening discourses will be delivered by Prof. J. Shield Nicholson and Mr. W. H. White. Sir Douglas Galton will be proposed as President for the meeting in 1895, at Ipswich.

PROF. BURDON SANDERSON, F.R.S., and Mr. T. Pridgin Teale, F.R.S., have been selected by the University Board o the Faculty of Medicine to represent the University of Oxford at the International Medical Congress to be opened at Rome on March 29.

THE annual Congress of the British Institute of Public Health will be held in London, from July 26 to 31, 1894, under the presidency of Dr. W. R. Smith. It will be arranged in five sections: Preventive Medicine, Chemistry and Climatology, Engineering and Building Construction, Municipal and Parliamentary, and Naval and Military Hygiene.

AN imperial *iradé* has been issued, a Turkish paper says, ordering the establishment in the chief town of each province of an antirabific laboratory similar to the one which has been working for some time in the capital. These Pasteur institutes will be established first of all in the chief towns of the most distant provinces of the empire, such as Yemen, Bagdad, Damascus, Erzeroum, and Monastir.

MR. KARL PEARSON has resigned his appointment as Gresham Lecturer on Geometry.

SEVERE earthquake shocks were felt in Odessa and other parts of Southern Russia on Friday and Sunday last.

DR. ELBS, Professor of Physical Chemistry in Freiburg University, has been appointed Professor in Giessen University.

MR. PETER JAMIESON has resigned his position on the scientific staff of the Fishery Board for Scotland.

THE death is announced of Emeritus Professor Swan, who held the Chair of Natural Philosophy in St. Andrews' University for twenty years.

M. EUGÈNE CATALAN, whose death we announced last week, was inadvertently stated to be connected with the Paris instead of the Brussels Academy of Sciences. Though born in Bruges eighty years ago, he was educated in Paris, and accepted French naturalisation. He entered the Polytechnic School in 1834, and was afterwards admitted into the civil engineering service, but gave up his post in order to devote himself to the teaching of mathematics, in which vocation he was very successful. He obtained a Professor's Chair at Charlemagne, and, at a later period, one at St. Louis College, and was also a *répétiteur* in the Polytechnic School. When the revolution of 1848 broke out, he ranked with the Republican party. After the *coup d'état*, however, he refused to take the oath of office, and returned to his native country, resuming his Belgian citizenship, and accepting a professorship in the School of Mines at Liège. He was the author of a large number of books on mathematics, and published many interesting theorems, principally relating to geometry and the theory of numbers.

THE Allahabad *Pioneer* says that the prize given by Sir Charles Elliott for scientific research in India has been awarded to Babu Chandra Kanta Basu, Madripur. His essay deals with the phenomenon known as the Barisal Guns.

WE learn from the *British Medical Journal* that a prize of 10,000 roubles (£1000) is offered by Count Orloff-Davidoff for the discovery of a remedy "perfectly certain to cure or to protect horned beasts against cattle plague." The efficacy of the remedy is to be proved by the same standard as those known to science as protective against small-pox, anthrax, swine fever, &c. The award of the prize is in the hands of the Curator of the Imperial Institute of Experimental Medicine of St. Petersburg acting on the advice of a committee of experts selected for the purpose. The competition is open to the whole world with the exception of active members of the above-named institute. The description of the proposed remedy must be clear and complete; it must be sent in, under the ordinary conditions as to concealment of the identity on the part of the author, on or before January 1, 1897. The award of the prize will be made on January 1, 1899. If no remedy satisfies the committee, a further competition will take place, and the award made on January 1, 1902.

MR. F. G. JACKSON, whose scheme of Arctic exploration from Franz Josef Land as a base has been frequently referred to in NATURE, announces definitely that he will set out on his expedition this summer, the whole cost of equipment being borne by Mr. Alfred C. W. Harmsworth, of St. Peter's, Kent.

THE Canadian Geological Survey, not content with mapping the peopled and fertile regions of the Dominion, have for several years been actively engaged in exploring the vast tracts of utterly unknown lands in the far north. Mr. J. B. Tyrrell, who has had much experience in pioneer work, started from Lake Athabasca in June 1893, with his brother Mr. J. W. Tyrrell, to cross the Barren Lands in canoes on the unmapped rivers. From Black Lake a portage was made to the head of a river, the Doobaunt, sketched in, from native report presumably, on Stieler's Atlas, but shown in practically the same position as the Messrs. Tyrrell found it to occupy. Descending this river and its chain of connected lakes for over 800 miles, they reached the head of Chesterfield Inlet on Hudson Bay in the beginning of September, and after completing the survey of that region, made a perilous canoe voyage in the open sea to Fort Churchill, whence the journey was pursued on foot, Winnipeg being reached, after many hardships and much suffering, early in 1894. Mr. A. P. Low, of the same Survey, carried out an important piece of exploration last summer, passing through the centre of the Labrador peninsula from the south to Ungava Bay on Hudson Strait, in the course of which he crossed 750 miles of country hitherto quite unknown. Mr. R. G. McConnell was also engaged in explorations on the upper valley of the Peace River, in the Rocky Mountain region.

SOME time ago, in the Gurhwal district in India, an immense slip from a precipitous mountain blocked the valley of the Behai-Ganga River. The dam is some nine hundred feet high, and is already consolidated in its lower portions. The water confined within it has now reached a height of 450 feet, and is fast increasing. It is feared that the winter rains will cause a sudden overflow of the water, and bring an overwhelming disaster to the villages in the valley beneath. Nothing can be done to avert the disaster. Lieutenant Crookshank, R.E., is stationed near to watch the progress of events, and give timely warning.

OUR contemporary and namesake, *Die Natur*, has an article by Dr. Karl Müller on Prof. Philippi's paper, to which we recently called attention, on the analogies between the floras of Chili and Europe. He regards them as furnishing a striking example of the general law that similar conditions will produce, on the most widely separated portions of the surface of the earth, the same type, whether of animal or vegetable life, but in different forms.

WE learn from the *Circular* of the Johns Hopkins University (Baltimore), that Captain John Donnell Smith has signified his intention of presenting to the University his valuable botanical library and herbarium, as soon as a suitable building shall be offered for their reception, and provision made for their maintenance in connection with a department for instruction and original work in botany. They are already open to the students in botany at the University. The herbarium is one of the largest and best selected private herbaria in existence, and is especially rich in the flora of Guatemala and other parts of Central America, where Captain Donnell Smith has made large collections himself, including a great number of new species and some new genera. This indefatigable collector has again started on another visit to Central America.

DURING the afternoon of February 23, a remarkable oscillation of the barometer took place in the northern parts of these islands, accompanied by a south-westerly gale of great force and suddenness. At 8 a.m. the reading published by the Meteorological Office for Stornoway was 29·39 inches, being a fall of 0·7 inch since the previous day, and at 6 p.m. the reading was 28·58 inches. But from a tracing of a self-recording aneroid, kindly sent to us by Mr. R. H. Scott, F.R.S., it appears that the minimum occurred there about 4 p.m., and was about 0·3 inch lower than the 6 p.m. reading. The fall during the eight hours preceding the minimum had been 0·9 inch, and between 2 and 4 p.m. the barometer fell at the rate of nearly 0·2 an hour, while the rise during the next two hours (as shown above) was nearly as rapid. This remarkable oscillation was fully borne out by the changes at other stations, where they were probably smaller in extent. By 8 a.m. on the 24th the centre of the disturbance had travelled in a north-easterly direction to the coast of Norway.

AT the Society of Arts, on the 28th ult. Mr. G. J. Symons read an interesting paper on "Rainfall records in the British Isles." About forty years ago, Mr. B. Denton read before that society a paper pointing out the advantage of daily rainfall values, and giving the means for about 100 stations, and in 1860 Mr. Symons printed in the *Builder* a summary for the year 1859; subsequently he obtained some small grants from the British Association, which enabled him to continue his useful work with great success. In the year 1860 the total number of stations from which he received records was only 168, but in the year 1892 the number had increased to 2850. Ireland has not a fair share of stations, although a large number of rain-gauges have been gratuitously distributed; the returns only amount to 192. The question of the size of the gauge was discussed, from those of 1 inch to those of 6 feet in diameter, and the practical result is that the rainfall collected does not differ as much as 5 per cent. in any case, and for the smaller gauges it agrees within less than 2 per cent., so that it becomes merely a question of the most convenient size for use. As regards the influence of elevation on the amount of rain collected, the decrease is owing chiefly to the velocity of the wind being greater at a height. The first observations of this kind were made by Dr. Heberden on the top of Westminster Abbey more than a hundred years ago. Prof. Hellmann has also shown that if a gauge on a roof can be screened from the wind, the rainfall will not differ materially from the amount measured on the ground. Among the various diagrams exhibited was one representing the relative rainfall of about 160 successive years. From 1730 to 1750 the rainfall was considerably deficient, and there was no period of more than five consecutive wet years down to very recent times, but from 1875-83 there were nine consecutive wet years. Attention was drawn to the peculiar fact that

since the year 1812 every year ending with 4 had less than the average rainfall, excepting that every twelfth year reckoning from 1860 has had more than the average rain. According to this, the present year should be a dry one. Another diagram represented a notable instance of a torrential rain which occurred in the metropolis on June 23, 1878. It is an unusual thing in London for an inch of rain to fall in twenty-four hours, but in this case 3¼ inches fell in an hour and a half.

THE U.S. *Monthly Weather Review* for November contains some remarks by the editor on a series of measurements of the growth of trees, made by Mr. J. Keuchler, of Gillespie County, Texas, about two hundred miles north-west from the Gulf Coast at Indianola. Mr. Keuchler seems to have adopted the idea that a tree bears the history of its climatic surroundings written in itself, and that its annual rings of growth vary in size mainly with the supply of water to the roots, so that broad rings indicate wet years, and thin rings that can scarcely be distinguished with the naked eye denote dry years. After carefully selecting trees for his measurements, he felled three oaks, two of which were over 130 years old. He cut a perpendicular section from each trunk near the thick end, planed its surface very smooth, and then varnished it over, which made the annual ring distinctly visible. From each section a table was prepared of the relative order and position of the annual rings; upon comparing these three tables they were found to correspond exactly, thus indicating that moisture is the principal cause of the difference in the breadth of the rings. Taking the width of the respective rings as a criterion of moisture, the record of 134 years shows 6 years extremely dry; 8 very dry; 19 dry; 17 average; 18 wet; 60 very wet; 6 extremely wet. The editor of the *Review* points out that the large number of very wet years is not at all in accord with the rainfall records during the years 1840 to 1890, and, in fact, no region on the globe is known where the distribution of the rainfall is similar to that given by these records. It is evident, therefore, that the breadth of the annual rings of growth adopted by Mr. Keuchler as corresponding to dry and average and wet seasons needs considerable modification. The width of the annual rings depend, at least in part, upon the evaporation, the sunshine, the temperature, and the distribution of rain in frequent showers or in frequent heavy floods. It is the combination of several favourable meteorological circumstances that must have produced the large number of broad rings which Mr. Keuchler has attributed to 60 very wet years and 6 other extremely wet years. In fact, the editor continues, it is best not to attempt to establish any fine details as to the climate from such a record of tree growth, but to be content with the general statement that there were 14 years during which the climate was unfavourable for the increase of woody fibre, 54 years during which there was an average favourability, and 66 years that produced large growth owing to very favourable conditions. All that can safely be concluded is that during 134 years there were 66 in which the rainfall was well conserved for the use of the tree.

A PAPER, by Dr. G. Agamennone, on the velocity of propagation of the principal earthquakes felt at Zante during 1893, was communicated to the Reale Accademia dei Lincei in December last. The method adopted for the calculation of the velocity was that used by Newcomb and Dutton in the case of the Charlestown earthquake of August 31, 1886. (*Amer. Jour. Sci.* vol. xxxv. 1888, p. 1.) For the earthquake of January 31, 1893, a velocity of 4·040 kilometres per second was obtained, with a probable error of 1·120. The earthquake of February 1, 1893, appeared to have travelled with an average velocity of 3·280 ± 0·700 kilometres per second, and that of March 20 was propagated at the rate of 2·330 ± 0·330 kilometres. In these three cases, Strasburg, at a distance of 1600 kilometres, was the most remote station from Zante at which records of the wave were obtained. The disastrous shock of April 17, 1893, was recorded at Zante at 6h. 30m. 20s., Rome mean time, and it reached Potsdam, 1730 kilometres distant, at 6h. 41m. 40s. From these times, and those obtained at eight intervening stations, a velocity of 2·340 ± 0·300 kilometres was calculated. The rate of progression of the wave felt on August 4 was 2·120 ± 0·27 kilometres per second. Taking all five earthquakes, and including only the observations of the times of maximum phase, a mean velocity of 2·43 ± 0·07 kilometres was obtained. The mean velocity derived from a discussion of the commencement of the disturbances on the seismograph records was 3·085 kilometres; but whether the difference is due to the higher velocity of the first earth tremors, or merely results from the inability of some of the seismographs to record very small movements, seems to be doubtful. The point is an important one, however, and one to which attention should be directed.

SINCE the experiments of Profs. Reinold and Rücker on the thinnest liquid films, the peculiar behaviour of the black areas in soap films has become well known. Herr F. Kohlrausch, in *Wiedemann's Annalen*, describes a method of producing glass films of equally slight thickness, which share the remarkable stability of black liquid films. These are obtained by blowing out one of the duplex capillaries used by the author for mounting electrodes. These blow out into spheres with a partition across the centre, which may be reduced to extreme thinness. Those which exhibit Newton's colours of the first and higher orders break very soon, but those which are reduced far enough to appear black are sufficiently stable to keep indefinitely. Any moisture must be pumped out of the sphere, and the openings sealed up. The black areas are almost indistinguishable from holes in the plate, but show slight reflection at large angles of incidence. A peculiar phenomenon connected with these spheres is the note they give out during cooling. This note often lasts half a minute, and is analogous to that of a Trevelyan instrument with the exception that air is substituted for lead.

THE results of the investigations that reached a successful termination during the first year of the existence of the Yale Psychological Laboratory, New Haven, Conn., have just been published under the editorship of Dr. E. W. Scripture. One of the most important of the papers in the volume bears the title "Investigations on Reaction-Time and Attention," and is by Dr. C. B. Bliss. The general results of the experiments are summed up asfollows: (1) The experiments did not indicate any difference in reaction-time produced by changing the colour of the light present in the field of vision. (2) No difference was detected between the times of reactions in the dark and those made while looking at a stationary incandescent light of six-candle power. (3) When this light was in motion the reaction-time was lengthened. (4) No difference was detected between the times of reactions in silence and those made while listening to the steady sound of a tuning-fork making 250 vibrations per second. (5) When the intermittent sound of a metronome was substituted for that of the fork, the reaction-time was lengthened. (6) The reaction-time to a sound heard in both ears is shorter than when the sound is heard only in one ear, even after making allowance for the difference in intensity.

THE ninth annual report of the operations of the U.S. Bureau of Ethnology during the fiscal year 1887–88 has recently been issued. Bound up with the report are two papers, in one of which Mr. John Murdoch describes the ethnological results of the International Polar Expedition to Point Barrow, Alaska; while the other, by Captain J. G. Bourke, contains a mass of information concerning the medicine-men of the Apache Indians. Mr. Murdoch's paper is a simple and exhaustive account of the

Eskimo of Alaska, containing all that is noteworthy about that body of people. Captain Bourke thinks that the title of "shaman" might be substituted with advantage for that of "medicine-man;" for this awkward compound, invented by early explorers in North America, must always mislead by conveying some implication of therapeutics. It is pointed out that medicine-men are but the priests of a form of belief and practice called shamanism, known in many parts of the world as a phase in religious evolution. Hoddentin, the pollen of the tule, is supposed by Apaches to possess mystic properties, and bags filled with it are worn as amulets and used as charms. Captain Bourke points out the similarity between the use of the tule pollen and that of the kunque or sacred corn meal of the Zuñi, and dwells upon many analogues to their practices found in both hemispheres. The izze-kloth is the magic cord of the Apache, and Captain Bourke gives a very complete description of it. He associates these cords with the quipus of the Peruvians and the wampum of the north-eastern tribes of America, and discovers analogies among nearly all the races of the earth, paying special attention to the rosaries and belt cords of the Roman Catholic Church. Major Powell remarks that though some people will hesitate to adopt all Captain Bourke's deductions, everyone will agree with his conclusions as to the necessity of breaking up, by the exhibition of true science, the sorcery and jugglery practices which both retard the civilisation of the tribes, and shorten and destroy the lives of many individuals among them.

A *Jahrbuch* has been published containing the results of observations made at Magdeburg Meteorological Observatory during 1892, under the direction of A. W. Grützmacher.

A "BULLETIN DES PUBLICATIONS NOUVELLES," just issued by MM. Gauthier-Villars et Fils, contains descriptions of all the works published by them during the latter half of last year.

THE results of botanical studies carried on at the University of Minnesota are to be reported in a serial, which will be published under the title "Minnesota Botanical Studies," edited by Prof. Conway M'Millan.

MR. JOHN ELLIOT, Meteorological Reporter to the Government of India, has issued the Monthly Weather Report, summarising the chief features of the weather in India during the month of September 1893.

MESSRS. W. WESLEY AND SON have issued a new "Natural History and Scientific Book Circular," No. 121, containing the titles of the works on natural history, scientific expeditions and voyages, anthropology, and ethnology, that they have for sale.

THE description and discusston of the meteorological observations made in Belgium during last year, contributed by M. A. Lancaster to the 1894 *Annuaire* of the Royal Observatory, of Belgium, has been published separately by F. Hayez, Brussels.

A TREATISE entitled "Researches on Matrices and Quaternions," by Dr. T. B. van Wettum, has been published by E. J. Brill, Leyden. The memoir is divided into four parts, dealing respectively with the matrix of the second order, some properties of versor-arcs, the matrix as a unit-quotient of vectors, and the solution of a linear vector-equation.

MESSRS. G. BELL AND SONS have just published the first part of an "Analytical Geometry for Beginners," by the Rev. T. G. Vyvyan. The book deals with the straight line and circle in a simple manner, and should be of use as an introduction to more advanced works on analytical geometry. The explanations are full, and the examples are numerous and properly graded.

MR. C. M. IRVINE, writing from Fence, Lesmahagon, calls attention to the excessive rainfall measured at that place during last month. With a gauge our feet above the ground, the total fall measured was 8·96 inches, and for this year 12·69 inches. The measurements for the same months, during a period of seven years (1887–1893) gave an average of 4·468 inches, and for the month of February 2·020 inches.

AN uncommon work in Japanese binding, printed on Japanese paper, and set up in Japanese characters, has been received. The author is Mr. Tokutaro Ito, and the work contains a number of papers, chiefly on botany and zoology, brought together and published in commemoration of the ninetieth birthday of his grandfather, Keisuke Ito. Among other subjects, the essays deal with the *Burmanniaceæ* of Japan, *Oxyria digynia*, Hill, found in Japan, and the revision of Japanese Pedicularis.

MESSRS. JARROLD AND SONS have just published a new and interesting work entitled "Object Lessons in Botany from Forest, Field, and Garden," by Mr. E. Snelgrove. Botany rightly taught is the most pleasurable of sciences; and the guiding principle adopted by the author in the preparation of his book, namely, that of using common objects for illustration of unknown characters and functions, not only arouses interest, but must impart a large amount of sound instruction. The book will be useful to teachers in elementary schools, and should be a means of opening pleasant paths to their young students.

TWO new volumes have recently been added to the Aide-Mémoire Series edited by M. Léauté, and obtainable from MM. Gauthier-Villars, or G. Masson, Paris. In one of the books, entitled "Gîtes Métallifères," by Prof. L. de Launay, the author deals chiefly with statistics relating to the production and use of metals, taking the metals one by one, and giving the annual consumption of each, and the sources of the ores. Mining engineers and metallurgists will find the book useful. The second work referred to above—"Construction des Navire," by Prof. A. Croneau—contains a good course on the principles of ship construction.

THE *Annuaire de l'Observatoire Royal de Belgique* has arrrived at its sixty-first year of issue. M. Folie contributes to the present volume an essay on variations of latitude; three articles on the determination of the constants of mutation and aberration; and one in which the question as to the direct or the retrograde movement of the instantaneous pole is discussed. M. Niesten writes on variations of latitude, and the Perseid meteors of 1893. M. Vincent gives instructions for the observation of periodic natural phenomena, and M. Lancester describes the weather in Belgium during last year. The *Annuaire* contains the usual record of astronomical discoveries, meteorological observations, and statistical tables.

DR. A. DODEL'S "Biologischer Atlas der Botanik" (*Iris* series), published by C. Schmidt, Zurich, contains as excellent a set of coloured botanical diagrams as it is possible to desire for teaching purposes. The collection comprises seven large wall maps, upon which sixty-seven figures of parts of *Iris sibirica* are depicted. The figures illustrate the root, stem, leaves, flowers, and fruit of the plant in an admirable manner, the magnification being stated in each case, and in accuracy of delineation and beauty of reproduction they could hardly be excelled. The whole of the illustrations are from original drawings contained in an unpublished monograph by Dr. Dodel.

A BULKY volume just issued, vol. viii. of the "Travaux et Mémoires du Bureau International des Poids et Mesures,"

has for its contents the first part of a memoir by Dr. Max Thiesen, entitled "Kilogrammes Prototypes." The paper contains the results of comparisons of the weights of forty-two standard kilograms, designated *Prototypes nationaux*, made by Dr. Thiesen between 1886 and 1888. Of the 251 comparisons made, 230 were executed according to the scheme adopted by the International Committee of Weights and Measures in 1886; the remaining 20 had for their object the determination of the influence of transport on the prototypes. The plan of observation and all the elements used in the reduction of the observations are included in the present paper; but the details of the investigation, and the discussion of the results, are reserved for a future volume.

THE astronomical observations made by Tobias Mayer, at Göttingen, from 1756 to 1761, were published in 1826 by the Commissioners of Longitude. Five years later, Baily's memoir on Mayer's catalogue appeared, together with a comparison of the places of most of the stars with those given by Bradley. The celebrated "Sternvergeichniss" has again been discussed, this time by Dr. A. Auwers, with the assistance of other astronomers, and the results are given in a volume published by Engelmann, of Leipzig. The catalogue thus produced contains the places of 1027 stars computed for the epoch 1755.0. The volume also includes a discussion of Mayer's positions with those given by Bradley and others for the same epoch, a good series of proper motions being obtained by the comparison.

IN these democratic days, very few journals affect to ignore the requirements of that undefinable quantity—the general public. This is what *Science Progress* does, however, in its first number, a copy of which has been sent to us. All the articles in this new publication are what our friends across the Channel term *articles de poids*—solid dissertations on the present state of knowledge of various subjects. Prof. Fitzgerald contributes a suggestive article on physical science and its connections, and Mr. J. W. Rodger describes the new theory of solutions founded by van't Hoff. Insular floras are passed in review by Mr. W. B. Hemsley, and the importance of the study of fossil plants is made out by Mr. A. C. Seward. The origin and nature of certain bacterial poisons forms the subject of an article by Dr. G. A. Buckmaster; the present outlook of vertebrate morphology is discussed by Prof. G. B. Howes, and a summary of the most important papers recently published in chemical physiology, or physiological chemistry, is given by Prof. W. D. Halliburton. Such are the subjects dealt with in the new magazine. References lie on the pages as thickly as leaves in Vallambrosa, and show the immense amount of work that has been done. The new venture appears to stand in the same relation to the majority of scientific journals as the heavy monthlies do to weekly newspapers. We hope that it will meet with a large measure of success.

IN a recent number of *Électricité* (Paris), M. G. Claude gives an account of some experiments he has made on the electric arc in an alternating circuit. The phenomena produced by the disruptive discharge, in spite of the numerous experiments made with a view to elucidate them, are still far from completely elucidated. Thus, for example, it is well known what lengthy discussions have taken place over the question whether the electric arc, either with a continuous or alternating current, is the seat of a back electromotive force, or whether it behaves simply as an ordinary metallic resistance; yet it would be hardly true to say that this point has been definitely settled. In one of his experiments M. Claude joins two points, between which there is an alternating difference of potential of 2400 volts (frequency about 80 per second), by about 12 incandescent lamps (16 candle-power, 100 volt), a condenser of 0·1 microfarad capacity, and a make and break key all placed in series. When the key is closed, the circuit is traversed by the charge and discharge currents of the condenser, the magnitude of which can easily be calculated, and which suffices to make the filaments of the incandescent lamps just glow. If now the key is opened so that there exists a small spark gap in the circuit (about 1 mm.), an arc will be struck at this point. Now this arc is certainly an additional resistance in the circuit, small it may be, since it is formed between metal points, but which certainly cannot be less than that which existed when the metal points were in contact. It is now found that the lamps show an increased brilliancy, and this brilliancy increases as the arc is made longer. This increase is such that, for the longest arc obtainable (a little over 1 mm.), the difference in potential between the terminals of each lamp rises from 30 volts to 90 volts, while the difference of potential between the terminals of the key is found to be about 1200 volts. The author gives the following explanation of this experiment:—The arc is a discontinuous phenomenon, and requires a certain minimum value to start, and thus, while the E.M.F. is below this value, no current passes, and the condenser remains uncharged. When the limiting E.M.F. is reached, the arc is struck, and the condenser is charged suddenly at a high potential. This charging of the condenser is limited to a fraction of the complete period, so that the charge current lasts a shorter time, and is of greater intensity than when no arc exists in the circuit. The absorption of energy in the lamps being proportional to the square of the current is increased, for the mean square of the current in the circuit is increased when the arc is present. The material forming the points between which the arc is struck, exerts an important influence on the facility with which the arc is maintained when the difference of potential diminishes, so that, although a much longer arc can be obtained by using carbon terminals, the above effect is not nearly so well marked as with terminals of iron or copper. It is of course necessary to have a condenser placed in the circuit to obtain the increased brilliancy of the lamps, for otherwise during the time the spark is unable to pass no current passes, while when the current does pass it has the same value it would have at the same part of the cycle if the spark gap were closed. On performing the experiment, M. Claude finds that when there is no condenser in circuit the luminosity of the lamps is slightly reduced when the arc is formed.

MR. A. GIBB MAITLAND, of the Queensland Geological Survey, points out that the sentences after that beginning "For a general colony map," in NATURE, vol. xlix. p. 109 (November 30, 1893), refer to the work being carried out by the staff on the Charters Towers Gold-field, and not to the whole colony.

THE additions to the Zoological Society's Gardens during the past week include an Indian Kite (*Milvus govinda*) from India, a Common Kestrel (*Tinnunculus alandarius*), a Golden Eagle (*Aquila chrysætus*), a Barn Owl (*Strix flammea*), a Tawny Owl (*Syrnium aluco*) British, a Great Eagle Owl (*Bubo maximus*) European, a Spotted Eagle Owl (*Bubo maculosa*) from South Africa, presented by the Crystal Palace Company; two Levaillant's Francolins (*Francolinus levaillanti*), two Barn Owls (*Strix flammea*) from Port Elizabeth, South Africa, presented by Mr. B. Matcham; a Bar-tailed Godwit (*Limosa lapponica*), a Grey Plover (*Squatarola helvetica*), a Dunlin (*Tringa alpina*) British, two Ceylonese Hanging Parrakeets (*Loriculus asiaticus*) from Ceylon, purchased; and Eland (*Oreas canna*, ♀) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE AURORA OF FEBRUARY 28.—A fine auroral display was observed in various parts of England on the evening of Wednesday, February 28. Several letters describing the phenomenon have been received, and the following from Mr. C. Thwaites gives a clear account of the general appearance at Norwich:—

"At a few minutes past seven o'clock a bright cone of light was seen springing up from the horizon at about east by north, this was followed by detached cloud-like streamers, which gradually joined into one vast, wide arch of brilliant light, extending, for a short time, completely across the heavens, slightly to the south of the zenith, to the south-west by south horizon. Other luminous patches also appeared on either side of this arch, one covered the space around Jupiter, others the constellations of Orion, Ursa Major, and Leo. Sometimes the rays or streamers gradually brightened, at other times they suddenly flashed into brightness; the effect of this pulsating light was very beautiful. The light was white, fading away at the edges of the rays, and was very similar to a strong, distant light seen through a haze or fog, which diffused the light, and softened its outlines. At half-past eight o'clock the rays had disappeared, and were followed by an arch of glowing light, which was centred at about the north-north-west, rising about fifty degrees towards the zenith."

Mr. Fowler, and other observers at the Astrophysical Laboratory, South Kensington, noticed a number of peculiarly bright clouds, flashing out chiefly in the west and south-west, between 7 and 8 p.m. He says: "From 8 p.m. to a little after 9 the phenomena observed were confined to the north, and took the form of a fine display of the aurora borealis. Streamers were comparatively rare, but at half-past eight there was a brilliant arc, reaching some ten degrees above the horizon at the highest point, which was in or very near to the magnetic meridian. Spectroscopic observations of the luminous clouds showed that the light consisted mainly of that which is characteristic of the aurora, being almost perfectly monochromatic and near wave-length 557. No clouds were seen when the aurora was brightest. During the maximum display of the aurora the characteristic bright line of the spectrum was seen in nearly every part of the sky, even where there was no visible haze or cloud." At the time of observation Mr. Fowler thought that the clouds did not owe their brightness simply to reflected aurora light, but as the observations towards the north were vitiated by the glare of the light of the Imperial Institute, he thinks that he may have been misled.

Rear-Admiral J. P. Maclear observed the aurora at Cranleigh, Surrey. The following is an extract from his description of the appearance presented:—"After sunset two white luminous clouds, like bright fog clouds, became apparent in a west north-west direction, and as darkness came on the northern horizon was lighted with a pale green light. At 8h. 45m. there was a rose-tinted patch like a cloud near the tail of the Great Bear, at the same time the low arch of light to the northward was bordered with a very faint rose tinge. At 9h. the light gradually faded away."

MIRA CETI.—Observations of this variable star have shown that it has continued to brighten since the predicted date of maximum (February 17). At the present time (March 4) it is a trifle brighter than δ Ceti, a star of magnitude 4·2, and is quite a conspicuous naked-eye star for a little while after darkness sets in. There are no indications that it has even yet reached the maximum. On some previous occasions it has reached the second magnitude. The predicted date of maximum was no doubt calculated on the basis of the period of 333 days, deduced by Argelander, but it is well known that the period, like the maximum brightness, is not always the same. There is evidence of a regular irregularity to the extent of twenty-five days. The present apparition is anything but favourable, owing to the proximity of the star to the sun.

According to the meteoritic hypothesis, the general light changes in such a variable as Mira are produced by the revolution of a subsidiary swarm of meteorites round a larger central one, the maximum luminosity occurring at periastron, when the collisions are most numerous. A perfectly constant period, however, can only occur in the case where the central swarm has a regular figure and density. In swarms such as we see in the spiral nebulæ, taking rotation into account, it is evident that the secondary swarm might reach periastron under very different conditions in successive revolutions, and the maximum luminosity might either precede or follow the periastron passage.

HALLEY'S COMET.—Prof. Glasenapp announces that the computing bureau established by the Russian Astronomical Society has undertaken the calculation of the true path of Halley's Comet with a view to predicting the exact date of the next return. He hopes that astronomers acquainted with unpublished observations of the comet will communicate the information to the Society.

IODINE AS A BASE FORMING ELEMENT.

AN important memoir is contributed to the current issue of the *Berichte* of the German Chemical Society, by Prof. Victor Meyer and Dr. Hartmann. A new substance of a somewhat surprising nature, the first member in all probability of an extensive series, has been prepared by them in the Heidelberg laboratory. We have been so impressed with the strongly-marked negative or acid-forming character usually exhibited by the halogen elements, that it is more or less astonishing to learn that a compound has been obtained containing iodine as the central, predominating, or grouping element, which not only contains that element acting in a tri-valent capacity exactly like nitrogen in ammonia, but which is a powerful *base*, combining with acids to form well-defined salts with elimination of water precisely as when a caustic alkali is neutralised by an acid. This remarkable new iodine compound is derived from an as yet unisolated base $I\begin{smallmatrix}H\\H\\OH\end{smallmatrix}$, similarly constituted to hydroxylamine $N\begin{smallmatrix}H\\H\\OH\end{smallmatrix}$. The substance itself is represented by the formula $I\begin{smallmatrix}C_6H_5\\C_6H_4I\\OH\end{smallmatrix}$, and just before transmitting the manuscript for publication, the information was appended that the pure diphenyl derivative $I\begin{smallmatrix}C_6H_5\\C_6H_5\\OH\end{smallmatrix}$ had likewise been isolated, but further particulars of it were reserved for a subsequent communication.

Prof. Meyer was led to suspect the possibility of the existence of such a compound from the fact that the oxy-iodine derivative of benzoic acid, the so-called iodoso-benzoic acid,

$$C_6H_4\,(IO)\,(COOH),$$

exhibits a very much feebler acid character than ordinary iodobenzoic acid, $C_6H_4I\,.\,COOH$, and partakes indeed more of the character of a phenol, indicating that the group $I:O$ is endowed with basic instead of acid properties. This supposition, moreover, is confirmed by the remarkable observation of Willgerodt, who has shown that the analogous derivative of the hydrocarbon benzene itself, iodoso-benzene $C_6H_5\,.\,IO$, forms a series of well-defined salts with acids. Hence it would appear that the as yet unisolated compound $H\,.\,I:O$ cannot be called hypo-iodous acid, for it is apparently a basic substance, and not an acid at all. An attempt was therefore made to saponify iodosobenzene by boiling it with dilute sulphuric acid, in order to convert it, if possible, into phenol and the sulphate of the supposed base. Dilute sulphuric acid readily dissolves iodosobenzene with formation of a sulphate, as shown by Willgerodt, but on mere boiling it still exhibits the reactions of iodosobenzene. Upon evaporation of the solution, and warming for several hours over the water-bath, however, it loses its capability of liberating iodine from potassium iodide, and a sulphate of a basic substance is indeed found to have been produced. As a method of preparation, however, the following is a much more convenient process:—

The iodosobenzene is placed directly in the calculated quantity of strongly cooled concentrated sulphuric acid. The solution becomes coloured brown, and contains no trace of the original iodosobenzene, as evidenced by its inability to liberate iodine; it consists almost entirely of the sulphate of the new base. The liquid is diluted by adding pieces of ice to prevent loss by rise of temperature, and the solution is most advantageously used to prepare the insoluble halogen salts, which much resemble those of silver, lead, and thallium, by adding a solution of potassium or sodium chloride, bromide, or iodide.

The free base is best obtained from the precipitated iodide by agitation with moist silver oxide. It may also be obtained directly from the sulphate by addition of baryta water; the solution thus obtained, however, is much more dilute. The aqueous solution of the base reacts very strongly alkaline. It cannot be readily obtained in the anhydrous condition, as it concentrates to a thick gum. Analyses of the iodide indicate that the empirical formula of the salt is C_4H_3I. Upon dry distillation the iodide decomposes completely to mono- and di-iodobenzene; hence its molecular formula must be three times the empirical, or $C_{12}H_9I_3$.

$$C_{12}H_9I_3 = C_6H_5I + C_6H_4I_2.$$

The formula of the base itself must consequently be

$$C_{12}H_9I_2OH.$$

The reaction for its formation from iodosobenzene may be most simply stated thus :—

$$2C_6H_5 . IO = I\begin{cases}C_6H_5\\C_6H_4I\\OH\end{cases} + O.$$

It may also be expressed so as to account for the action of the sulphuric acid as follows, starting with the sulphate of iodosobenzene :—

$$C_6H_5I : \overline{SO_4 + \begin{matrix}H\\H\end{matrix}}\begin{matrix}OH\\C_6H\end{matrix} . IO = I\begin{cases}C_6H_5\\C_6H_4I\\OH\end{cases} + H_2SO_4 + O.$$

The chloride, $C_{12}H_9I_2Cl$, is a white curdy precipitate much resembling silver chloride. It crystallises from warm acetic acid, but the crystals are most readily obtained by mixing the aqueous solution of the free base with cold acetyl chloride, and boiling the resulting precipitate in the liquid for a short time ; the clear solution deposits white rosettes of needles on cooling. The crystals melt at 200°–201°, decomposing into chlorbenzenes like the iodide.

The bromide, $C_{12}H_9I_2Br$, is a pale yellow precipitate similar to silver bromide ; it melts at 167°–168° with similar decomposition. The melting point of the iodide is 144°.

The nitrate was obtained from the sulphuric acid solution by the addition of nitric acid, in the form of a white semi-solid precipitate, which changes into a mass of crystals upon agitation with ether. It dissolves in hot water.

The sulphate is readily soluble in water, as is evident from the mode of preparation ; it dries to a solid, which has not yet been crystallised.

Concerning the second member of the series, $I\begin{cases}C_6H_5\\C_6H_5\\OH\end{cases}$, it is stated that it has been obtained from its iodide by the action of moist silver oxide, and that it is likewise a strongly alkaline substance readily soluble in water. The iodide, a polymer of iodobenzene, passes completely into the latter substance upon dry distillation.

$$I\begin{cases}C_6H_5\\C_6H_5\\I\end{cases} = 2C_6H_5I.$$

Further details of these interesting compounds, which must of necessity considerably modify our conception of the nature of iodine, are promised for the next number of the *Berichte*.

A. E. TUTTON.

PRINCE HENRY THE NAVIGATOR.

THE Royal Geographical Society held a special meeting on March 5, to celebrate the five-hundredth anniversary of the birth of Prince Henry the Navigator, the real initiator of modern maritime exploration. H.R.H. the Duke of York and the Portuguese Minister were present amongst the large audience, and appropriate addresses, illustrated by reproductions of early charts and historical portraits, were given by Mr. Clements R. Markham, F.R.S., President of the Society, Sir George Taubman-Goldie, Captain Wharton, F.R.S., Hydrographer, Mr. Beazley, Mr. H. Yule Oldham, Lecturer on Geography at Cambridge, and the Portuguese Minister. The anniversary was celebrated on a large scale with considerable pomp at Oporto, the ceremonies occupying three days.

If the formal celebration of the lives of the initiators of great movements in history and in science is a privilege of which their successors do well to avail themselves, the ceremonies observed at Oporto and in London, on March 4 and 5, were grateful acts. Prince Henry, distinguished from all his namesakes by his inseparable surname "the Navigator," was born on March 4, 1394, the son of King John I. of Portugal, and of Philippa, daughter of the Duke of Lancaster. From his early years he showed himself exceptionally studious, and when taking part in the siege of Ceuta, in 1415, he undoubtedly learned much of the interior trade of Africa, which supplemented the knowledge derived from the Arab geographers. But it is probable that the main incentive in his life-long effort to promote navigation and maritime discovery was the prospect of achieving the sea-route to India, and of making his country the first mercantile power in Europe. At the age of twenty-four he had definitely made up his mind on the subject of his life-work, and chose as his residence Sagres, at the extreme south-western corner of the Iberian peninsula facing the unknown ocean. The Prince made himself a master of the mathematics and astronomy of the day, and strove to induce mariners to follow his example and make use of the astrolabe in navigation. Observations at sea with an instrument so crude were necessarily very unsatisfactory, and, like their predecessors, the sailors of that day kept prudently within sight of land. Aided by the funds of the Order of Christ, Prince Henry fitted out expedition after expedition to trace out the African coast to the southward past Cape Nun. Inducements to trade were held out to adventurous merchant seamen of all nations, but these were insufficient as long as the explorers ventured no further than Cape Bojador. In 1434 Gil Eannes rounded that Cape, but the barren coast of the Sahara still met his eyes. In 1443 Antonio Gonsalvez crossed the Tropic of Cancer, reached and passed Cape Blanco, and brought home gold and slaves. From this time advance was more rapid, the inducements of commerce brought more volunteers to the work, and in three years the fertile coasts beyond Cape Verde were reached, and before the death of the Prince, in 1460, his efforts were rewarded by the rolling back of the cloud of absolute ignorance from over 1500 miles of hitherto unknown coast. The enterprise thus inaugurated went on with increasing success until Diaz rounded the Cape of Good Hope in 1486, and Vasco da Gama fulfilled the life's ambition of Prince Henry by reaching India in 1497, and raising Portugal to the height of its short-lived fame.

Prince Henry emphatically lived for his work, pursuing it without intermission in spite of the vast weight of prejudice and indifference against which he had to fight, and the result of that work is his best monument. He, if any one man, was the first to stir into strength the movement toward maritime exploration, which not only revealed the true form and extent of the most ancient continent, but in direct succession led to the discovery by Cabral of the new world, a discovery in no way brought about by the earlier voyages of Columbus, although these in a sense were the outcome of the same original impulse. It is through Ca da Mosto, a Venetian sailor engaged in African discovery for the Prince, that the best account of him as a man, and of his methods as a patron of exploration, are handed down. In his words—"He was the noblest Prince of his age, a man whose smallest virtue would suffice to immortalise him."

SCIENCE IN THE MAGAZINES.

SCIENCE makes a good show in the March magazines. Sir Robert Ball, F.R.S., contributes to the *Fortnightly* an article on "The Significance of Carbon in the Universe." The object of the article is to call attention to an investigation carried out by Dr. G. Johnstone Stoney, F.R.S., nearly thirty years ago, but the significance of which has not been widely recognised. From the tenor of the article we presume that the author refers to Dr. Stoney's paper "On the Physical Constitution of the Sun and Stars," read before the Royal Society in 1867. The paper is well known to workers in astronomical physics, though Sir Robert laments that some eminent physicists whom he questioned were unaware of its existence. Dr. Stoney gave evidence to show that the photospheric clouds on the sun were composed of carbon. In his words—"We have strong reasons for suspecting that the luminous clouds consist, like nearly all the sources of artificial light, of minutely divided carbon ; and that the clouds themselves lie at a very short distance above the situation in which the heat is so fierce that carbon, in spite of its want of volatility, and of the enormous pressure to which it is there subjected, boils." (*Roy. Soc. Proc.* vol. xvi. p. 29, 1867-8.) Sir Robert Ball has taken the result contained in this conclusion, and expanded it into a lucid article containing much that is interesting. Dr. J. W. Gregory describes his adventurous journey to Mount Kenya. It is impossible not to admire the indomitable spirit he displayed throughout the whole expedition. He went to Africa to obtain information upon certain points, and though he found himself stranded at Mombasa before anything had been done, he got together a party of forty Zanzibaris, marched into the interior, accomplished his task, and returned to the

coast in safety. Dr. Gregory's objects in visiting Kenya were: (1) To collect the flora and fauna of the different zones; (2) to see if an Alpine flora occurred similar to that of corresponding altitudes in Kilima Njaro; (3) to examine the geological structure of the mountain with a view to the determination of its position in the African mountain system; (4) to see if there were any true glaciers upon it; (5) especially to determine whether these had at any time a greater extension than at present. All these points were satisfactorily settled, and the information obtained during the exploitation of the region traversed is of prime scientific importance. An interesting question as to the origin of the Rift Valley is raised, of which the following is a description: "From Lebanon, almost to the Cape, there runs a long, deep, and comparatively narrow valley occupied by the sea, by salt steppes that represent former lakes, and by a series of over twenty lakes, of which only one has an outlet to the sea. This is a condition of things absolutely unlike anything else on the surface of the earth. . . . . But if the Rift Valley is unique as far as the earth is concerned, there are structures elsewhere which may be compared with it. It has long been known that there are on the moon, in addition to the well-known ring systems—generally spoken of as volcanoes—a series of long, straight clefts or furrows, known as 'rills.' The great East African depression would present to an inhabitant in the moon much the same aspect as the lunar rills do to us. Not the least interesting of the problems raised by this Rift Valley, is the possibility that it may explain the nature of these lunar clefts which have so long been a puzzle to astronomers."

Under the title "Scientific Problems of the Future," Lieut.-Colonel Elsdale considers, in the *Contemporary*, four leading problems, some, if not all, of which seem practically certain of solution in the next generation, if not in our own. The conquest of the air is the first of these problems, and the conclusion is arrived at that if the rate of progress of the last thirteen or fourteen years is kept up for a similar period in the future, aerial navigation will be an accomplished fact. The second of the problems is the diminution of the large percentage of the total resistance to a vessel's motion through the water due to surface or skin friction. "This friction," says the author, "is the leading and essential cause of the great waste of power in the propulsion of all vessels of man's design, whether partly or wholly submerged, when compared with the natural propulsion of fish or marine animals, such as whales, under corresponding circumstances and conditions. Hence the question of the possible reduction of this friction is one of vast and supreme importance to the marine engineer." Two other questions to which answers may be expected in the future are—"How can we best, by some simple and practical process, reduce coal to a condition in which it will, when brought into conjunction with the inexhaustible reservoir of oxygen in the atmosphere, give us the necessary elements for the production of an electric battery?" and "how to reduce the vegetable foods which at present are only adapted to animals like the cow, the sheep, or the horse, to a condition suited to the human digestion and to the human palate?" "Shakespeare's Natural History—a new light on Titus Andronicus," is the subject of an article by Mr. Phil Robinson. Shakespeare's authorship of this play has been disputed by many eminent critics. Mr. Robinson shows, however, that the natural history references in the play are almost identical with those of all the other plays attributed to Shakespeare. It has been objected that though the panther is referred to three times in "Titus Andronicus," it is not mentioned in any other of Shakespeare's plays. The reply to this brings out the following bit of information:—"If anyone will glance over the bard's flora, he will find that Shakespeare uses a great number of common plants only once—for instance, the holly, poppy, clover, brambles, lavender, and harebell, &c., and most remarkable of all, perhaps (and in a hunter, such as Shakespeare undeniably was), *fern*. . . . . Among other trees he only mentions the ash once (and then as the shaft of a Volscian spear!), the birch once, as furnishing 'threatening twigs,' the lime-tree once. Among others, he never mentions at all the walnut-tree, the larch, the fir, the chesnut, the alder, the poplar, or the beech."

A well-illustrated and simple account of earthquakes and the methods of measuring them is contributed by Dr. E. S. Holden to the *Century*. The Lick Observatory is furnished with a complete set of Prof. Ewing's seismometers, and Dr. Holden describes them, while their arrangement and use are shown by means of several woodcuts. After stating the Rossi-Forel scale of earthquake intensity, a means is indicated of making the scale even more useful than it is. From earthquake records, it has been found possible to assign a mechanical value to each of the ten numbers of the scale. Taking an acceleration of one millimetre per second as a unit, Dr. Holden has calculated that I. on the Rossi-Forel scale corresponds to $\frac{1}{10}$ of the acceleration due to gravity, or 20 units; II. corresponds to $\frac{1}{25}$ of gravity, or 40 units; III. corresponds to 60 units; IV. to 80 units: V. to 110 units; VI. to 150 units; VII. to 300 units; VIII. to 500 units; and IX. to 1200 units. All the shocks felt in San Francisco in the years from 1800 to 1888 have been evaluated in this way. There were 417 shocks in all, and the sum total of their accelerations was 33,360 units of intensity. "The average intensity of the 417 shocks of these 80 years results as IV., and this is $\frac{1}{120}$ part of gravity. The total intensity for the whole period is 3·4 times the acceleration of gravity; that is, if all the earthquake force which has been expended in San Francisco during these 80 years were concentrated so as to act at a single instant, it would be capable of producing an acceleration almost $3\frac{1}{2}$ times that of gravity."

Harper's Magazine contains an excellent article entitled "The Welcomes of the Flowers," in which Mr. W. Hamilton Gibson traces the development of knowledge as to flower-fertilisation from the time of Nehemias Grew to Darwin, and exemplifies the method of cross-fertilisation by a number of well-chosen examples. The article is embellished with twenty-two remarkably fine illustrations. The Bessemer process of steel-making, and the plant used in the steel works of the United States, forms the second of a series of articles on "Great American Industries," edited by Mr. R. R. Bowker. Dr. T. M. Prudden writes on "Tuberculosis and its Prevention."

Mr. Frank Beddard, F.R.S., contributes to *Blackwood* a popular description of the characters and habits of some remarkable earth-worms, under the title "The Newest about Earth-worms." *Chambers's Journal* contains several chatty articles. In one of these, entitled "A Vegetable with a Pedigree," mention of the asparagus is traced back to about 425 B.C. Other articles deal with Italian granite, great cork forests, and Brazilian snakes. A facetious review of the "History of Four-footed Beasts and Serpents," by the Rev. Edward Topsel, an Elizabethan zoologist, appears in *Cornhill*. That distinguished author wrote of birds, beasts, and fishes which have never come within the ken of latter-day naturalists. Dr. T. Lauder Brunton, F.R.S., is the author of a short paper on "The Progress of Pharmacy" in the *Humanitarian*, and Sir Douglas Galton dwells on the necessity of observing "abnormal children" in elementary schools, in order to establish a sound basis for the proper conduct and development of our educational system. *Good Words* contains an illustrated article on "Celestial Photography," in which Mr. R. A. Gregory describes, among other celestial sights—

> "Regions of lucid matter, taking form,
> Brushes of fire, hazy gleams.
> Clusters and beds of worlds, and bee-like swarms
> Of suns, and starry streams."

Mr. Douglas Archibald describes "Clouds and Cloudscapes" in the *English Illustrated Magazine*, his article being accompanied by illustrations of the typical forms of clouds. *Scribner's* and *Longman's Magazines* have been received in addition to those already noted. The former contains a fine engraving of Signor Tito Lessi's painting, "Milton visiting Galileo," and a description of "Subtropical Florida," by Mr. C. R. Dodge; and students of anthropology will find interest in an account of "Savage Spiritualism," contributed to the latter.

THE CAMBRIDGE DIPLOMA IN AGRICULTURE.

THE question of agricultural education at Cambridge—of which the latest development is the establishment of a Diploma in Agriculture—is comparatively recent. The movement began some three years ago (in July, 1890) with a letter addressed by the President of the Board of Agriculture to the Duke of Devonshire in his capacity of Chancellor of the University. This led to the appointment of a University syndicate (*i.e.* committee), who framed a carefully weighed scheme of agricultural education and examination, the funds for which were to be supplied partly by the University and partly by the Cam-

bridgeshire County Council. The scheme was thrown out—on financial grounds—by the Senate, and here it seemed likely that agricultural education would come to a standstill, had it not been for the action of the County Councils of the Eastern Counties,[1] who, with the help of certain University professors, organised the Cambridge and Counties Agricultural Education Committee, an arrangement by which the counties supply the funds, while the University members supply the teaching. Under this scheme agricultural students are now receiving at Cambridge instruction in a number of subjects bearing directly on agriculture. The students are not necessarily members of the University, nor is agriculture a recognised department of University study; but it has now been practically sanctioned by the appointment of a University syndicate, whose duty it is to superintend the examinations on which the new diploma is to be granted. This procedure has a precedent in the successfully established diploma in State Medicine, and cannot fail to exert —both as a check and a stimulus—a wholesome effect on the unofficial agricultural department.

The first examination will be held in July. It consists of two parts: Part i. embraces botany, chemistry, physiology, entomology, geology, engineering, and book-keeping, in so far as each subject bears on agriculture. Part ii. comprises practical agriculture and surveying. The examinations are open to all who present themselves, and who pay the moderate fee demanded. Intending candidates may, it seems, obtain information from Prof. Liveing (who has taken the chief share in the work from the University side of the question) or from Mr. Francis Darwin.

ON HOMOGENEOUS DIVISION OF SPACE.

§ 1. THE homogeneous division of any volume of space means the dividing of it into equal and similar parts, or cells, as I shall call them, all sameways oriented. If we take any point in the interior of one cell or on its boundary, and corresponding points of all the other cells, these points form a homogeneous assemblage of single points, according to Bravais' admirable and important definition.[3] The general problem of the homogeneous partition of space may be stated thus:—Given a homogeneous assemblage of single points, it is required to find every possible form of cell enclosing each of them subject to the condition that it is of the same shape and sameways oriented for all. An interesting application of this problem is to find for a crystal (that is to say, a homogeneous assemblage of groups of chemical atoms) a homogeneous arrangement of partitional interfaces such that each cell contains all the atoms of one molecule. Unless we knew the exact geometrical configuration of the constituent parts of the group of atoms in the crystal, or crystalline molecule as we shall call it, we could not describe the partitional interfaces between one molecule and its neighbour.

Knowing as we do know for many crystals the exact geometrical character of the Bravais assemblage of corresponding points of its molecules, we could not be sure that any solution of the partitional problem we might choose to take would give a cell containing only the constituent parts of one molecule. For instance, in the case of quartz, of which the crystalline molecule is probably $3(SiO_2)$, a form of cell chosen at random might be such that it would enclose the silicon of one molecule with only some part of the oxygen belonging to it, and some of the oxygen belonging to a neighbouring molecule, leaving out some of its own oxygen, which would be enclosed in the cell of either that neighbour or of another neighbour or other neighbours.

§ 2. This will be better understood if we consider another illustration—a homogeneous assemblage of equal and similar trees planted close together in any regular geometrical order on a plane field either inclined or horizontal, so close together that roots of different trees interpenetrate in the ground, and branches and leaves in the air. To be perfectly homogeneous every root, every twig, and every leaf of any one tree must have equal and similar counterparts in every other tree. So far everything is natural, except, of course, the absolute homogeneousness that our problem assumes; but now, to make a homogeneous assemblage of molecules in space, we must suppose plane above plane each homogeneously planted with trees at equal successive intervals of height. The interval between two planes may be so large as to allow a clear space above the highest plane of leaves of one plantation and below the lowest plane of the ends of roots in the plantation above. We shall not, however, limit ourselves to this case, and we shall suppose generally that leaves of one plantation intermingle with roots of the plantation above, always, however, subject to the condition of perfect homogeneousness. Here, then, we have a truly wonderful problem of geometry—to enclose ideally each tree within a closed surface containing every twig, leaf, and rootlet belonging to it, and nothing belonging to any other tree, and to shape this surface so that it will coincide all round with portions of similar surfaces around neighbouring trees. Wonderful as it is, this is a perfectly easy problem if the trees are given, and if they fulfil the condition of being perfectly homogeneous.

In fact we may begin with the actual bounding surface of leaves, bark, and roots of each tree. Wherever there is a contact, whether with leaves, bark, or roots of neighbouring trees, the areas of contact form part of the required cell-surface. To complete the cell-surface we have only to swell out[1] from the untouched portions of surface of each tree homogeneously until the swelling portions of surface meet in the interstitial air spaces (for simplicity we are supposing the earth removed, and roots, as well as leaves and twigs, to be perfectly rigid). The wonderful cell-surface which we thus find is essentially a case of the tetrakaidekahedronal cell, which I shall now describe for any possible homogeneous assemblage of points or molecules.

§ 3. We shall find that the form of cell essentially consists of fourteen walls, plane or not plane, generally not plane, of which eight are hexagonal and six quadrilateral; and with thirty-six edges, generally curves, of meeting between the walls; and twenty-four corners where three walls meet. A cell answering this description must of course be called a tetrakaidekahedron, unless we prefer to call it a fourteen-walled cell. Each wall is an interface between one cell and one of fourteen neighbours. Each of the thirty-six edges is a line common to three neighbours. Each of the twenty-four corners is a point common to four neighbours. The old-known parallelepipedal partitioning is merely a very special case in which there are four neighbours along every edge, and eight neighbours having a point in common at every corner. We shall see how to pass (§ 4) continuously from or to this singular case, to or from a tetrakaidekahedron differing infinitesimally from it; and, still continuously, to or from any or every possible tetrakaidekahedronal partitioning.

§ 4. To change from a parallelepipedal to a tetrakaidekahedronal cell, for one and the same homogeneous distribution of points, proceed thus:—Choose any one of the four body-diagonals of a parallelepiped and divide the parallelepiped into six tetrahedrons by three planes each through this diagonal, and one of the three pairs of parall el edges which intersect it in its two ends. Give now any purely translational motion to each of these six tetrahedrons. We have now the 4×6 corners of these tetrahedrons at twenty-four distinct points. These are the corners of a tetrakaidekahedron, such as that described generally in § 3. The two sets of six corners, which before the movement coincided in the two ends of the chosen diagonal, are now the corners of one pair of the hexagonal faces of the tetrakaidekahedron. When we look at the other twelve corners we see them as corners of other six hexagons, and of six parallelograms, grouped together as described in § 15 below. The movements of the six tetrahedrons may be such that the groups of six corners and of four corners are in fourteen planes as we shall see in § 14; but if they are made at random, none of the groups will be in a single plane. The fourteen faces, plane or not plane, of the tetrakaidekahedron are obtained by drawing arbitrarily any set of surfaces to constitute four of the hexagons and three of the quadrilaterals, with arbitrary curves for the edges between hexagon and hexagon and between hexagons and quadrilaterals, and then by drawing parallel equal and similar counterparts to these surfaces in the remaining four hexagonal

[1] The scheme is now carried on by funds supplied by the County Councils of Cambridgeshire, the Isle of Ely, Essex, Norfolk, Northants, Leicestershire, Hunts, East and West Suffolk, and by a grant from the Board of Agriculture.

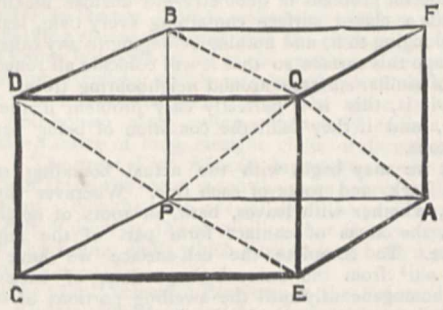
[2] A paper read before the Royal Society on January 18, by Lord Kelvin, P.R.S.

[3] *Journal de l'École Polytechnique*, tome xix. cahier 33, pp. 1-128 (Paris, 1850), quoted and used in my "Mathematical and Physical Papers," vol. iii. art. 97, p. 400.

[1] Compare "Mathematical and Physical Papers," vol. iii. art. 97, § 5.

and three quadrilateral spaces in the manner more particularly explained in § 6 below. It is clear, or at all events I shall endeavour to make it clear by fuller explanations and illustrations below, that the figure thus constituted fulfils our definition (§ 1) of the most general form of cell fitted to the particular homogeneous assemblage of points corresponding to the parallelepiped with which we have commenced. This will be more easily understood in general, if we first consider the particular case of *parallelepipedal* partitioning, and of the deviations which, without altering its corners, we may arbitrarily make from a plane-faced parallelepiped, or which we may be compelled by the particular figure of the molecule to make.

§ 5. Consider, for example, one of the trees of § 2, or if you please a solid of less complex shape, which for brevity we shall



(FIG. 7, of § 9.)

call S, being one of a homogeneous assemblage. Let P be a point in unoccupied space (air, we shall call it for brevity), which, for simplicity we may suppose to be somewhere in the immediate neighbourhood of S, although it might really be anywhere far off among distant solids of the assemblage. Let PA, PB, PC be lines parallel to any three Bravais rows not in one plane, and let A, B, C be the nearest points corresponding to P in these lines. Complete a parallelepiped on the lines PA, PB, PC, and let QD, QE, QF be the edges parallel to them through the opposite corner Q. Because of the homogeneousness of the assemblage, and because A, B, C, D, E, F, Q are points corresponding to P which is in air, each of those seven points is also in air. Draw any line through air from P to A and draw the lines of corresponding points from B to F, D to Q, and C to E. Do the same relatively to PB, AF, EQ, CD; and again the same relatively to PC, AE, FQ, BD. These twelve lines are all in air, and they are the edges of our curved-faced parallelepiped. To describe its faces take points infinitely near to one another along the line PC (straight or curved as may be): and take the corresponding points in BD. Join these pairs of corresponding points by lines in air infinitely near to one another in succession. These lines give us the face PBDC. Corresponding points in AE, FQ, and corresponding lines between them give us the parallel face AFQE. Similarly we find the other two pairs of the parallel faces of the parallelepiped. If the solids touch one another anywhere, either at points or throughout finite areas, we are to reckon the interface between them as air in respect to our present rules.

§ 6. We have thus found the most general possible parallelepipedal partitioning for any given homogeneous assemblage of solids. Precisely similar rules give the corresponding result for *any possible partitioning* if we first choose the twenty-four corners of the tetrakaidekahedron by finding six tetrahedrons and giving them arbitrary translatory motions according to the rule of § 4. To make this clear it is only now necessary to remark that the four corners of each tetrahedron are essentially corresponding points, and that if one of them is in air all of them are in air, whatever translatory motion we give to the tetrahedron.

§ 7. The transition from the parallelepiped to the tetrakaidekahedron described in § 4 will be now readily understood if we pause to consider the vastly simpler two-dimensional case of transition from a parallelogram to a hexagon. This is illustrated in Figs. 1 and 2; with heavy lines in each case for the sides of the hexagon, and light lines for the six of its diagonals which are sides of constructional triangles. The four diagrams show different relative positions in one plane of two equal homochirally similar triangles ABC, A′B′C′; oppositely oriented (that is to say, with corresponding lines AB, A′B′ parallel but in inverted directions). The hexagon AC′ BA′ CB′, obtained by joining A with B′ and C′, B with C′ and A′, and C with A′ and B′, is clearly in each case a proper cell-figure for dividing plane space homogeneously according to the Bravais distribution of points defined by either triangle, or by putting the triangles together in any one of the three proper ways to make a parallelogram of them. The corresponding operation for three-dimensional space is described in § 4: and the proof which is obvious in two-dimensional space is clearly valid for space of three dimensions, and therefore the many words which would be required to give it formal demonstration are superfluous.

§ 8. The principle according to which we take arbitrary curved surfaces with arbitrary curved edges of intersection, for seven of the faces of our partitional tetrakaidekahedron, and the other seven correspondingly parallel to them, is illustrated in Figs. 3, 4, 5, and 6, where the corresponding thing is done for a partitional hexagon suited to the homogeneous division of a plane. In these diagrams the hexagon is for simplicity taken equilateral and equiangular. In drawing Fig. 3, three pieces of paper were cut, to the shapes *kl*, *mn*, *uv*. The piece *kl* was first placed in the position shown relatively to AC′, and a portion of the area of one cell to be given to a neighbour across the frontier C′A on one side was marked off. It was then placed

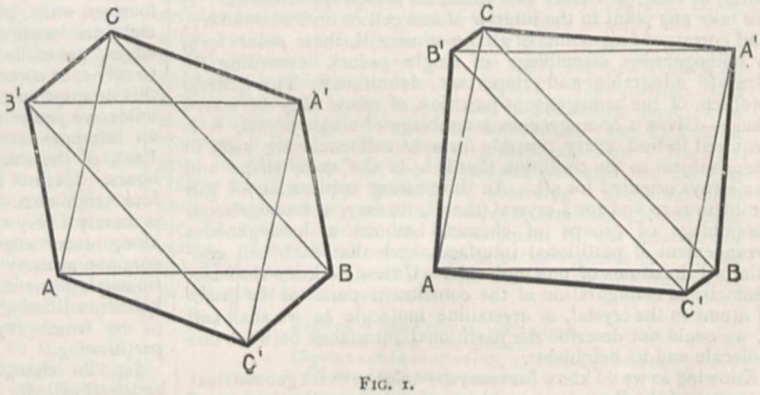


FIG. 1.

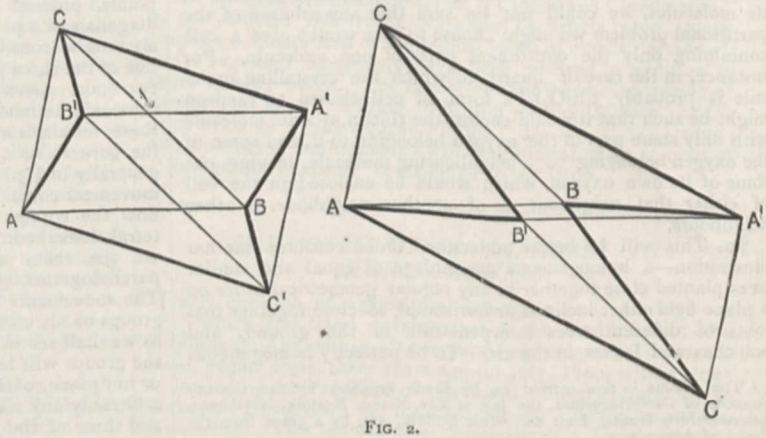


FIG. 2.

in the position shown relatively to A′C and the equivalent portion to be taken from a neighbour on the other side was marked. Corresponding give-and-take delimitations were

marked on the frontiers C'B and B'C, according to the form *mn*; and on the frontiers BA', AB', according to the form *uv*. Fig. 4 was drawn on the same plan but with one pair of frontiers left as straight lines, and the two other pairs drawn by aid of two paper templets. It would be

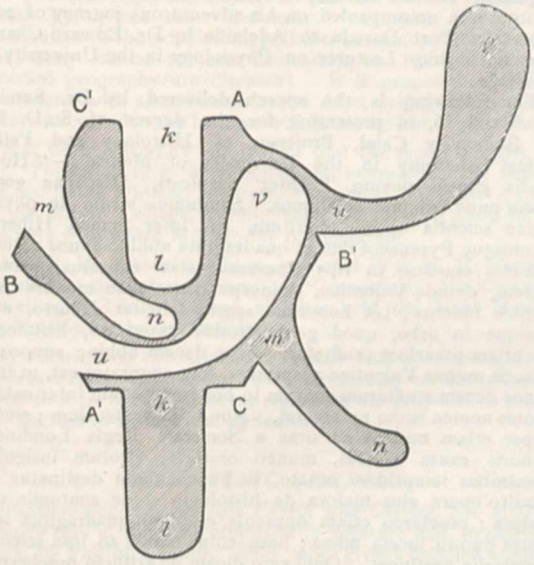


FIG. 3.

easy, but not worth the trouble, to cut out a large number of pieces of brass of the shapes shown in these diagrams and to show them fitted together like the pieces of a dissected map. Figs. 5 and 6 are drawn on the same principle; Fig. 6 showing,

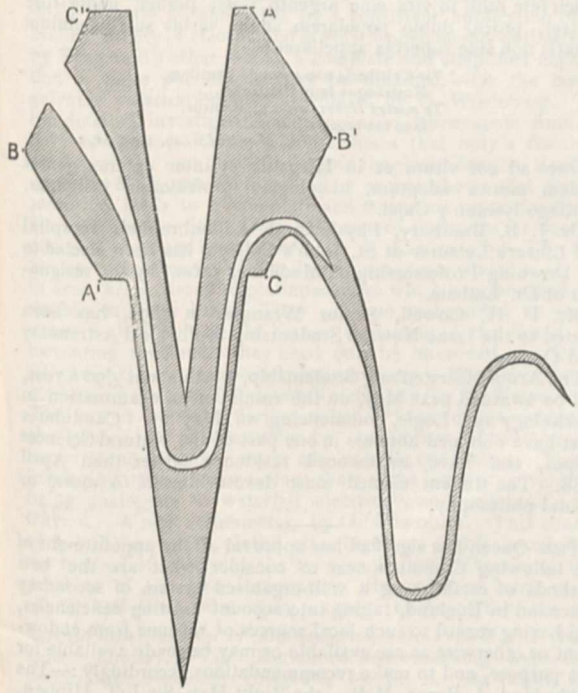


FIG. 4.

on a reduced scale, the result of putting pieces together precisely equal and similar to that shown in Fig. 5. In these diagrams, unlike the cases represented in Figs. 3 and 4, the primitive hexagon is, as shown clearly in Fig. 5, divided into isolated parts. But if we are dealing with homogeneous division of solid space, the separating channels shown in Fig. 5 might be sections, by the plane of the drawing, of perforations through

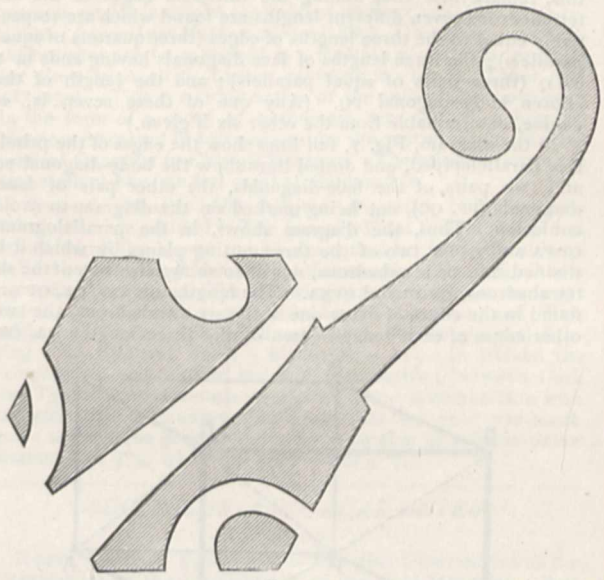


FIG. 5.

the matter of one cell produced by the penetration of matter, rootlets for example, from neighbouring cells.

§ 9. Corresponding to the three ways by which two triangles can be put together to make a parallelogram, there are seven,

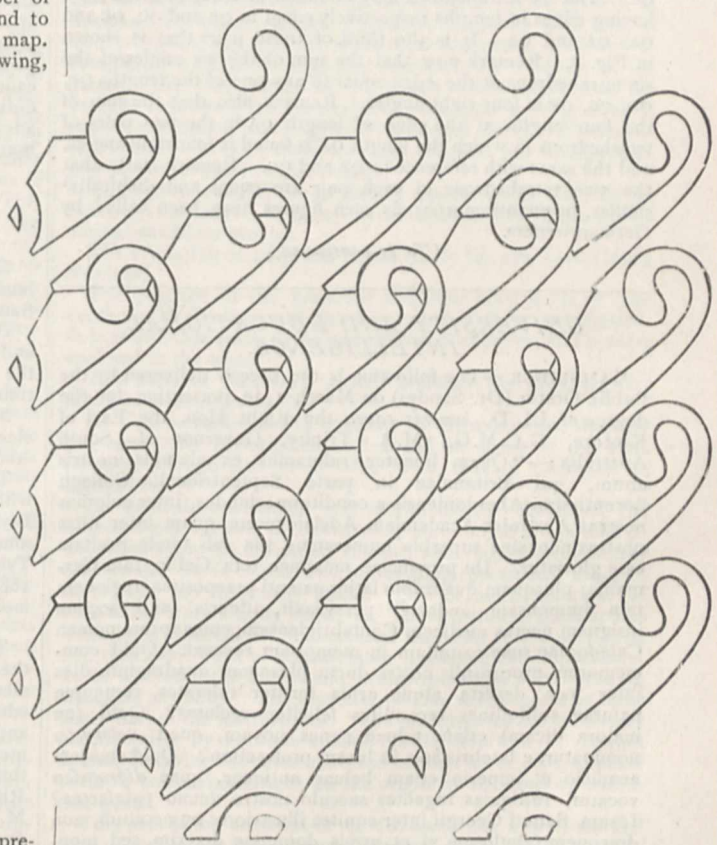


FIG. 6.

and only seven, ways in which the six tetrahedrons of § 4 can be put together to make a parallelepiped, in positions parallel to

those which they had in the original parallelepiped. To see this, remark first that among the thirty-six edges of the six tetrahedrons seven different lengths are found which are respectively equal to the three lengths of edges (three quartets of equal parallels); the three lengths of face-diagonals having ends in P or Q (three pairs of equal parallels); and the length of the chosen body-diagonal PQ. (Any one of these seven is, of course, determinable from the other six if given.)

In the diagram, Fig. 7, full lines show the edges of the primitive parallelepiped, and dotted lines show the body-diagonal PQ and two pairs of the face-diagonals, the other pair of face-diagonals (PF, QC), not being marked on the diagram to avoid confusion. Thus, the diagram shows, in the parallelograms QDPA and QEPB, two of the three cutting planes by which it is divided into six tetrahedrons, and it so shows also two of the six tetrahedrons, QPDB and QPEA. The lengths QP, QD, QE, QF are found in the edges of every one of the six tetrahedrons, the two other edges of each being of two of the three lengths QA, QB,

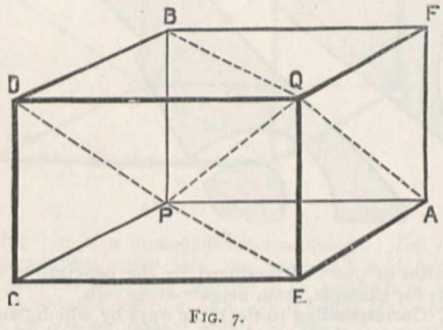


FIG. 7.

QC. The six tetrahedrons may be taken in order of three pairs having edges of lengths respectively equal to QB and QC, QC and QA, QA and QB. It is the third of these pairs that is shown in Fig. 7. Remark now that the sum of the six angles of the six tetrahedrons at the edge equal to any one of the lengths QP, QD, QE, QF is four right angles. Remark also that the sum of the four angles at the edge of length QA in the two pairs of tetrahedrons in which the length QA is found is four right angles, and the same with reference to QB and QC. Remark lastly that the two tetrahedrons of each pair are equal and dichirally[1] similar, or enantiomorphs as such figures have been called by German writers.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—The following is the speech delivered by the Public Orator (Dr. Sandys) on March 1, in presenting for the degree of LL.D. *honoris causa* the Right Hon. the Earl of Kintore, G.C.M.G., M.A. Trinity, Governor of South Australia:—"Quam libenter salutamus ex alumnis nostris unum, qui Britanniae in parte Septentrionali Collegii florentissimi Aberdoniensis a conditore oriundus, inter colonias nostras Australes Academiam Adelaidensem, quam inter filias nostras non sine superbia numeramus, sua sub tutela positam esse gloriatur. Ibi provinciae maximae tota Gallia, tota Germania, plusquam quadruplo latius patenti praepositus, regionem tam immensam audacter peragravit, itineris tanti socium insignem nactus medicum Cantabrigiensem, cuius ipsum nomen Caledoniae suae castellum in memoriam revocat. Quid commemorem proconsulis nostri ductu plusquam quadraginta dies inter loca deserta atque arida fortiter toleratos, rerumque naturae solitudines reconditas feliciter reclusas? Quid (ne maiora dicam) etiam talpae genus novum, quod *notoryctes* nominatur, e latebris suis in lucem protractum? Quid eiusdem auspicio et imperio etiam beluae antiquae, quae *diprotodon* vocatur, relliquias ingentes saeculo nostro denuo patefactas? Ipsum Sancti Georgii inter equites illustriores numeratum, non draconem fabulosum vi et armis domuisse dixerim, sed monstrorum haud minus horrendorum vestigia immania sumptu et labore maximo detegenda curavisse. Talium virorum auxilio non modo imperii Britannici provinciae remotissimae vinculis artioribus nobiscum consociantur, sed etiam scientiarum fines nostris a filiis totiens propagati per spatia indies latiora extenduntur. Duco ad vos scientiarum patronum illustrem, provinciae maximae et proconsulem et investigatorem indefessum, virum et suo et fratris sui nomine nobis coniunctissimum, Algernon Keith-Falconer, Comitem de Kintore." Lord Kintore was accompanied on his adventurous journey of 2000 miles from Port Darwin to Adelaide by Dr. Edward Charles Stirling, Trinity Lecturer on Physiology in the University of Adelaide.

The following is the speech delivered by Dr. Sandys, on March 6, in presenting for the degree of Sc.D. Dr. S. Ramon y Cajal, Professor of Histology and Pathological Anatomy in the University of Madrid:—"Hodie laudis genus novum libenter auspicati, Hispanae gentis civem nunc primum salutamus. Salutamus virum de physiologiae scientia optime meritum, qui inter flumen Hiberum montesque Pyrenaeos duo et quadraginta abhinc annos natus et fluminis eiusdem in ripa Caesaraugustae educatus, primum ibidem, deinde Valentiae, deinceps Barcelonae munere Academico functus, tot honorum spatio feliciter decurso, nunc denique in urbe, quod gentis totius caput est, histologiae scientiam praeclare profitetur. Fere decem abhinc annos professoris munus Valentiae auspicatus, fore auguratus est, ut intra annos decem studiorum suorum in honorem etiam inter exteras gentes nomen suum notesceret. Non fefellit augurium; etenim nuper etiam nostras ad oras a Societate Regia Londinensi honoris causa vocatus, muneri oratorio, virorum insignium nominibus iampridem ornato, in hunc annum destinatus est. Omitto opera eius maiora de histologia et de anatomia conscripta; praetereo etiam opuscula eiusdem quadraginta intra lustra duo in lucem missa; haec enim omnia ad ipsa scientiae penetralia pertinent. Quid vero dicam de artificio pulcherrimo quo primum auri, deinde argenti ope, in corpore humano fila quaedam tenuissima sensibus motibusque ministrantia per ambages suas inextricabiles aliquatenus explorari poterant? In artificio illo argenti usum, inter Italos olim inventum, inter Hispanos ab hoc viro in melius mutatum et ad exitum feliciorem perductum esse constat. Si poeta quidam Romanus regione in eadem genitus, si Valerius Martialis, inquam, qui expertus didicit fere nihil in vita sine argento possi perfici, hodie ipse adesset, procul dubio popularem suum verbis suis paululum mutatis non sine superbia appellaret:—

> 'Vir Celtiberis non tacende gentibus,
> Nostraeque laus Hispaniae,...
> Te *nostri Iberi ripa* gloriabitur,
> Nec me tacebit Bilbilis.'
>
> *Martial*, i. 49, 1–2; 61, 11–12.

Duco ad vos virum et in Hispania et inter exteras gentes laudem merito adeptum, histologiae professorem insignem, Santiago Ramon y Cajal."

Dr. J. B. Bradbury, Physician to Addenbrooke's Hospital and Linacre Lecturer at St. John's College, has been elected to the Downing Professorship of Medicine, vacant by the resignation of Dr. Latham.

Mr. P. H. Cowell, Senior Wrangler in 1892, has been elected to the Isaac Newton Studentship in Physical Astronomy and Optics.

The Arnold Gerstenberg Studentship, worth about £90 a year, will be awarded next May, on the results of an examination in Psychology and Logic, commencing on May 21. Candidates must have obtained honours in one part of the Natural Sciences Tripos, and have commenced residence earlier than April 1888. The student elected must devote himself to moral or mental philosophy.

THE Queen has signified her approval of the appointment of the following Commissioners to consider what are the best methods of establishing a well-organised system of secondary education in England, taking into account existing deficiencies, and having regard to such local sources of revenue from endowment or otherwise as are available or may be made available for this purpose, and to make recommendations accordingly:—The Right Hon. J. Bryce, M.P.; the Right Hon. Sir J. T. Hibbert, M.P.; Mr. Henry Hobhouse, M.P.; Mr. H. Llewellyn Smith; Prof. R. C. Jebb, M.P.; Mrs. Henry Sidgwick; Mr. M. E. Sadler; the Rev. A. M. Fairbairn; the Hon. E. Lyttelton; Mrs. Bryant, D.Sc.; Dr. R. Wormell; the Very Rev. E. C. Maclure; Mr. George J. Cockburn; Mr. J. H. Yoxall; Sir Henry Roscoe, M.P., F.R.S.; Lady Frederick Cavendish; Mr. C. Fenwick, M.P.

[1] A pair of gloves are dichirally similar, or enantiomorphs. Equal and similar right-handed gloves are chirally similar.

A NEW departure in University Extension classes has been made at the Croydon centre, where a course of lectures on the "Geology and Scenery of the Alps" is being delivered by Miss M. M. Ogilvie, D.Sc. The course consists of ten lectures, six referring to general subjects bearing on the main question. Four lectures are devoted to special districts: the Western Alps, the Eastern Alps, the Bavarian Alps and North Tyrol, and the "Dolomites" of South Tyrol. The distribution of the population, political boundaries, trade routes, and many similar subjects controlled by the geology and physical geography are discussed. It is proposed to follow this course with an excursion to the Alps, during which various points discussed in the lectures will be studied on the ground.

MR. G. H. MORLEY informs us that the report that the late Mr. Thomas Avery, of Birmingham, bequeathed the sum of £2,000 to the Midland Institute, is incorrect. He left £2,000 to the Mason College, Birmingham, and only £1,000 to the Institute with which Mr. Morley is connected.

MR. F. W. DYSON has been appointed Prof. H. H. Turner's successor at the Royal Observatory, Greenwich. Mr. Dyson is a Fellow of Trinity College, and has held the Isaac Newton Studentship for the last two years.

WE learn from the Allahabad *Pioneer* that the Senate of the Madras University have reported unfavourably on the reference made to it by the Government regarding the proposal to establish degrees in science and agriculture.

SCIENTIFIC SERIALS.

Wiedemann's Annalen der Physik und Chemie, No. 2.—On kathode rays in gases at atmospheric pressure and in extreme vacua, by Philipp Lenard. This paper gives a detailed account of the behaviour of kathode rays when allowed to penetrate through a metallic screen in the walls of the vacuum tube into the air or other gas outside. It is shown that their behaviour is of a distinctive character, and largely independent of the electric forces producing them. Photographic plates were successfully employed in studying the distribution and divergence of the rays in air and other gases.—Concerning the theory of magnetic and electric phenomena, by Hermann Ebert. This is an attempt to show that by a consistent application of the cyclical theory of electric and magnetic phenomena, as illustrated by Fitzgerald's ether model, a complete and simplified explanation of these phenomena may be obtained.—On the laws of galvanic polarisation and electrolysis, by O. Wiedeburg. This is a detailed investigation of polarisation phenomena from the point of view of a theory which assumes that only a fractional portion of the ions clustering round the electrodes give rise to an opposing electromotive force. The author shows that this assumption leads to a complete and consistent representation of observed facts.—Some forms of immersed electrodes for measurements of electrolytic resistance, by F. Kohlrausch. The electrodes, which consist of small platinum plates about 1 sq. cm. in area, are soldered to platinum wires which are mounted in a double capillary tube. They are also surrounded by a glass vessel with a hole at the bottom for letting in the liquid. In measuring resistances they need only be immersed, no further adjustments or precautions being necessary.—Some experiments concerning the so-called waterfall electricity, by K. Wesendonck. The author quotes a large number of experiments elucidating the generation of electricity by the impact of water-spray, vapour, and air upon water and metallic conductors. Vapour impinging upon a water surface charges the latter positively, this being analogous to waterfall electricity, and independent of friction.—A new actinometer, by O. Chwolson. This consists of two thermometers placed close together, and is based upon the method of observing the changes in the difference of temperature of the two instruments, the warmer being in the shade, and the colder being exposed to the rays of the sun.

American Journal of Mathematics, vol. xvi. No. 1 (Baltimore, January.)—Zur Kettenbruchentwickelung hyperelliptischer und ähnlicher Integrale, by E. B. van Vleck (pp. 1–91), is illustrated by numerous diagrams, but we miss the usual useful index of contents accompanying long papers in this *Journal*.—Waves and jets in a viscous liquid, by Mr. A. B. Basset, F.R.S. (pp. 93–110), in continuation of an article by Prof. Greenhill, in the ninth volume, in which he discusses wave-motion in a frictionless liquid, here considers certain problems of like character when the viscosity of the liquid is taken into account.—Sur l'inversion des intégrales de fonction à multiplicateurs, by M. E. Picard (pp. 111–122), discusses in greater detail some points touched upon in chapter vi. of his memoir sur les fonctions algébriques de deux variables indépendantes (*Journal des Mathematiques*, 1889). On orthogonal substitutions that can be expressed as a function of a single alternate (or skew symmetric) Linear substitution, by H. Taber (pp. 123–130). This is a continuation of the author's previous work in the form of a proof of a theorem for certain orthogonal matrices discussed in a paper read by the writer at the Mathematical Congress in Chicago last year. The selected portrait is an excellent one (we feel sure) of Sophus Lie.

Symons's Monthly Meteorological Magazine, February, contains an article entitled "The January Frost." The author has tabulated all the lowest temperatures that he has been able to collect between the 5th and 8th of that month, and arranged them according to counties. The following are the minimum readings: Essex – 2°, Berwick – 3°, Aberdeen, Nottingham, and Warwick – 4°, York – 5°, Northumberland, Roxburgh, and Stirling – 6°, Fife and Perth – 8°, Forfar – 11°. In Ireland the temperature was higher, but still remarkable; between Cork and Tyrone several records were below 10°. A comparison with the great cold of January 1881 shows that that year was much more severe; the general mean for a number of representative stations was 3°·9, while this year it was 4°·7.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, February 8.—"Further Observations on the Organisation of the Fossil Plants of the Coal-Measures. Part I. *Calamites*, *Calamostachys*, and *Sphenophyllum*." By W. C. Williamson, LL.D. F.R.S., and D. H. Scott, M.A., Ph.D., F.L.S., F.G.S.

(1) *Calamites*.—The first part of the paper gives a detailed account of the vegetative structure of *Calamites*. It is proved that the primary structure of the young stem, before growth in thickness had begun, agreed in all essential points with that of an *Equisetum*, and thus the anatomical characters are found to completely confirm the supposed equisetaceous affinities of the genus. The true nature of the canals which accompany the vascular bundles in the internodes of *Calamites* is demonstrated, and their complete homology with the carinal canals of *Equisetum* established. In both cases the canal contains the disorganised protoxylem of the vascular bundle.

The development of the secondary tissues, which were always formed in *Calamities*, is traced in detail, and their origin from a normal cambium proved.

The formation of periderm in the cortex has also been clearly observed.

The position of the branches and their exact mode of connection with the tissues of the main stem is fully investigated. It is shown that many of the branches were abortive, and became enclosed in the wood.

The roots of *Calamites*, as M. Renault has proved, were identical with *Astromyelon*.

(2) *Calamostachys*.—The anatomy of the axis of the strobilus has been fully investigated, and found to agree in the main features, though not in details, with that of *Calamites* or *Equisetum*.

In general anatomical and morphological characters the homosporous species, *C. Binneyana*, and the heterosporous *C. Casheana* show the closest agreement, and only present minute differences. In *C. Binneyana*, developing spores, still grouped in tetrads, are frequently found. One or more members of each tetrad were usually abortive. The abortion of these spores must have allowed of an increased nutrition of the survivors, and thus have been of considerable physiological importance. In *C. Casheana* the micro- and macro-sporangia were borne on the same strobilus. The diameter of the macrospores is three times that of the microspores. The macrospores are constantly accompanied by abortive spores. This abortion of certain spores, involving the better nutrition of their sister-cells, appears to throw considerable light on the origin of heterospory within this genus.

This axis of the strobilus of *C. Casheana* has a well-marked zone of secondary wood, thus affording direct evidence of the occurrence of secondary growth in a heterosporous cryptogam.

The affinities of *Calamostachys* are fully discussed. The fructification is evidently Calamarian, and the relation to *Calamites* itself is a close one.

(3) *Sphenophyllum*.—As is well known, the slender jointed stem bore verticils of superposed leaves, the number of which, in each whorl was some multiple of 3. In *S. plurifoliatum*, the species first described, the leaves probably numbered 18 in a whorl. The primary wood was triarch and centripetal, and so far resembled that of certain Lycopodiaceæ, with which, however, the genus has otherwise little in common. Abundant secondary tissues were formed. The cambium can be clearly demonstrated, and occupies the normal position between wood and bast. Sieve tubes have been detected in the phloem of *S. insigne*. Internal periderm was formed, giving rise to a regular scale-bark.

The fructification of *Sphenophyllum*, as has been shown by M. Zeiller, is that previously described under the name of *Bowmanites Dawsoni*. The axis of the strobilus bore numerous whorls of partially coherent bracts. The very long sporangiaphores, each bearing a single recurved sporangium, arise from the upper surface of the whorl, two sporangiophores corresponding to each bract. The whole structure is quite unlike that of any other vascular cryptogam. The plant, so far as observed, was homosporous, and the alleged heterospory of another species is very doubtful. The genus is entirely isolated, and, though the structure is now completely known, its affinities cannot be determined until additional forms have been discovered.

March 1.—"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part IX. Section 1. On the Therosuchia." By H. G. Seeley, F.R.S.

This paper discusses the classification of reputed Permian and Triassic Reptilia which have been referred to the Anomodontia as Theriodonts.

Prof. Cope's definition of the Theriodontia as distinguished from the Anomodontia by characters of the post-orbital arch is regarded as unsupported by evidence. The author would limit the Theriodontia to animals which conform to Sir R. Owen's original definition based on the dentition (1876), and have temporal vacuities and a small quadrate bone.

It appears that there is a series of groups of South African Reptilia which agree in having a palate which has some resemblances to mammals but approximates to *Sphenodon*, lizards, and crocodiles. All these sub-orders are combined as the Therosuchia. In this order or group may be included the Deuterosauria from the Permian rocks of Russia.

The relation of the Therosuchia to other Anomodontia is shown in the following grouping:—

THEROSUCHIA.—Pareiasauria, Procolophonia, Gorgonopsia, Dinocephalia, Deuterosauria, Theriodontia (*Lycosauria*, *Cynodontia*, *Gomphodontia*), Endothiodontia [Theromora]. THECODONTIA.—Dicynodontia, Kistecephalia. MESOSAURIA.

"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part IX. Section 2. On the Reputed Mammals from the Karroo Formation of Cape Colony." By H. G. Seeley, F.R.S.

The author re-examines the remains of *Theriodesmus*, and contests the interpretation of the carpus given by Prof. Bardeleben, producing specimens of South African reptiles in which there is a single bone beneath the radius, as in *Theriodesmus*.

"Researches on the Structure, Organisation, and Classification of the Fossil Reptilia. Part IX. Section 3. On *Diademodon*." By H. G. Seeley, F.R.S.

The author describes fragments of jaws and teeth from Upper Karroo strata at Wonderboom and Aliwal North, collected by Messrs. R. D. Kannemeyer and Alfred Brown. They may possibly belong to more than one genus; but, in absence of sufficient knowledge of the skull to establish differences, the four species are referred to a new genus, *Diademodon*.

The teeth are highly specialised, but distinct in plan from *Tritylodon*, and from all known reptiles. They closely approximate to some of the higher mammalia. The author refers *Diademodon* to a division of the Theriodontia in which the teeth become worn with use, which is named Gomphodontia.

Physical Society, February 23.—Prof. A. W. Rücker, F.R.S., President, in the chair.—A note on a new electrical theorem was read by Mr T. H. Blakesley. Two or more distributions of electromotive forces in any network of conductors which produce at every part of the network the same currents, are defined as *equivalent systems*. The following theorem is then stated and proved: In any system of conductors possessing seats of electromotive force at any number of points, if any of these sources be moved along the various bars of the conducting system, and where a point of junction is encountered, each becoming a seat of the *same* electromotive force in *each* of the newly encountered bars, then the disposition at any moment is equivalent to that at any other moment, and therefore to the original disposition. Equivalent systems might also be defined as being such as produce equal expenditure of power in each part. From the above theorem the following propositions are deduced by the author: (1) That if any closed surface contains a portion of a network, then an electromotive force in any bar cutting the surface can be replaced by equal electromotive forces (in opposite directions as regards the surface) in all the other bars cutting the surface, without disturbing the current in any part of the network. (2) If two systems of electromotive forces be equivalent, one may be derived from the other.—Prof. C. V. Boys, F.R.S., read a note on the attachment of quartz fibres. When torsion fibres are required to carry large weights approaching the breaking weight, the ordinary method of attachment by shellac is not always satisfactory, for if the part of the fibre in the cement is twisted or bent, the yielding of the shellac causes uncertainty of zero. To avoid these troubles, Prof. Boys has devised and perfected a method of soldering the fibres, full details of which are given in the paper. After selecting a fibre of the right diameter and length, small weights are fixed on the ends by shellac. The end parts are then cleaned by dipping in strong nitric acid, washed, silvered, and electro-coppered. The weights are then cut off, and the coppered ends soldered to tags of tinned metal foil, chloride of zinc being used as a flux, and its capillarity serving to hold the ends to the tags whilst the latter are heated. The superfluous copper and silver are dissolved off by nitric acid, the tags and solder being protected by beeswax. After washing in boiling water the fibre is ready for use. Melted shellac is used for securing the tags to the torsion rod and suspended body. Several ingenious details of procedure to avoid capillary difficulties in the cleaning, plating, and washing processes are described in the paper. If fibres are required to conduct electricity, they are silvered and washed after the tags have been soldered on. Such fibres the author considers essential for making connection with electrometer needles of the greatest delicacy, for liquid connections are fatal to stability. Methods of rendering fibres visible by smoking with arsenic or magnesium are mentioned in the paper. At the meeting a perfectly circular hole, $\frac{1}{1000}$ of an inch in diameter, made by soldering round a quartz fibre passing through a hole in a metal plate, and then drawing out the fibre, was exhibited under a microscope. Mr. Inwards asked if the shellac used to secure the tags was melted or dissolved. Mr. Blakesley inquired if silvering fibres did not destroy their perfect elasticity. Dr. Sumpner wished to know if any data as to the relative torsional rigidity of silvered and unsilvered fibres had been obtained, and if the electric resistance of silvered fibres had been determined. Mr. Watson said silvered fibres had been successfully used in electrometers. As regards their torsion, he had found it differ from day to day, and the resistance varied enormously. In reply to question, Prof. Boys described the exact process of soldering the coppered fibre to the tags. As to the torsion of silvered fibres, he would not expect much increase, as the film was very thin. He also thought the elasticity would not be destroyed, for silver and gold make very good torsion wires.—Mr. Littlewood read a note on a method of determining refractive indices, particularly well adapted for either homogeneous or heterogeneous liquids. A vertical scale stands in the liquid contained in a vessel open at the top, and two marks on the part of the scale below the liquid are observed in succession through an inclined telescope capable of moving horizontally parallel to itself along a graduated bar. The horizontal distance between the two positions of the telescope in which the two divisions on the vertical scale are sighted is noticed, and the corresponding distance between the sighted position of two marks on the part of the scale above the liquid determined. When the length between the two marks on the scale in air is equal to that between those in the liquid, the ratio of the corresponding horizontal distances moved through by the telescope gives the index of refraction of a uniform liquid. For liquids in which the density varies in a vertical direction, observations of several points on the scale in the liquid enable the curved path of the light in the liquid to be traced out with considerable accuracy. The accuracy of the laws of diffusion might be tested in this way. The President said the method described was a novel and interesting way of picking out the layers of liquid of different refracting power.

Chemical Society, February 15.—Dr. Armstrong, President, in the chair.—The following papers were read:—The

analytical determination of probably available "mineral" plant food in soils, by B. Dyer. The author has made a series of determinations of the average acidity of the root sap of about 100 plants in order to measure the power of dissolving the mineral constituents of soils possessed by plants. These experiments seemed to indicate the suitability of a 1 per cent. solution of citric acid as an analytical soil solvent; the effect of this solution on a number of the Rothamsted soils was therefore tried. The conclusion is drawn that valuable indications of comparative ("mineral") soil fertility are obtained by the use of such a solution. After the reading of the paper, Sir Henry Gilbert gave a short sketch of the development of soil analysis.—The behaviour of the more stable oxides at high temperatures. Part ii., by A. A. Read. At 1750°, Sb_2O_5 is converted into Sb_2O_3, V_2O_5 into V_2O_3, and Fe_2O_3 into Fe_3O_4, whilst the oxides of cobalt and nickel are reduced to the metallic state.—The stability of the oxides considered in relation to the periodic law, by G. H. Bailey. In the even series of the periodic classification, the oxides are more stable the higher the atomic weight of the element concerned, the temperature of decomposition being taken as an index of stability; in the odd series the oxides become less stable as the atomic weight increases.—The interaction of benzil and benzylamine in presence of zinc chloride: a preliminary note, by F. R. Japp and W. B. Davidson. On heating benzil, benzylamine, and zinc chloride together at 100°, tetraphenylazine, benzyllophine, and dibenzyllophinium chloride are obtained.

Geological Society, February 16.—W. H. Hudleston, F.R.S., President, in the chair.—The Wollaston medal was awarded to Geheimrath Dr. Karl Alfred von Zittel, professor of geology and palæontology in the University of Munich, in recognition of the important services which he has rendered to palæontological science during a long period of time.—Mr. Aubrey Strahan was awarded the balance of the proceeds of the Wollaston Donation Fund, in token of appreciation of his geological work in several parts of England and on the Welsh border.—Mr. William Talbot Aveline received the Murchison medal, together with a sum of ten guineas, in recognition of the importance of his work as a geological surveyor.—The balance of the proceeds of the Murchison Geological Fund was handed to Mr. George Barrow, as a testimony of the value of his geological work both in Yorkshire and in Scotland.—The Lyell medal, with the sum of £46, was awarded to Prof. John Milne, F.R.S., of the Imperial College of Engineering, Tokio, Japan, in testimony of appreciation of his investigations in seismology.—The balance of the proceeds of the Lyell Geological Fund was presented to Mr. William Hill, in testimony of the value of his work amongst the Cretaceous rocks of this country during the last eight years.—A sum of £25 from the proceeds of the Barlow-Jameson Fund was given to Mr. Charles Davison, in token of appreciation of his work in geological dynamics, including under that term the study of earthquakes.—The President then read his anniversary address, which may be summarised as follows:—In continuation of the subject of the preceding anniversary address, relating to some recent work of the Geological Society, the remaining portion of the papers contributed within the septennial limits is classified under two groups. In the first group are placed papers descriptive of the newer palæozoic rocks, the older palæozoic rocks, and the fundamental rocks, and on general petrology, which relate more especially to the geology of the British Isles. This group is considered in detail, and constitutes the bulk of the address. In the second group are placed numerous papers which may roughly be classified under the following headings:—Miscellaneous geology, foreign and colonial—a somewhat exhaustive division, comprising about a score of papers, dealing with many subjects in different parts of the world. African geology, especially, comes to the front in this group. Miscellaneous invertebrate palæontology—a score of papers may be thus classified. Most of these matters are for the consideration of specialists, relating to corals, crinoidea, bryozoa, ostracoda, cephalopoda, and to siliceous organisms. In palæobotany there has only been one paper of any importance; whilst under the heading dynamical problems are a few papers dealing with the movement of material. A notice of the Inverness earthquake, and a communication on the origin of the basins of the great lakes of America, complete this category. The detailed consideration of the first group commences with the newer palæozoic rocks. The carboniferous system has not yielded any important stratigraphical papers of late years, but there have been some interesting communications respecting the coal measures. Questions as to the origin and faunal character of these are discussed by more than one writer, and very important deductions, as to the delimitation of the marine and freshwater beds, have been drawn. The subject of coal in the south-east of England was considered, *à propos* of a paper read at the Society some years ago, and the prospects of coal-getting at Dover and elsewhere in this part of England discussed. In Devonian geology, the structure and peculiarities of the South Devon limestones form the subject of an interesting communication; and there are also important stratigraphical papers in this connection, more especially one written subsequent to the visit of a party from the International Geological Congress of London. In the older palæozoic rocks a considerable amount of work has been done, more especially amongst the Silurian and Ordovician of the north-west of England, where additional evidence has been furnished of the value of graptolite-zones as a means of comparison with the older palæozoics of distant areas; and a further contribution has also been made to our knowledge of beds of this age in the Cross-Fell inlier. The papers dealing with the fossiliferous Cambrian are not numerous, but they are of great importance, including the recognition of a very low Cambrian fauna at the top of the Penrhyn quarries, and Sir J. W. Dawson's correlation of American with European Cambrians. The discovery of *Olenellus* in the "fucoid beds" of the north-west Highlands also serves to fix the Cambrian age of the Durness limestone, to which formation the altered limestone of Strath in Skye, at one time regarded as of Liassic age, is now held to belong. The physical relations and the post-Cambrian metamorphism of the rocks of the north-west Highlands are also considered under this heading. The fundamental rocks are roughly divided into three categories, viz. the sedimentary series, the volcanics, and the crystalline schists. The first includes the Torridon sandstone, the Longmynd rocks, the unfossiliferous Cambrians of Wales, &c. The volcanic series has already formed part of the subject of an address from the chair. Oddly enough, the best defined pre-Cambrian, or fundamental sedimentary series, is to be found in the north-west Highlands, a district which only a few years ago was an enigma, but which we hope may now supply a clue to regions more obscure. This, of course, is the Torridon sandstone, which has a well-defined base and a well-defined summit. Then there are certain rocks which some regard as Cambrian, others as pre-Cambrian, such as the Howth Hill and Bray Head beds, claimed as Upper Monian. Crossing St. George's Channel, we find ourselves in Anglesey, a land of pre-Cambrian mysteries. The older rocks have been described as belonging to the Monian system, an arrangement much controverted, and this controversy has extended to Shropshire. Lastly, there is the long-standing contention as to whether the unfossiliferous Cambrians of North Wales really belong to that system or should be placed on a lower horizon. The Malvernian controversy relates, in the main, to the crystalline schists. Under the heading of General Petrology is grouped a very large series of papers, more than sixty in number, divided roughly into two primary classes, according as they relate to the British Isles or to foreign countries, the former class being alone considered in detail. The arrangement is topographical, and the rocks under this heading may be of any age from the Archæan upwards. Scotland has yielded seven papers in this group—most of them of very great interest and importance, one or two being somewhat controversial. The subject of contact-metamorphism is raised with reference to more than one Scotch locality; and from the Lake District there has been a communication on the Shap granite and associated igneous and metamorphic rock, which again brings this question into prominence. Some of the papers relating to Wales have already been dealt with in a previous address, but the subjects of the variolite and also of the nodular felstones of the Lleyn are noticed on the present occasion. In Devonshire the rocks formerly known as "felspathic traps" have been described as basalts and andesites; whilst the igneous origin of the Dartmoor granite has been maintained against one of those theories which from time to time crop up with respect to this well-known *massif*. Allusion is also made to the controversy with respect to the Start rocks. There have been four papers dealing with the Lizard peninsula, in which questions as to priority of the several igneous masses and as to the origin of the banded gneisses are entertained. It cannot be doubted that considerable progress has been made of late towards a recognition of the true character of these rocks, which, for the extent of territory they occupy, are perhaps without equal in point of interest throughout the British Isles. The

address concludes with a notice of the rocks of Brittany and the Channel Isles, which have attracted the attention of more than one author.

CAMBRIDGE.

Philosophical Society, February 26.—Prof. Hughes, President, in the chair.—The following communications were made:—On current-sheets, specially on ellipsoids and anchor-rings, by Mr. R. H. D. Mayall. The electric currents induced in thin uniformly conducting sheets of any shape placed in a variable magnetic field were considered; and it was shown that they could be determined by the solution of a differential equation of the second order with the aid of the appropriate boundary conditions. Orthogonal curvilinear co-ordinates were used in every case, the equation to the surface of the conductor being got by making one co-ordinate constant. In this way results were worked out for the infinite plane, the sphere, the infinite right circular cylinder, and the ellipsoid with three unequal axes. The case of the anchor-ring was also discussed, and a set of linear equations found to determine the unknown coefficients in the expression for the current function. These were solved for the particular case when the exciting disturbance was represented by a harmonic of the first degree and symmetrical about the axis of the ring; and a simple expression was found for the modulus of decay of free currents of the same type.—The complete system of quaternariants for any degree, by Mr. D. B. Mair. A method is given for finding the concomitants of a quaternary form of any degree or of simultaneous quaternary forms. The cases of a single quadratic, a single cubic, a single quartic, a system af two quadratics, and a system of three quadratics, are treated at length.—The configuration of a pair of equal and opposite hollow straight vortices, of finite cross-section, moving steadily through a fluid, by Mr. H. C. Pocklington.—On a class of definite integrals connected with Bessel's functions, by Mr. A. B. Basset.

PARIS.

Academy of Sciences, February 26.—M. Lœwy in the chair.—On the scientific work of Jean Louis Armand de Quatrefages de Bréau, by M. Edmond Perrier.—On the equation of the vibrations of a membrane, by M. H. Poincaré.—On a way of obtaining a uniform circular movement by means of two vibratory movements, by M. Marcel Deprez.—Observations of the new planet AV (Courty, 1894, February 11), made at the Paris Observatory, by MM. O. Callandreau and G. Bigourdan.—On the application of the method of successive approximations to the ordinary differential equations of the first order, by M. Ernest Lindelöf.—Observations on the preceding communication, by M. Émile Picard.—The combustion of the ordinary ballistic explosives, by M. P. Vieille. The old black and brown powders do not show combustion by parallel surfaces, whereas the new colloidal powders give data satisfying exactly the criterion of combustion by parallel surfaces.—On the fundamental laws of heat, by M. G. Mouret. The three laws concerning,—the conservation of entropy in reversible operations, the conservation of heat in conduction, and the increase of entropy in irreversible operations, appear to be fundamental laws of heat, and not derivable from a more general law.—On a means of compensating the E.M.F. of a hydro-electric pile, by M. J. Schürr.—Measurement of the difference of phase between two alternating sinusoidal currents of the same period, by M. Albert Hess.—Action of heat on the double nitrites of metals of the alkali group and metals of the platinum group: ruthenium compounds, by MM. A. Joly and E. Leidié. The formulæ $Ru_2(NO_2)_6.4KNO_2$ and $Ru_2O(NO_2)_4.8KNO_2$ are now assigned to the potassium ruthenium nitrites. At 360°-440° in a vacuum, explosive decomposition occurs of the latter compound, with the production of nitrogen, nitrogen dioxide, potassium nitrite, and an insoluble black substance, $3Ru_2O_5.K_2O$. The preparation and properties of the sodium compounds, $Ru_2(NO_2)_6.4NaNO_2+4H_2O$ and $Ru.NO.Cl_3.2NaCl$ are described. The former yields the compound $Na_2O.3Ru_4O_9$ on heating in sulphur or mercury vapours; at a red heat RuO_2 is produced.—On the isomerism of the nitrobenzoic acids, by M. Œchsner de Coninck. A study of the relative solubilities of the ortho-, meta-, and para-nitrobenzoic acids in distilled water, dilute alcohol, ether, benzene, light petroleum, carbon bisulphide, and chloroform is given.—On some derivatives of the oxazine and eurhodine series, by M. Charles Lauth.—Analysis of a damaged cheese; extraction of a new ptomaine, by M. Charles Lepierre. A well-crystallised base of the formula $C_{16}H_{24}N_2O_4$ has been isolated. It is bitter, inodorous, slightly acid to phthalein, soluble in alcohol but hardly soluble in water, and gives the usual alkaloid reactions but does not yield a tannin precipitate. Its specific rotatory power $[\alpha]_D = +11{\cdot}3°$ in water. It causes diarrhœa.—On some laboratory apparatus, by M. André Bidet.—On the odour of benzoic acid (remarks on inodorous substances), by M. Jacques Passy.—Anatomy of the salivary glands of the *Philantidæ*, by M. Bordas.—On the internal characteristics of the grape, and their utilisation in the determination of species and the distinction of hybrids, by M. Gustave Chauveaud.—Artificial reproduction of *avens*, by M. Stanislas Meunier.—The five days' hurricane, from February 8 to 12, 1894, in Bohemia. A letter from M. Ch. V. Zenger to M. A. Cornu.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Thermodynamics of Reversible Cycles in Gases and Saturated Vapours: Dr. M. I. Pupin (K. Paul).—The Badminton Library—Big Game Shooting. 2 vols.: C. Phillipps-Wolley, &c. (Longmans).—Philip's Systematic Atlas: E. G. Ravenstein (Philip).—Nature Pictures for Little People: M. Mawer, &c. (Sunday School Association).—Le Climat de la Belgique en 1893: A. Lancaster (Bruxelles, Hayez).—Man the Primeval Savage: W. G. Smith (Stanford).—Report on North-Western Manitoba: J. B. Tyrrell (Ottawa, Dawson).—Ergebnisse der Meteorologischen Beobachtungen Jahrg. xv. (Hamburg).—A Treatise on Elementary Hydrostatics: J. Greaves (Cambridge University Press).—Joh. Müller's Lehrbuch der Kosmischen Physik and Atlas to ditto.—Fünfte umgearbeitete und Vermehrte Auflage: Dr. C. F. W. Peters (Braunschweig, Viewig).—Analytical Geometry for Beginners: Rev. T. G. Vyvyan, Part 1 (Bell).—Introduction to Elementary Practical Biology: C. W. Dodge (New York, Harper).—Aero-Therapeutics: Dr. C. T. Williams (Macmillan).—Lehrbuch der Petrographie: Dr. F. Zirkel, Zweiter Band (Leipzig, Engelmann).

PAMPHLETS.—The Texan Monsoons: M. W. Harrington (Washington).—Die Tropischen Orkane der Südsee, &c.: E. Knipping (Hamburg).—The Function of Museums, as considered by Mr. Ruskin: W. White.—Meteorology at the Paris Exposition: A. L. Rotch.

SERIALS.—Geological Magazine, March (K. Paul).—Records of the Botanical Survey of India, Vol. i. Nos. 1 and 2 (Calcutta).—American Naturalist, February (Philadelphia).—Botanical Gazette, February (Madison, Wis.)—Geological Journal, March (Stanford).—Observaciones Magnéticas y Meteorologicas del Real Colegio de Belen, Julio-Dic. 1889 (Habana).—Bulletin of the New York Mathematical Society, Vol. 3, No. 5 New York, Macmillan).—Science Progress, No. 1 (Scientific Press).—Quarterly Journal of Microscopical Science, March (Churchill).

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