THURSDAY, AUGUST 16, 1900.

A STANDARD TEXT-BOOK OF PHYSICS.

Müller-Pouillet's Lehrbuch der Physik und Meteorologie. Neunte umgearbeitete und vermehrte Auflage von Dr. Leopold Pfaundler. In drei Bänden. Erster Band, Mechanik, Akustik. Pp. xxi + 888 (1886). Zweiter Band, unter Mitwirkung des Dr. Otto Lummer, Erste Abtheilung, Optik. Pp. xx + 1192 (1894–1897). Zweite Abtheilung, Wärme. Pp. xiv + 768 (1898). Dritter Band, Elektrischen Erscheinengen. Pp. xvi + 1062 (1888–1890). (Braunschweig: Friedrich Vieweg und Sohn.)

THE appearance of the second part of the second volume of this work marks the completion of the ninth edition of an important treatise on experimental physics which has for many years been widely used in Germany. The importance of the work lies in the fact that it aims at giving a full description of physical apparatus and experimental methods, no attempt being made to expound mathematical theories, and none but the most elementary mathematics being employed or assumed as one of the reader's acquirements.

Herein the work differs from most of our English text-books of physics, in which the tendency has latterly been to combine a certain amount of mathematical theory with short accounts of experiments in illustration of the theory, both the mathematical and experimental portions being of necessity very incomplete. This tendency, probably necessitated by our examination system, will, as long as it continues, prevent our having in English such complete works on experimental physics as that now before us.

Any work on physics, however, in several volumes produced at different times, must, when completed, present some lack of uniformity among its parts, especially if the part dealing with that branch of the subject which varies most rapidly is not produced last. This is the case in the present instance. The volume on magnetism and electricity was published some ten or twelve years ago, several years before the appearance of the volumes on light and heat. The reason given is that, on account of the rapid advance made in electricity, the volume dealing with this branch in the previous edition appeared much more out-of-date than the other volumes, and therefore had more need of revision. For the same reason, on now reviewing the whole of the present edition, one cannot help being struck with the fact that the volume dealing with electricity and magnetism far less adequately represents the present state of the subject in this branch than do the other volumes in their own regions.

In the first volume of the present edition, dealing with mechanics and sound, after an introductory chapter on fundamental notions and a short discussion of uniform and uniformly accelerated motion of a point in a straight line, the subject of mass and force is immediately taken up, further treatment of kinematics being postponed to a later stage. It seems to the writer to be preferable, especially in an elementary book on the subject, to deal more fully with kinematics before going on to dynamics proper. The student should first become well acquainted with the notions of velocity, acceleration, their composition and resolution, and should give special attention to cases in which the acceleration is not in the same direction as the velocity. In this way he is enabled to acquire a much clearer idea about acceleration as a quantity with a direction of its own, and is therefore much better prepared to make the transition from his previous vague notion of force to the more accurate dynamical meaning of the term.

The subject of mass and its measurement is discussed at some length, and in a very instructive manner. The action of a force in producing acceleration in a body is finally adopted as the basis of the dynamical measurement of mass. This system involves the definition of force. A definition of mass (due to Mach) independent of the definition of force is referred to in a footnote on p. 85, viz.: bodies which (by gravitation) produce equal but opposite accelerations in each other are said to have equal masses. This includes the definition of the ratio of the masses of two bodies as the ratio of the accelerations which they produce in each other, and when a unit of mass is chosen, the mass of any other body is measured by the acceleration given to the unit divided by the acceleration experienced by the body itself.

The phraseology is sometimes not as accurate as one could wish; thus on p. 92 we find the expression "an acceleration of one metre," and in the following sentence, "a velocity of one metre"; and again, the kilogramme is stated to be both the unit of mass and the gravitational unit of force. Although explanations follow, it must lead to some confusion in the mind of a beginner to find that a kilogramme means sometimes a mass and sometimes a force. It is of the greatest importance in an exposition of the principles of dynamics that one meaning only should be attached to every technical term. A similar confusion arises in connection with the term "weight," about which there is a lengthy discussion on pp. 96–99. The difficulty might have been much diminished by reserving the word kilogramme to mean a mass and weight to mean a force—viz. the resultant force acting on a body falling freely near the earth. The common use of the terms should be explained afterwards.

On pp. 326–333 a short account is given of the behaviour of spinning tops and gyroscopes, with a general explanation of the couples called into play by a deflection of the axis of rotation. The "drift" of a shell fired by a cannon is ascribed mainly to gyrostatic action. The constantly increasing angle between the axis of rotation and the direction of motion causes the air in front of the shell to exert a force tending generally to raise the head of the shell with respect to the centre of mass; this produces a deflection of the point of the shell to the right, and the increased pressure thus introduced on the left side causes a deflection to the right. It is possible that, with a shell of suitable shape, the pressure of the air would tend to raise the rear end, and the gyrostatic deflection would in this case be to the left. As is remarked in a footnote, however, the greater friction on the under side of the shell probably plays an important part, and this always causes a drift to the right.

In Chapter v. a good elementary account of the laws of capillarity is given. On p. 444 Quincke's falling drop method of measuring surface tensions is described, the weight of the drop being stated to be equal to the product of the surface tension and the circumference of the line of contact. Lord Rayleigh has shown that this is not correct even if the liquid motion in the drop at the moment of separation be neglected; the excess of pressure in the drop corresponding to the curvature of the surface (supposed cylindrical near the plane of contact) has the effect of diminishing the size of the drop to one-half the value stated, and this result agrees more closely with experiment.

The second part of the volume, on sound, resembles in its general mode of treatment most other elementary text-books on the subject. The general nature of wave-motion is made quite clear by numerous diagrams of wave-curves and wave-machines. The deduction given on p. 638 of the expression $\sqrt{E/D}$ for the velocity of propagation of sound-waves is not satisfactory, since it involves the tacit assumption that the whole energy is half potential and half kinetic.

In connection with the experimental measurement of the velocity of sound in water in tubes, referred to on p. 643, the influence of the walls and Kundt's measurements in tubes with walls of different thicknesses should have been mentioned, and in the description of the resonance tube experiment, no method is given for eliminating the end correction.

The last chapter contains an interesting account of the researches of von Helmholtz and others on the vibrations of violin strings, combination tones, analysis of sounds, and the theory of consonance and dissonance.

In the second volume (light and heat) the author is assisted by Dr. Lummer, who, we are told in the preface, is chiefly responsible for the part dealing with optical systems and the theory of optical instruments. This part of the work has been largely re-written for the present edition, and brought well into line with the modern views on image-formation founded by Abbe.

As is the case in doing most things, there are two ways of writing a book on geometrical optics. The first, until recently the usual, method is to begin with very special cases, such as thin lenses, and proceed by degrees to the more general cases of thick lenses and systems of lenses.

The other, and more modern, method is to begin with the general case of a point-point correspondence between two portions of space, of such a kind that to a pencil of rectilinear rays passing through a point in one region corresponds a pencil of rectilinear rays passing through a point (the image) in the other region; then to introduce the special cases of image-formation by reflecting or refracting surfaces and centred systems, including lenses. The two methods thus proceed on opposite lines.

The latter method has been perfected by Abbe, and is the one adopted by Czapski and, though necessarily in a more elementary and restricted manner, in the present work.

After two chapters dealing with the nature of light, photometry, refraction and reflection at plane surfaces, Chapter iii. treats of the formation of images by refraction at a single spherical surface; then the general case of any number of spherical surfaces separating different media, with their centres in a straight line; and, finally, two co-axial centred systems, with the special case of a "telescopic" system in which the "interval" is zero. The lens is regarded as two centred systems, each consisting of a single spherical surface.

Chapter xii. is devoted to the theory and use of "stops," the calculation of magnifying power and brightness of images in centred systems, and, finally, the laws of formation of images of illuminated objects, as in the ordinary use of the microscope. Here purely geometrical methods break down, and diffraction spectra play an all-important part. A highly interesting account follows o Abbe's theory of microscope images and its remarkable verification by the use of the diffraction plate, in which is shown how the similarity of image to object, as well as the resolving power of the instrument, depends upon the number of diffraction spectra whose rays enter the objective and take part in the final image-formation. How these principles are applied in the construction of microscope-objectives is set forth in the chapter on optical instruments, which also contains details of many of the latest improvements in optical instruments of all kinds.

The second part of vol. ii. (on heat) does not differ from the corresponding part of the previous edition so fundamentally as is the case with the part on optics; but it is brought more nearly up-to-date by many additions, including the work of Olszewski and Linde on the liquefaction of gases, a chapter on thermochemistry, steam calorimeters, recent determinations of the specific heat of water at various temperatures and of the mechanical equivalent of heat. No reference is made, however, to recent improvements in the choice of a unit of heat.

Thermodynamics does not receive very much attention, few applications being mentioned beyond Kelvin's definition of absolute temperature, and a calculation of the change of melting point produced by pressure. Some details are given, however, of the parts and action of steam, air, and gas engines.

A short chapter on meteorology, dealing with climatic conditions and their changes, brings this volume to a close.

As to the third volume, it suffers, as was remarked before, in comparison with the other volumes from having been written several years ago. Still, it contains a large mass of useful information about electrical and electro-technical apparatus, much of which is not usually found in text-books on electricity and magnetism.

It is impossible, in the space at our disposal, to give more than a very rough sketch of a work which extends to close upon 4000 pages, and many excellent qualities of the work must for this reason remain unmentioned. One of the chief features is the large number (nearly 3000) of excellent illustrations, and, chiefly in the section on optics, some very beautiful coloured plates. Explanations are, as a rule, given very clearly, and often aided by numerical examples worked out. Further, on account of the very large number of experiments and forms of apparatus described, as well as the numerous references to original papers, the work is certain to prove useful, as it no doubt has already done, to students and teachers of physics.

HUXLEY'S PHYSIOLOGY.

Lessons in Elementary Physiology. By Thomas H. Huxley, LL.D., F.R.S. Enlarged and revised edition. Pp. xxiv + 611. (London: Macmillan and Co., Ltd., 1900.)

HUXLEY'S "Lessons in Elementary Physiology" was probably the best book of its kind which has ever been written. It set forth the elements of human anatomy and physiology in so clear and concise a form, and the little volume formed so complete a compendium of the essential facts which had accumulated in the science with which it dealt, that it was at once welcomed as supplying a want which had long been felt—that of a popular and, at the same time, an authoritative exposition of the subject. Its success was enormous. Edition after edition was sold in rapid succession, and the booklet—for it was nothing more—was not only adopted in schools throughout this country as *the* text-book with which the teaching of physiology was to be begun, but it was soon translated into every civilised language, and even, it is said, into more than one barbaric tongue.

The secret of its success lies on the surface. It was written in the English which was characteristic of the Master: its language trenchant, flowing, and well chosen, its similes apposite, its facts duly marshalled and leading up to their logical conclusion. And the book was what it was intended to be—a popular account, which, while retaining scientific accuracy, should not be burthened by unnecessary details, nor by theories which might or might not ultimately prove correct. Moreover, the ground was clear—where there are now a dozen similar treatises, there was then not one. But it is safe to assert that "Huxley" would in any case have taken the first place.

An entirely new edition of the "Lessons"—the first since the lamented death of the original author—has now made its appearance under the auspices of Sir Michael Foster and Dr. Sheridan Lea. Michael Foster has been associated with the book throughout its whole career. Sheridan Lea's name appears now for the first time in connection with it; but although the responsibility is joint, the labours of preparation have fallen chiefly upon Dr. Lea's shoulders. We may be sure that the work has been a labour of love to the editors. The intimate friendship which existed between them and Huxley, their veneration for his memory, their desire to maintain the high standard and reputation of the work, must have caused them to put forth their best efforts to ensure its continued success.

In surveying the changes which have been introduced, the point of chief interest appears to be to notice whether the introduction of these changes has tended in any way to modify the original character of the work. We have already seen that this character was that of a popular exposition of the science suitable especially for schools, and the questions naturally arise, is the book still of this nature? Has it been modified to suit it to other purposes than that for which its author originally wrote it?[1] It must be conceded that the book retains in a measure its character as a popular expositor. This is largely owing to the fact that the editors have preserved "as far as possible the original author's own form of exposition and indeed his own words." But it must also be admitted that its character in this respect has been modified by changes and additions. The purport of these appears to have been to adapt the book for use by students of medicine, a design which may be laudable but cannot fail to affect the general tone of the work. Students of medicine require to learn anatomy and physiology with a minuteness of detail not necessary in a work which is intended to be of a popular nature. Not only is it important that the unquestioned facts of the science should be set before them, but they require also to be made cognizant of statements which, however probable, are not universally accepted as facts, and of theories which may or may not ultimately prove to be correct. And herein it appears to me lies the difference between the new "Huxley" and the old. That the change tends, as the editors claim, to increase the sphere of usefulness of the work, may be perfectly true, but the essential character and original aim of the work has been thereby affected. If there is a gain on the one side there is a loss on the other, and it is impossible that it should not be so; it is a question of opinion whether the gain counterbalances the loss. For my own part, while recognising the able manner in which the new material is worked up and incorporated with the old and the increased value which is thereby imparted to the work as a text-book preliminary to the study of physiology, I must frankly confess that I regret the change. Students of medicine have already more than one elementary text-book in which the facts and chief theories of physiology are set forth with all the clearness that could be desired, and in one instance at least with a wealth of illustration which cannot be surpassed or even approached in a book of so small a size as "Huxley." On the other hand, the amount of detail which has been introduced into this edition, while valuable for the medical student, is unnecessary or unsuitable for the school boy. Perhaps it was impossible to avoid this change, perhaps it was desirable to make it; at any rate it has been made, and as years go on the development of the book must proceed along the lines which have been now laid down. That it will be as successful on these lines as it has been upon the old ones may be confidently assumed so long as it remains under the management of the present editors, but I believe that my regret that the change has been introduced will be shared by most of those who remember the appearance of the original book in the late sixties and the enthusiasm with which it was then received.

E. A. SCHÄFER.

[1] "The following 'Lessons in Elementary Physiology' are primarily intended to serve the purposes of a text-book for teachers and learners in boys' and girls' schools."—*Extract from Preface to the First Edition*, 1866.

THE GLUCOSIDES.

Die Glykoside. By Dr. J. J. I. van Rijn. Pp. xvi + 511. (Berlin: Gebr. Borntraeger, 1900.)

THE student of chemistry or botany, who may have attempted to grope his way through the tangle of chemical facts relating to plant products, will be grateful to the author of this exhaustive monograph on the glucosides, or *glykosides* as he prefers to spell it, where the latest information, with all the necessary references, is easily found.

The study of the glucosides may be said to date from Liebig and Wöhler's remarkable discovery of the decomposition of amygdalin by its own ferment or enzyme emulsin. The discovery of other glucosides followed in fairly rapid succession. Among these may be mentioned, without reference to chronological sequence: salicin, derived from willow bark; populin, from aspen leaves; æsculin, from the bark of the horse chestnut; daphnin, from *Daphne mezereum*; phloridzin, from the bark of apple, pear and other fruit trees; hesperidin, from the fruit of limes, oranges and lemons; potassium myronate or sinigrin, from black mustard seed; ruberythric acid, from madder root, &c. They all undergo decomposition by a process of hydrolysis into grape sugar, and at least one other constituent drawn from such very varied groups of compounds as phenols, alcohols, aldehydes, mainly of the aromatic series, and in the case of black mustard seed, from a sulphocyanide. No trustworthy explanation of the constitution of these substances was, or could be, forthcoming until the structure of their proximate constituents had been ascertained.

The most important contribution to our knowledge of the glucosides in recent years has been undoubtedly that of Emil Fischer in his classical researches on the sugars. The formation of the glucosides of the simple alcohols and phenols, and of similar compounds of the mercaptans and ketones, has not only given a valuable clue to the structure of the natural products, but has revealed the close analogy which exists between these compounds and the members of the disaccharoses (cane and milk sugar and maltose). Moreover, the identification of new sugars has led to the successful search for these substances among the glucosides and other plant products. Rhamnose or methyl pentose is found to replace glucose in several glucosides: quercitrin, hesperidin, frangulin, baptisin, datiscin, &c., whilst chinovose, another pentose, is contained in chinovite.

Many other interesting points have arisen. The hydrolysing action of the enzyme accompanying one glucoside has been shown, not to be confined to that glucoside, but to extend to others, although, at the same time, strictly limited to a particular series of compounds. The enzyme of yeast has in a similar way been recognised as not exclusive, although restricted in its hydrolysing power. The action of emulsin and yeast on amygdalin is instructive. Emulsin effects complete hydrolysis of the glucoside into benzaldehyde hydrocyanic and two molecules of glucose, whereas the enzyme of yeast only removes one glucose group. Fischer, who discovered this curious difference between the two enzymes, has allotted the following formula to the second product:

$$\begin{array}{l} C_6H_5CH.CN \\ \quad | \\ \quad O.CH.CHOH.CHOH.CH.CHOH.CH_2OH. \\ \quad \lfloor\text{———}O\text{———}\rfloor \end{array}$$

The splitting off of more than one molecule of glucose on hydrolysis occurs with populin, hesperidin, helleborin and others.

All these facts are recognised and carefully recorded in the volume before us.

The work is divided into two parts. The first part deals with the artificial glucosides; the second, with the natural products. In the first part, the compounds are arranged in a strictly chemical order; in the second, according to the natural order of plants. In reference to this arrangement, the author lays stress on the fact that the study of the constituents of plants should not follow a chemical classification, but should include all compounds occurring in the same natural order; because, he explains, it is only in this way that the chemical, morphological and anatomic properties will appear in their true light. The goal of the chemist should not be determined by purely utilitarian motives, but Rochleder's principle should be borne in mind that "the relationship of plants is determined by compounds of the same chemical nature which they contain."

There are one or two points mentioned in the book which are new to us, and may interest our readers. It appears now that sinigrin, the glucoside of black mustard seed, is not hydrolysed, as usually represented in text-books, without the addition of the elements of water; but the glucoside contains one molecule of water $C_{10}H_{16}NS_2KO_9 + H_2O$, and the decomposition then falls into line with the hydrolysis of other glucosides,

$$C_{10}H_{16}NS_2KO_9 + H_2O = C_3H_5NCS + C_6H_{12}O_6 + KHSO_4.$$

According to Beyerinck, indigo does not occur in the oldest of the indigo plants (*Isatis tinctoria*) as the glucoside indican, as usually stated; but in the form of indoxyl, which rapidly oxidises to indigo in contact with air; whilst the glucoside indican which is found in *Indigofera leptostachya* and *Polygonum tinctorium* may be extracted and left in contact with air without undergoing any change in the absence of enzymes and bacteria.

J. B. C.

AN OXFORD TEXT-BOOK.

An Introduction to the Study of the Comparative Anatomy of Animals. By G. C. Bourne, M A., F.L.S. Vol. i. Pp. 258. (London: G. Bell and Sons, 1900.)

THIS admirable little book is designed to meet the requirements of the elementary examinations of the leading universities of Great Britain, and though of necessity largely concerned with creatures upon which laboratory treatises exist in abundance, it has been so framed as to supplement and not supersede certain of these, the author having aimed at "the lessons that may be learned and the conclusions which may be drawn" rather than the detailed description of the facts themselves. The work opens with an "Introduction," in which it is pointed out that in the study of natural science, as in other things, something of the nature of a creed is necessary for action, and there is given a definition of "evolution," on the basis of the principles involved in which the science of comparative anatomy is said to be founded. Passing on to treat of the elementary principles of morphology and physiology, the author proceeds to deal with the anatomy of the frog, the elements of histology of the Vertebrata, the cell and cell theory, and phenomena of development up to the formation of the germinal blastemata. The Protozoa are next dealt with, including the Mycetozoa and Volvocinæ; and, *apropos* of Volvox and Zoothamnium, there follows a chapter on the Protozoa and Metazoa, with a discussion of their inter-relationships. The Cœlenterata follow, based on the study of Hydra and Obelia, with a concluding chapter on classification. The book is novel in conception, accurate, up-to-date, and thoroughly artistic in execution. Bütschli on the "Schaumplasma," Boveri on the Ascaris egg, Maupas on the Ciliata, Keuten on Euglena, Hertwig on Actinosphærium, the mitotic processes in Amœba bi-nucleata, the immortality of the Protozoa, are conspicuous among topics of the times handled in a manner well calculated to arouse the imaginative faculty, which, under our prevailing systems of elementary biological training, is apt to be ignored. Unlike many of its predecessors and contemporaries, the book is written in choice English. It is in places even racy; and in such paragraphs as those in which the author unfolds the points of dissimilarity between Vertebrate and Invertebrate (dog, fish, and lobster), a perspicuity is noticeable equal to that of a good French writer at his best. It recalls most nearly the irresistible charm of the late M. Paul Bert's "Première Année d'Enseignement Scientifique."

The illustrations, fifty-three in number, are mostly original and altogether admirable, and those of the Hydra, based on the author's unpublished researches, will unquestionably become popular—that of the median longitudinal section of this animal being the best we know. On p. 47 the author gives two new figures of the frog's heart, which, as regards the detailed structure of the pylangium and the ostia of the carotid and pulmocutaneous arteries, are wholly unconventional. It is explained in the preface that these are drawings of reconstructional models from sections, and we dare not doubt their accuracy. The question, however, arises how far the facts they reveal may be true of but one individual; and the author would have done well to have either intimated this or left the matter aside till further investigated. Again, we regret the too forced introduction of analogy to the inanimate, as, for example, of the nervous system to the telegraphic apparatus. In this, however, the author is but acting in the spirit of the times. His book is simply charming and well worthy his reputation; and while its literary style should alone ensure for it a wide circulation, it cannot fail to exercise a leavening and humanising influence on the youthful mind. It is to be followed by a second volume, dealing with the Cœlomate Metazoa, and the sooner this appears the better for biological science and culture.

OUR BOOK SHELF.

The Ore Deposits of the United States and Canada. By J. F. Kemp. Pp. xxiv + 462; index and 163 illustrations. Third edition. (New York and London: The Scientific Publishing Company, 1900.)

OF Prof. Kemp's industry as a compiler there can be no question. The last edition of his work on ore deposits is teeming with information, and his footnotes alone are a proof of the thoroughness with which he has conducted his search after facts. But it is not a book which appeals to the elementary student, because he is launched into a mass of details without sufficient preparation in the introductory part, which is sadly lacking in woodcuts. And further, there is evidence of haste or want of care in correcting the book for the press. Surely a writer on ore deposits should be able to spell such names as "Pošepný," "Sjögren" and "Přibram" with strict accuracy. Errors in spelling ordinary French and German words are frequent, and when one notes as many as nine mistakes in seven consecutive lines, there are fair grounds for complaint. It is not only in his spelling that Prof. Kemp evinces carelessness. A mineralogist would not speak of specular iron as "specular hematite"; the product of a zinc mine should not be called *spelter*, as the word denotes the metal, not the ore. By one of his sentences, one might infer that Prof. Kemp would not admit sulphide of sodium among the metallic sulphides. It is not good English to say: "*Considerable* limonite has also resulted from the weathering of clay-ironstone nodules."

In spite of frequent and unpardonable minor blemishes, which could easily have been avoided by employing a careful proof-reader, the book will be found very useful by those who require a summary of the innumerable memoirs and papers describing American ore deposits.

Prof. Kemp's conclusion that an amendment is needed of the laws regulating the tenure of ore deposits in the Western States will be warmly endorsed by most mining men. C. L. N. F.

Physiology for the Laboratory. By Bertha Millard Brown, S.B. Pp. viii + 167. (Boston: Ginn and Co., 1900.)

THIS little book sets forth, in twenty-two brief chapters, certain practical directions for the study of the elements of anatomy, histology and physiology of the vertebrate body, and the first principles of bacteriology. Many of the instructions given are in interrogatory form, and for simple experiment and observation of the living in action, in which lies the very essence of the science of physiology, the student is commendably referred to his or her own body. Beyond this, however, there is nothing in the book that is new, or which calls for comment in these pages. The mode of treatment is begotten of a conviction on the part of the authoress, that "there is needed a radical change in the teaching of physiology"; and we read with astonishment the statement that while the method of teaching botany, chemistry and other sciences "has long been that of going first to the study of the specimen and then to the text-book," this has not been the case for "physiology"—that having apparently been taught from the text-book alone. She is writing, however, of State schools of America, and if the accusation be applicable to them generally, we wish her success in her enterprise.

Michigan Board of Agriculture. Annual Report 1898–99. Pp. 465. (Michigan: State Board of Agriculture, 1899.)

IN this volume are included the thirty-eighth annual report of the Secretary of the Michigan State Board of Agriculture, and the twelfth annual report of the Experiment Station of the State Agricultural College. Many subjects of interest are dealt with in both reports, but only a few can be referred to here. Experiments with Indian corn, to test the influence of thickness of planting upon the character of the crop, show that a gradual increase occurs in the yield of dry matter and protein as the distance between the rows and between individual plants is increased. It appears that, to obtain the greatest yield of valuable nutrients, Indian corn should be planted in rows fully three and a half feet apart, and the seeds six and nine inches apart in the rows. The establishment of several large beet-sugar factories in the State last year has caused increased attention to be given to experiments in beet culture. An interesting detail of some new experimental work, to which reference is made by Prof. C. D. Smith, director of the Experimental Station, is the breeding of bees with longer tongues. It is hoped that, by selection and breeding, a variety of honey bee will be developed capable of extracting nectar from the blossoms of the clover grown in the State.

Among the subjects of *Bulletins* published in the report are:—forestry, strawberry culture, methods of combating disease-producing germs and fruit-growing.

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.*]

Change of Feeding Habits of Rhinoceros-birds in British East Africa.

THE enclosed extract from a letter just received by me from my friend, Captain Hinde, of the British East Africa Protectorate, will interest all zoologists. It is a curious fact that a bird which is so valuable as Buphaga in clearing parasitic insects from cattle that we lately agreed to give it special protection at the International Conference on the Preservation of African Wild Animals, should now, by a sudden change of conditions induced by man, become a dangerous and noxious creature. This fact shows how difficult is the problem presented by the relations of civilised man to a fauna and flora new to his influence.

E. RAY LANKESTER.

Natural History Museum, London, August 10.

"The following case of wild birds changing their habits may interest you:—The common rhinoceros-bird (*Buphaga erythroe-pyncha*) here formerly fed on ticks and other parasites which infest game and domestic animals; occasionally, if an animal had a sore, the birds would probe the sore to such an extent that it sometimes killed the animal. Since the cattle plague destroyed the immense herds in Ukambani, and nearly all the sheep and goats were eaten during the late famine, the birds, deprived of their food, have become carnivorous, and now any domestic animal not constantly watched is killed by them. Perfectly healthy animals have their ears eaten down to the bone, holes torn in their backs and in the femoral regions. Native boys amuse themselves sometimes by shooting the birds on the cattle with arrows, the points of which are passed through a piece of wood or ivory for about half an inch, so if the animal is struck instead of the bird no harm is done. The few thus killed do not seem in any way to affect the numbers of these pests. On my own animals, when a hole has been dug, I put in iodoform powder, and that particular wound is generally avoided by the birds afterwards; but if the birds attack it again, they become almost immediately comatose and can be destroyed. This remedy is expensive and not very effective. Is there any other drug you could suggest that would be less likely to be detected? Perhaps you know that I reported three years ago that these birds rendered isolation under the cattle plague regulations useless in some districts, as I proved beyond doubt they were the only means of communication between clean and infected herds under supervision, a mile or two apart. These birds I have never seen on the great herds of game on the open plains, but I have seen them on antelope and rhinoceros in the immediate neighbourhood of Masai villages, and herds of cattle; on the other hand, I have never seen the small egret on cattle, though often on rhinoceros and gnũ."

Atmospheric Electricity.

IN NATURE of June 14 Mr. Wilson replies to the objections raised in my letter of March 29 to his explanation of the origin of atmospheric electricity. Before proceeding to consider Mr. Wilson's reply to my objections it may be well that the point at issue between us should be clearly defined, as Mr. Wilson, in my opinion, somewhat confuses it. Mr. Wilson says, "Mr. Aitken contends there is no such thing as dust-free air in the atmosphere." Now I certainly made no such statement, for the simple reason that I do not know whether such a condition exists to any extent or not, only a few cases being on record. What I did state was, "So far as our knowledge goes, it can hardly be said there is such a thing as dust-free air in our atmosphere, and the cases in which low numbers have been observed are so extremely rare that they can hardly have any bearing on phenomena of such widespread existence as atmospheric electricity, even though we suppose those few particles to be afterwards got rid of." I simply asked for a verdict of "not proven" against Mr. Wilson's theory. I think it will be admitted that it rests with Mr. Wilson, and those who think with him, to prove that the air is generally dust-free at elevations higher than ordinary cumulus and nimbus clouds, as without this dustless air the supersaturation necessary for condensation on ions is admittedly not possible.

Mr. Wilson discusses the question of the number of dust particles in the atmosphere from Mr. Rankin's Ben Nevis observations and my own at Kingairloch, and points out that practically dust-free air has been observed on Ben Nevis. Such is the case, but so far as I know dust-free air has been observed on only a few occasions, and such isolated instances have evidently no bearing on the case. Mr. Wilson then turns to my observations and says "the mean number of dust particles in a series of 258 observations, extending over nearly five years, amounting to 338 per c.c.; on one occasion the number was as low as 16 per c.c." The above statement, it must be clearly understood, refers to 258 of the tests made in the purest air, and is not the mean of all the observations. In the tables there are 688 observations for Kingairloch: of these I find there are 41 in which the reading was under 100, 341 were over a 100 but less than 1000 per c.c., whilst the remaining 306 observations were all over 1000 per c.c. The 16 per c.c. referred to by Mr. Wilson only occurred once. In the other years referred to the lowest figures were 38, 43, 67 and 205 per c.c. So that, as already said, the conditions represented by those low figures, such as 0 on Ben Nevis and 16 at Kingairloch, are so exceptional that they are not likely to play any part in phenomena so universal as atmospheric electricity.

Mr. Wilson, referring to the selected observations taken at Kingairloch on the pure air coming from the Atlantic, says: "Air coming from such a region can hardly be considered as abnormal. Moreover, such observations are necessarily made in air within a few feet of the ground; at a greater height it is likely to be less contaminated." Taking the last of these points first, an examination of the diagrams given along with the tables, from which Mr. Wilson made his extracts, will show that whenever the air became pure the readings low down and high up were nearly alike. This is shown by the curves in the diagrams for Ben Nevis and Kingairloch being nearly alike during these periods. Further, it may be seen from the curves that there was sometimes less dust at low than at high level when the air came from the Atlantic.

An examination of the tables from which Mr. Wilson took his Kingairloch figures easily refutes his assumption that the air of the Atlantic, as given in these tables, "can hardly be considered as abnormal." In the tables will be found the results of tests made in France, Italy and Switzerland. Observations were made at three places in France on the shores of the Mediterranean, at Hyères, Cannes and Mentone. An analysis of the figures for these places, made during visits extending over five years, shows that the lowest number observed was 725 per c.c., and of eighty-eight tests only ten were under 1000 per c.c., the others being all over 1000. At the Italian Lakes observations were made at Bellagio and Baveno. Many of these observations were made at elevations up to 2000 feet. In all, 188 tests were made: of these the lowest was 300 per c.c. On only thirteen occasions was the number under 1000, and 175 readings gave numbers over 1000 per c.c.

Perhaps it may be objected that all these Continental tests were made in low level polluted air. We shall therefore now examine the result of the observations made on the Rigi Kulm, given in the same tables. The top of the Rigi is 5900 feet above sea-level, but it has only the purifying effect of 4400 feet, as it is only about that height above the surrounding plains. During the tests, made on the visits during the five different years previously referred to, 259 observations were taken on thirty-two days, and the lowest number observed was 210 per c.c. Ninety-seven observations gave readings under 1000 per c.c., whilst the other 162 tests were all over 1000 per c.c. These tests, at both high and low level, give no support to Mr. Wilson's statement that the Atlantic air on the west coast of Scotland "can hardly be considered as abnormal."

Let me further support this point by reference to observations made by others of the air in different parts of the world. Prof. G. Melander, of Helsingfors, in his work, entitled "Sur la condensation de la vapeur d'eau dans l'atmosphère," gives the results of 268 tests made of the air at Salève, Biskra, Torhola, Loimola, Kristianssund and Grip. In all these 268 samples of air tested there were only five with less than 500 per c.c., and no low numbers were observed.

I now turn to the very interesting series of observations made by Mr. E. D. Fridlander and published in the *Quarterly Journal* of the Royal Meteorological Society, vol. xxii. No. 99, July 1896. In this paper Mr. Fridlander gives the results of his observations made during a voyage round the world from this country to America, across that continent to Santa Cruz Bay, from there across the Pacific Ocean to New Zealand, then to Australia, and homewards by the Indian Ocean, Arabian Sea and Mediterranean, visiting Switzerland on the way. On the western side of the Atlantic the numbers were high, being from 2000 to 4000 per c.c., though the vessel was far from land, its position being 55° 0′ N., 42° 11′ W. Lower numbers were obtained between Labrador and Newfoundland, the readings there being from 420 to 840 per c.c. Readings as low as 280 per c.c. were got in the Gulf of St. Lawrence. On the Pacific coast the lowest was 700 and highest 4500 per c.c. On the Pacific Ocean the lowest reading was 280 per c.c. and highest 2125. Few readings were obtained in New Zealand under 1000 per c.c. In the Indian Ocean the air seems to be rather purer than most places, or at least was so when the observations were made. Readings as low as 200 per c.c. were obtained, and they seldom were over 500. Tests made on only two days in the Arabian Sea gave a minimum of 280 and a maximum of 1375. One day's tests in the Red Sea gave from 383 to 490 per c.c. The result of two days' tests of the Mediterranean air gave a minimum of 875 and a maximum of 2500 per c.c. A result which agrees with that already given for the French coast of the Mediterranean.

Mr. Fridlander's tests of the air in Switzerland give results similar to those already referred to for the Rigi Kulm. At almost all the places the numbers were always over 1000 per c.c., though the observations were made at considerable elevations. But on the Riffelberg (altitude 7400), where Mr. Fridlander spent some days, the numbers varied from 225 to 4000 per c.c. On the summit of the Bieshorn (altitude 13,600) the lowest observation gave 140 per c.c., which, so far as I know, is the lowest number yet observed in Switzerland. When we compare the figures given by Prof. Melander and Mr. Fridlander of the dust particles in the air of different parts of the world with those obtained in the Atlantic air on the west coast of Scotland, we are forced to admit that the latter is abnormally pure.

The rate of fall of cloud particles as given by the calculations of Mr. Wilson seems to be much too rapid. He assumes that the air in which clouds are formed is always rising. This can hardly be said to be the fact. Suppose a large area of the earth's surface to be covered with cloud, forming a vast sea, such as one sometimes sees from the top of a mountain. It is evident that the air over all that area cannot be rising at any considerable rate, and yet the clouds will be seen to keep nearly the same elevation for hours. If the air be still, and if Mr. Wilson's calculations are correct, then the mountains ought to rise out of such a cloudy sea at the rate of nearly 500 feet per hour, a phenomenon which, I venture to say, no one has ever seen.

Mr. Wilson seems to think, though all the dust particles in cloudy air will not become centres of condensation, it is a matter of no importance, as he thinks the cloud will act as a perfect filter, by the descending cloud particles coming in contact with, and absorbing, the inactive dust particles. So that all particles that do not become active centres of condensation will be carried out of the air by the falling drops, and leave the air rising through the cloud particles dustless. He gives no evidence in support of this assumption other than the purification of dusty air in a closed vessel with wet sides. Now dusty air in a closed vessel takes a considerable time to become dust-free, and I think it may be contended that gravitation plays no inconsiderable part in the process, perhaps more than the wet sides referred to by Mr. Wilson. So far as my observations go, there is no evidence of any such powerful purifying effect in clouds. At least when making observations in old clouds, both at top and bottom of them, there were always observed a large number of dust particles, but whether any had been absorbed by the cloud particles or not it would be impossible to say. If any had been absorbed, certainly many were still free.

That clouds have not the purifying effect claimed for them by Mr. Wilson may be best shown by reference to the observations made on the Rigi Kulm on May 21, 1889 (*Proc.* Roy. Soc. Edin., vol. xvii. p. 193). On the morning of that day, when I left Lucerne on my way to the Rigi Kulm, the sky was covered with cloud, and when ascending the mountain the cloud was entered at an elevation of about 2000 feet below the top. On arriving at the top the clouds were still very dense, and remained so till the evening; afterwards they settled down to the level of the kulm, when a vast sea of clouds was disclosed stretching in all directions with the peaks of the higher Alps standing out like islands. Under these conditions the observations made on the top of the Rigi on that day were evidently taken in air just above the upper surface of a uniform stratum of cloud 2000 feet deep, where, according to Mr. Wilson, there ought to have been dustless air, yet the observations showed there were still 210 particles per c.c. Next morning the clouds still extended in most directions and were much thinner, and the number of dust particles had increased to over 800.

I may as a well here call attention to the fact that during the night the upper surface of the clouds had only settled down about 1000 feet. How much of this was due to the cloud particles falling through the air, and how much to evaporation, it would be hard to say. Probably evaporation played the principal part, as the clouds were now much thinner, and the evaporation probably took place from the upper surface, as in the morning the air on the Kulm was dry—the wet-bulb depression being as much as 6°, and a wind of some strength was blowing from the south-east. The rate of descent of the particles in this cloud was therefore much slower than the rate of fall calculated by Mr. Wilson.

Mr. Wilson, in criticising my remarks on the re-evaporation of cloud particles, says: "But all drops that have survived the great tendency to evaporate which accompanies the initial stages of their growth will surely continue to grow so long as the rate of expansion remains the same, or even if it be much reduced." Here again Mr. Wilson assumes that clouds are always rising. Now a great part of the life of a cloud, and the air in which the particles are carried, is spent in moving horizontally, and sometimes even downwards, and occasionally with but little movement in any direction; and it is during this stable condition that the opportunity is given for the re-evaporation of the smaller drops. Mr. Wilson points out that if a very slight proportion of the water in a drop were to evaporate, it would cool the drop and check the evaporation, a statement with which all will agree. But though the cooling may check evaporation, it will not stop it. The particles in a cloud are close together, and those condensing vapour and growing warmer soon part with their heat by radiation and by contact with the air, so that the heat lost by the evaporating particles is rapidly supplied to them by the condensing ones, and, as we shall see later, this exchange of heat takes place at a much quicker rate than one might imagine.

I do not think that practical chemists will agree with Mr. Wilson's statement that all the ammonia, nitric acid and other impurities, out of which the sun can manufacture nuclei, will be washed out of the air by the rain. The difficulty of removing the last traces of gases by washing is well known.

Are meteorologists prepared to accept that part of Mr. Wilson's theory which necessitates the formation of rain-clouds at an elevation of 7500 feet above the top of the ordinary cumulus and nimbus clouds? In other words, are meteorologists prepared to affirm that there are two distinct rain zones—one where the ordinary rain-clouds condensed on dust nuclei are formed, then over these clouds clear air for 7500 feet, above which the ion rain-clouds are formed? This upper ion-cloud must result in rain if the theory is correct, otherwise there will be no separation of the positive and negative ions. I leave it to the meteorologists to say whether rain-clouds have ever been observed at elevations of 20,000 to 30,000 feet—not above sea-level, but above the surface of the ground.

Mr. Wilson does not seem to think that my remarks on the rapid growth of cloud particles in supersaturated air have any bearing on the subject, and objects to my use of the term explosive in reference to the condition of supersaturated air. If I had known a better term I would have used it. Though supersaturated air is in a condition of equilibrium with itself, yet when nuclei are introduced into it there is at once a rapid rush of vapour molecules towards the condensing particles, and a rapid breakdown of conditions all round the nuclei, which seems to me not at all inaptly compared to an explosion—centripetally, of course. Mr. Wilson grounds his objection to the rapid growth of the ion-cloud particles in supersaturated air on the difficulty and slowness with which the condensing drops part with the heat developed by the condensing vapour. I shall not follow Mr. Wilson in his comparison of a condensing with an evaporating drop, as it is not easy to see the changes taking place in the latter, but will rather refer to an experiment which Mr. Wilson, and others who have experimented on this subject, must often have seen. Take a glass flask in which there is a little water, full of ordinary air, and provided with means of expanding the air in the flask, and either returning the air to the flask, or admitting filtered air. Go on repeating the process of expanding and cloud-making in the flask. After this has been done a number of times, the nuclei become fewer and fewer, and at last only a very few are left in the air. Every one must have noticed when making this experiment that the cloud particles are very small on the first expansion, and that they fall very slowly, almost imperceptibly, but that at the end of the experiment, when the last dust particles become nuclei, the water particles are large and fall rapidly like rain drops. At the beginning of the experiment, with plenty of dust in the air, there is almost no supersaturation, the nuclei being so close the tension is relieved as soon as it is formed. When, however, only a few particles are present, there are large spaces between the nuclei where supersaturation can take place, and it is by falling through this supersaturated air that the drops, when few in number, are able to grow so quickly and become so large. It therefore seems probable that something of the same kind will happen if ions were to become nuclei in supersaturated air. Whenever an ion becomes active it will rapidly grow to the dimensions of a rain-drop in the same manner and for the same reason that the dust-nucleused drops do in supersaturated air. These little drops evidently have a way of parting with the heat of condensation at a very much quicker rate than Mr. Wilson is disposed to admit.

It is this capacity for rapid growth in supersaturated air that makes it so improbable that ions can ever give rise to a cloudy form of condensation. To form a cloud a large number of them would require to become active at the same moment. But this is evidently not possible in a rising column of air. The ions which rise on the top of the ascending column will become active first, and by falling through the lower supersaturated air will grow with great rapidity and give rise to a rainy, but cloudless form of condensation.

There are some points connected with ions about which I think the readers of NATURE would be glad to have some information, and which I think Mr. Wilson, with the aid of the apparatus at his disposal, could give us. For instance, one would like to know (1) how long ions remain in air in an inclosed vessel, when both + and − ions are present; (2) when only + or − ions are in the air; (3) whether the presence of dust has any effect on the duration of their life. For practical purposes one would also like to know further (1) how many ions are generally in the air near the ground; (2) what amount of electricity they carry with them.

Finally, one would like to know how many ions will pass up through a cloud and escape at the top; as one would almost expect, these ions, with their electric charges, will be more likely to be cleared out of the air by rain than the dust particles, and whether both kinds are equally liable to be washed out by rain. If not, the inequality may help to explain some important electrical phenomena. JOHN AITKEN.

Ardenlea, Falkirk, June 27.

The Melting Points of Rock-forming Minerals.

IN connection with the abstracts of papers read before the Royal Dublin Society by Dr. J. Joly, F.R.S., and myself, given in NATURE for July 12 (p. 262), I might perhaps be permitted to draw attention to a few points. The same subject has been recently dealt with by Mr. C. E. Stromeyer (*Mem.* Manchester Lit. and Phil. Soc., vol. xliv. Part iii. No. 7, 1900) and by Prof. Sollas, F.R.S. (*Geol. Mag.*, July 1900).

In the first place it may be noted that the "melting point" of a substance under a definite pressure has a perfectly definite meaning. The "softening point," on the other hand, obviously depends on the magnitude of the distorting force with which the softness is tested, as well as on the other conditions of experiment.

It is an established fact that the melting points of a very large number of substances vary with the pressure. Bunsen, as far back as 1850, perceived the geological application of this phenomenon. In discussing the crystallisation of plutonic rocks, it is the melting points of the minerals under enormous pressures which really concern us. These pressures are probably sufficient to alter the melting points through several hundred degrees. There are then two ways open for us to ascertain these melting points. Firstly, we might determine them by direct experiment at the necessary large pressures; or, secondly, we might measure the melting points at ordinary atmospheric pressure and determine the rate of increase (or decrease) of melting point with increase of pressure ($d\theta/dp$). Considering the gigantic pressures with which we have to deal, it seems decidedly easier to adopt the second method. The agreement between the results obtained from the application of the thermodynamic formula

$$\frac{d\theta}{dp}=\frac{\theta(v_l-v_s)}{L}$$

(where θ = absolute melting temperature; (v_l-v_s) = the change of volume at the instant of melting; L = the latent heat in mechanical units) with the results of experiments (*e.g.* M. A. Battelli, *Journal de Phys.*, t. viii. p. 90, 1887), seems to justify the application of that formula to the case of the minerals in question, in the absence of direct experiment. It is true that the formula was deduced for a reversible system, and that no natural process is reversible. But a similar objection would hold against the application of any theoretical formula to the conditions obtainable in experimental work. In the present case it is only claimed for the formula that it will afford an approximate estimate of the melting points of minerals under large pressures; and after all, even direct measurement of such high temperatures as are involved is always attended with uncertainty. In order to apply this formula we require θ, (v_l-v_s), and L. The melting points of the most important minerals at atmospheric pressure have been determined by Dr. Joly and Mr. R. Cusack (*Proc.* Roy. Irish Acad., Ser. 3. vol. ii. p. 38; vol. iv. p. 399). A large part of the volume change on melting is, I submit, afforded us by the difference in density between the crystalline mineral and its fused glass. Now it is characteristic of amorphous substances to pass gradually and continuously from solid to liquid (*cf.* Preston, "Theory of Heat," pp. 270 and 286); and so it is highly probable that such a mineral glass will pass without sudden volume change into the liquid state, and it has, in fact, passed gradually in the inverse direction. It is not contended that any given mineral ever existed as a glass in the molten magma of an igneous rock, but only that it existed as a liquid.

In my paper, above referred to, I have shown how the "fusibility" of a mineral must be connected with its latent heat, and hence by a comparison of relative fusibility and melting temperature we may often deduce the relative latent heats of two minerals. Thus, for example, the "fusibility" of labradorite is 3 on von Kobell's scale, and its melting point is 1229° C., whereas orthoclase has a melting point of only 1175° C., but is much less "fusible," viz. 5 on von Kobell's scale. Hence I infer that the latent heat of orthoclase is decidedly greater than that of labradorite. Similarly, the latent heat of augite is less than that of orthoclase. But the volume-change on melting of augite is greater than that of orthoclase. Therefore $d\theta/dp$ is greater for augite than for orthoclase. It is thus possible to arrive at the order of melting points of minerals under the pressure of rock formation. If, after ascertaining this order, it is still found to be inconsistent with the order of crystallisation, as shown by microsopical examination, it may be necessary to examine the more complicated influences of solution, &c., on the crystallising points of the minerals.

In conclusion, I may point out that it must be a matter of extreme importance in measuring the melting temperature of quartz to make sure that the specimen used is pure, and in particular free from the alkalis. Messrs. Shenstone and Lacell (NATURE, May 3, 1900, p. 20) have found that rock crystal very often contains sodium and lithium, traces of which might be expected to lower the melting point. Further, it has long been known that quartz, with a density of 2·66, passes into the variety of silica with density 2·3 at a temperature below its melting point (*cf.* Fremy, *Enc. Chim.* 6, p. 142). And similar transformations are common among metals. Is it not possible then that the phenomena observed by Dr. Joly may have nothing to do with the fusion point of quartz, but are simply cases of molecular transformation at a temperature below the melting point? J. A. CUNNINGHAM.

Royal College of Science, Dublin.

Observation of the Circular Components in the "Faraday Effect."

AFTER repeated attempts to determine the nature of the "Faraday effect," I have succeeded in observing that ordinary light, when passing from a surface into a medium in such a way as to be under the influence of a magnetic field, is broken up into two circular components oppositely polarised.

The system used consisted of two rectangular prisms of glass placed with their diagonal faces parallel and separated by a plate of mica of approximately ¼ λ retardation. The lines of force were parallel to this plate. A ray of ordinary light from a sodium flame sent into the system normal to this plate was successively totally reflected parallel to the lines of force and then at right angles to the mica, which served to change the phase and to keep the absolute direction of the circular vibrations the same. The rays passed five times around within this system, giving twenty internal reflections.

The separation of the rays agreed, so far as could be determined, with the calculations based on the assumptions usually made in explaining this phenomenon. When the field was reversed, the direction of vibration of each circular component was reversed. This does not establish the assumption of a relative change in the velocities usually made, as a relative change in the phase of the components, or both, would produce the same effect. It does show, however, that a medium in a magnetic field transmits, in the direction of the lines of force, light vibrations by circular components only. D. B. BRACE.

Physical Laboratory, University of Nebraska, August 1.

Physical Structure of Asbestos.

CAN any of your readers tell me where I can find a good account of asbestos and its *physical structure?* The ordinary works of reference I am acquainted with give too meagre an account to be of any use. GEOFFREY MARTIN.

13 Hampton Road, Bristol, August 1.

THE BRADFORD MEETING OF THE BRITISH ASSOCIATION.

IT is now possible to give a forecast of the chief subjects to be brought before the various Sections of the British Association at the forthcoming Bradford meeting. The following outlines of sectional programmes show that many matters of importance and wide scientific interest will be dealt with, so that the Bradford meeting promises to be a memorable one. No particulars as to the probable proceedings of the Physics Section have yet been received.

CHEMISTRY.

Prof. W. H. Perkin, jun., F.R.S., the President of Section B (Chemistry) is this year setting a precedent in the conduct of the sectional meetings. Several members of the Association have been asked to furnish reports on the present state of knowledge in the particular departments of chemistry with which they are especially conversant, and the reading of these reports will be followed by discussion.

In accordance with this programme, Mr. Francis H. Neville, F.R.S., will present a report dealing with the properties and interactions of the metals. The following questions will be brought forward for discussion in connection with the report:—

1. Are the methods usually employed in studying the equilibrium between two or more substances with change of temperature immediately applicable to the study of alloys, and are similar results obtained in the two cases? Thus, with varying conditions of temperature and concentration, a system of ferric chloride and water deposits (1) ice; (2) $Fe_2Cl_6,12H_2O$; (3) $Fe_2Cl_6,7H_2O$; (4) $Fe_2Cl_6,5H_2O$; (5) Fe_2Cl_6, $4H_2O$; (6) Fe_2Cl_6 or (7) mixtures of the phase numbered n with that numbered $(n+1)$? Are the solubility curve of ferric chloride and the freezing point curves of metallic mixtures of the same kind?

2. How far does (1) microscopic examination, and (2) change in physical properties, such as electromotive force, &c., enable us to detect the existence of a compound in an alloy?

3. In what definite proportions are metals known to combine? Is any regularity manifest with respect either to their position in the periodic system or to their valency with regard to non-metals?

4. What methods are available for determining the molecular weights of the metals, and can it be asserted in any cases, other than those of mercury, zinc and cadmium, that the molecular weight is satisfactorily determined?

5. Can a definition be given of a metallic element which makes it possible to distinguish between metals and non-metals?

6. Can any explanation be given which will satisfactorily account for (1) the difference between metallic and electrolytic conduction, and (2) the remarkable changes in the electrical conductivity of metals attending admixture?

As some of the questions bearing upon this subject are of as great importance to the physicist as to the chemist, physical members of the Association are to be invited to join in the discussion. Dr. Adolf Liebmann will contribute a report on recent improvements in the treatment of textiles, a subject which acquires peculiar importance from the fact that the 1900 Meeting of the Association is being held in the centre of a district devoted to the textile industry. Dr. Arthur Lapworth will give a report on our knowledge of the chemistry and constitution of camphor. Attention has of late years become so concentrated on the chemistry of the camphor group as to make an authoritative discussion on the constitution of camphor almost a necessity to the organic chemist. Mr. William J. Pope will present a report on our present knowledge of stereochemistry; it is understood that special attention will be given in this report to the work done during the past twelve months on the optical activity of compounds containing an asymmetric nitrogen, tin or sulphur atom. Among the other papers to be presented at the meeting is one on the specific heat of gases at temperatures above 400°, by Prof. H. B. Dixon, F.R.S.; and Mr. H. T. Brown, F.R.S., will give an account of his recent work on the diffusion of gases and liquids. The papers of special local interest include one on the treatment of Bradford sewage, by Mr. F. W. Richardson, the City analyst; and also a paper on the treatment of woolcombers' effluents, by Mr. W. Leach. The title of the sectional address to be delivered by the President is, of course, not yet announced; it is understood, however, that the address will deal with the teaching of chemistry.

GEOLOGY.

The proceedings of Section C (Geology) will open at 10.30 a.m. on Thursday, September 6, with the delivery of the address of its president, Prof. W. J. Sollas, who has chosen for his subject, "The History of the Earth in relation to a Scale of Time." Prof. Sollas will take a wide scope in discussing this subject, and will introduce such fundamental matters as the constitution of the earth, the relative value of the various geological periods, the origin of ocean basins, the formation of mountain-chains, and the evolution of the organic world. We may be sure that his discourse will be brilliant and suggestive. It is probable that Prof. J. Joly will also treat on the knotty problem of the duration of geological time at the same, or a subsequent, meeting of the Section.

As befits the place of meeting, the geology of the Carboniferous rocks will receive much attention. A joint discussion with the botanists (Section K), on the conditions which existed during the growth of the forests of the Coal Period, will be held on Monday, September 10, when Mr. A. Strahan and Mr. J. E. Marr will open the debate from the geologist's standpoint. The Coal-measures of the West Riding form the subject of a paper by Mr. W. Cash, and those of North Staffordshire of one by Mr. W. Gibson, of H.M. Geological Survey; while the fossil fishes of the Carboniferous rocks will be discussed by Dr. E. D. Wellburn. Prof. W. B. Scott has promised a paper, with lantern illustrations, on the geology and palæontology of Patagonia, which promises to be of great interest. Prof. A. P. Coleman, of Toronto, brings forward an account of a ferriferous horizon in the Huronian of Lake Superior, and will also present the final report of the Committee for the investigation of Pleistocene deposits in Canada. Mr. J. J. H. Teall will describe a plutonic complex of Sutherland, and its bearing on current hypotheses as to the genesis of igneous rocks. Glacial subjects, as usual, will receive due attention; papers on the local phenomena will be brought forward by Dr. Monckman and Messrs. Muff, Jowett and others, and on those of Welsh localities by Mr. E. Greenley and Mr. J. R. Dakyns. The concretions of the magnesium limestone of Durham will be discussed by Dr. Abbott. Tidal ripple-marks will be described by Mr. Vaughan Cornish; and the caves and pot-holes of Ingleborough and district by their explorer, Mr. S. W. Cuttriss, in both cases with lantern illustrations. Mr. A. C. Seward will treat of the Jurassic flora of the Yorkshire coast. Among the reports of committees will be that which deals with the course taken by underground waters in the Ingleborough district, giving the result of recent experiments; and excursions have been arranged to the sites of the investigation. As usual, short afternoon sectional excursions to places of geological interest in the neighbourhood of Bradford will be included in the arrangements of the Section.

ZOOLOGY (AND PHYSIOLOGY).

Dr. R. H. Traquair, F.R.S., the President of Section D (Zoology and Physiology), will address the Section on "The Bearings of Fossil Ichthyology on the Doctrine of Descent." Major Ronald Ross will (by request) address the Section on "Malaria and Mosquitoes." Messrs. Gamble and Keeble will give an account of their researches on the "Colour-Physiology of Hippolyte," illustrated by lantern projections and practical demonstrations. Prof. L. C. Miall, F.R.S., will read a paper on the "Respiration of Aquatic Insects"; and other papers on the natural history of insects will be given by Messrs. T. H. Taylor, Wilkinson, Walker, and Dr. Munro. Prof. S. J. Hickson, F.R.S., will read a paper on "The Nuclei of Dendrocometes." Among the reports of committees, Mr. Stanley Gardiner's account of his researches on the Coral Islands of the Indian Ocean is awaited with particular interest.

GEOGRAPHY.

In Section E (Geography), the President, Sir George Robertson, will deliver his address on Thursday, September 6, at 11 a.m. The subject of the address is appropriately "Geography and the Empire." Amongst the subjects to which special attention will be directed in the Section may be mentioned that of "Colonial and Foreign Surveys." Papers dealing with these will be read by Mr. E. G. Ravenstein and Mr. B. V. Darbishire; and Dr. H. R. Mill will contribute a paper on "The Treatment of Regional Geography." Problems of applied commercial geography will be dealt with by Mr. G. G. Chisholm in a paper on "Some Consequences that may be Anticipated from the Development of the Resources of China," and Mr. E. Heawood on the "Commercial Resources of Africa."

An important paper on "Railway connection between Europe and Asia" will be contributed by Sir Thomas Holdich; and it is hoped that Mr. C. R. Beazeley will return in time to give an account of his journeys on the recently-opened portions of the Siberian Railway.

The excellent work initiated by Mr. T. G. Rooper while H.M. Inspector of Schools at Bradford, and carried on by Mr. E. R. Wethey, one of the secretaries of the Section, makes papers on "School Geography," and the teaching of elementary geography generally, of special interest at this meeting. Mr. Rooper and Mr. Wethey will each describe parts of their work, and will exhibit some of the maps and models used as illustrations, in the exhibition which forms a novel feature of the Bradford meeting.

In the department of geographical exploration, Mr. C. E. Borchgrevink will give an account of the voyage of the *Southern Cross* in the Antarctic regions. Captain H. P. Deasy will describe his journeys in Central Asia; Captain E. S. Grogan contributes a paper, "Through Africa from the Cape to Cairo"; and Mr. Cutliffe Hyne one on "Arctic Lapland."

On special and more technical subjects there will be papers on "Large Earthquakes in 1899," by Prof. John Milne; on the "Distribution of Relative Humidity," by Mr. E. G. Ravenstein; on "Snow Ripples," by Mr. Vaughan Cornish; and on "The Origin of Moels," by Mr. J. E. Marr.

MECHANICAL SCIENCE.

Sir Alexander Binnie, the President of Section G (Mechanical Science), will survey the various stages of scientific progress which have led to the modern conception of natural phenomena. Several interesting papers by local engineers will be read before the Section. One, by Mr. J. Watson, will describe the Bradford waterworks and the very fine reservoirs belonging to that system. In connection with this there will be an excursion on the Saturday to the reservoirs. A paper will be read by Prof. Hele-Shaw on the resistance of road vehicles to traction. A proposal will be made to appoint a committee of the Association to carry out an exhaustive series of experiments on road resistance. Much interest will no doubt be excited by the paper which is to be read by Mr. J. H. Glass on the coal and iron ore fields at Shansi and Honan, and railway construction in China. This paper will be illustrated by a number of lantern slides showing the Chinese methods of working these mineral deposits. In view of the great industry of Bradford, the paper by Prof. Beaumont on the application of photography to textile designing is likely to create great interest. In the department of electrical engineering there is a good programme of papers. The Small Screw Gauge Committee will submit a report descriptive of a series of experiments which have been carried out by Mr. Price in the engineering laboratory at University College, London; and in connection with this, a paper will be read by Mr. O. P. Clements on screw threads used in cycle construction and for screws subject to vibration. Mr. A. Mallock will give an account of experiments he has made to determine the tractive force, resistance, and acceleration of electric trains. Mr. Aldridge's paper on the automobile for electric street traction will describe a novel process, by means of which, in certain circumstances, it is possible to organise a tram service without tram rails, and this paper will be illustrated by the cinematograph, showing an actual system at work.

ANTHROPOLOGY.

In the Anthropological Section, the President, Prof. J. Rhys, proposes to devote his opening address to "the prehistoric ethnology of the British Isles," a subject full of matter for discussion, on which he is entitled to speak with peculiar authority. Several important papers are expected in the department of anthropometry, especially a note by Dr. Beddoe on the "vagaries of the Cephalic Index," and a paper by Prof. Cunningham on the "Sacral Index." Mr. H. Ling Roth contributes a classification of various modes of ornamenting the skin, such as tattooing, cicatrisation, and the like. Dr. Haddon promises an account of his recent visit to Borneo, with special reference to the industries and daily life of the natives. A discussion is being arranged on the subject of "Animal Worships," with reference to the vexed question of the significance of totemism; and Mr. David Boyle, of Toronto, will contribute a study of the phenomena of Neo-Paganism among the natives of certain parts of the Dominion of Canada. Among other archæological papers, special interest attaches to Mr. Arthur Evans's account of his recent discovery of tablets inscribed with an Ægean script, in the Mycenæan palace of Gnossus in Crete; and to Mr. F. Ll. Griffith's discussion of the origin of the Egyptian hieroglyphic system. There will be papers, as usual, on objects of archæological interest in the neighbourhood of Bradford.

BOTANY.

Prof. Vines, the President of Section K (Botany), in his address on Thursday, September 6, will take as his subject the progress of botany in the nineteenth century. It has been arranged to hold a joint discussion with some of the members of the Geological Section on the conditions under which the forests of the Coal Period grew. The origin and manner of formation of Coal, the climatic and physical conditions which prevailed during the deposition of the Coal-measures, the most striking characteristics of the vegetation, and other questions will probably be dealt with. The local committee propose to form a small museum of specimens and photographs to illustrate the botany and geology of the Coal Period.

On Friday afternoon a semi-popular lecture, illustrated by lantern slides, will be delivered by Mr. Percy Groom, on "Plant-form in relation to nutrition."

Among the papers already promised, the following may be mentioned:—On the presence of seed-like organs in certain Palæozoic Lycopods, by Dr. D. H. Scott; the origin of modern Cycads, by Mr. Worsdell; the fertilisation of *Caltha palustris*, by Miss Thomas; on a new type of transition from stem to root in seedlings, by Miss Sargant; the anatomy of the stem of *Angiopteris evecta*, by Miss Shove; the structure of the nucleolus, also a demonstration of the structure of the eye-spot and flagellum of *Euglena*, by Mr. Wager; the biology and cytology of a new species of *Pythium*, by Dr. Trow; the biology of *Acrospeira mirabilis*, by Mr. Biffen; the histology and reproduction of the Laminariaceæ, and additional notes on the cytology of the reproductive cells in the Dictyotaceæ and Fucaceæ, by Mr. J. Lloyd Williams; on the effect of salts on the CO_2 assimilation of *Ulva latissima*, by Mr. Arber; on fungi found on the scale-insects of Ceylon, by Mr. Parkin; the structure and affinities of *Dipteris conjugata*, with notes on the geological history of the Dipteridinæ, by Mr. Seward and Miss Dale.

RECORDING TELEPHONES.

NOW that the telephone has become, even in this country, an instrument of such universal commercial and general employment, the advantages of an apparatus that will satisfactorily record the messages transmitted through an ordinary telephone line are so strikingly apparent that it is unnecessary to enlarge upon them. That it should have been possible to construct such an apparatus has been evident since the invention of the phonograph. But the direct combination of the phonograph with the telephone, which seems so simple in theory, has presented difficulties in practice which up to the present have not been successfully overcome, and the phonograph of to-day, over twenty years since its invention, remains little more than a scientific toy, whereas its contemporary, the telephone, has become an almost indispensable adjunct of civilisation. It would appear, however, that the problem of recording telephone messages is nearing a practical solution, for there have been quite recently put forward, under the names respectively of the "Telephonograph" and the "Telegraphone," two separate inventions of a recording telephone.

The first of these instruments—the "Telephonograph"—is the invention of Mr. E. O. Kumberg, and contains little that is novel in principle, being simply a combination of the phonograph with a loud-speaking telephone receiver, in which the inventor has sought by a suitable design of apparatus to diminish the distortion of voice which is usual with such an arrangement. The invention consists of a phonograph in which a loud-speaking telephone receiver is substituted in place of the ordinary diaphragm to which one speaks. The telephonic currents varying in the receiver set up vibrations in a soft iron diaphragm which is attached by a short stiff wire at its centre to a second diaphragm of mica. The centre of this mica diaphragm is connected by a link with the cutting style, which accordingly traces on the wax cylinder of the phonograph a record of the message transmitted through the telephone. The cylinder can then be subsequently used in connection with the speaking diaphragm of the phonograph to repeat the recorded message. Unfortunately, neither the telephone nor the phonograph is free from distortion, and the "Telephonograph" may be expected to possess in an enhanced degree the imperfection of each of its components; from what we learn, it seems that Mr. Kumberg's invention is by no means perfect in articulation.

The second instrument which has been brought forward under the name of the "Telegraphone" is, we believe, entirely new in its principle, and if it realises but a part of what is claimed for it by its inventor represents a very great advance in telephony. This instrument is the invention of Herr Valdemar Poulsen, a Danish electrician, and is on view at the Paris Exhibition. It is briefly described in a note contributed by Herr Poulsen to the *Comptes rendus* for June 25, and somewhat more fully in an article which appears in the *Revue Générale des Sciences* for June 30.

It is, of course, perfectly well known that if a piece of steel be placed between the poles of an electromagnet which is excited by a current, a magnetic field is set up in the steel, the strength and direction of which depend upon the strength and direction of the current in the exciting coils of the electromagnet, and the magnetism thus induced in the steel is still retained by it when removed from the inducing magnetic field. This is the principle which Herr Poulsen has utilised in the construction of his new recording telephone. In place of the ordinary telephone receiver he uses a simple electromagnet, the current transmitted through the telephone line passing round the exciting coils of the magnet. When, therefore, any one speaks into the transmitting instrument at the far end of the telephone line, the magnetic field due to the electromagnet will vary in strength and direction in accordance with the varying electric currents transmitted through the lines. Between the poles of the magnet is passed a steel wire or band, which is moved forward in the direction of its length at a uniform and rapid velocity. At each point of this wire there will be produced a magnetisation proportional to the current which was flowing through the coils of the electromagnet at the moment when that section of the wire was passing between its poles. There will thus be established in the steel wire a magnetic record of the telephonic message, and just as the varying electric currents have been utilised to produce in the wire a magnetisation varying from point to point along its length, so, by the converse process, may this magnetisation be employed to set up currents in a telephone receiver, and thus reproduce the original speech. It is only necessary to connect the coils of the electromagnet in series with a receiving telephone, and to cause the steel wire on which the magnetic record has been made to pass once again at the same speed and in the same direction between the poles of the magnet; for the variation of the magnetic field which the wire produces as it moves along will generate currents proportional to the rate of variation of this field, and the telephone will respond in the same way, and with the same degree of accuracy, as did the receiving telephone in the early Bell combination of a pair of magneto-telephones prior to the employment of a microphone and a battery.

The diagrams in Figs. 1 and 2 show the arrangement of the apparatus. C is the electromagnet on which are the bobbins of wire B and B′, which are connected either to the transmitting or receiving instrument according as it is desired to record a message or to listen to one already recorded. Between the poles P and P′ of the electromagnet passes the steel wire F, which is wound in a helix over two drums, T and T′, to which the ends of it are attached and which are driven by an electric motor,

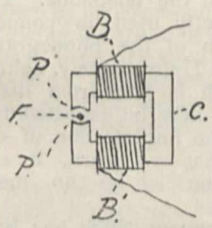


FIG. 1.

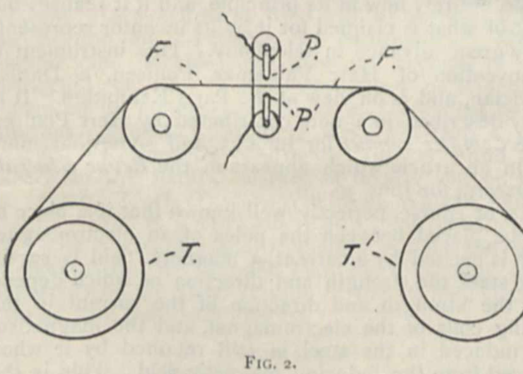


FIG. 2.

so that the wire winds off one drum on to the other. The drums rotate at such a speed as to give the wire a linear velocity between the poles of a metre per second. At the same time the magnet C is moved at right angles to the direction of motion of the wire, so that for one revolution of the drums the magnet moves a distance equal to the pitch of the helix.

The message thus recorded can be effaced, according to Herr Poulsen, by the simple process of passing the steel wire between the poles of the magnet when the latter is excited by a steady current from a battery. This operation establishes in the wire a uniform magnetic field at right angles to its length, and this field, so far from interfering with recording a future message, appears to be necessary before any such record can be made. But if it be desired to keep the record, this may be done instead, and the wire used over and over again to repeat the same message. A thousand repetitions can be made, it is said, without any diminution in loudness or distinctness.

If the recorded message is not sufficiently loud, it is possible with a comparatively simple arrangement to greatly increase its loudness. For this purpose it is necessary to arrange a series of parallel steel wires or bands as shown in Fig. 3, all of which have been previously prepared for receiving a magnetic record by being passed between the poles of a magnet excited by a steady current. The wires are moved at a uniform rate. The first wire, 1, passes first between the poles of an electromagnet M, which is connected to the telephone line, and consequently receives a magnetic record of the transmitted message. The wire next passes between the poles of a second electromagnet, A, which is connected in series with a similar magnet A′, between the poles of which the second wire, 2, passes. As the wire 1 passes between the poles of the magnet A currents are induced in the coils of this magnet, which, traversing also the coils of the companion magnet A′, produce a magnetic record in the wire 2. A similar action occurs as the first wire passes between the poles of the magnets B, C, . . . Z, which are connected in series with the magnets B′, C′, Z′, so that there is established in each of the wires 2, 3, 4, . . . n, similar magnetic records. The wires 2, 3, 4, . . . n pass finally between the poles of a number of electromagnets, Ω_2, Ω_3, Ω_4, . . . Ω_n, which are all joined in series with a telephone receiver, T. If the two magnets which are joined together in series, such as A, A′, B, B′, . . . are arranged in the same perpendicular to the direction of the steel wires, and if all

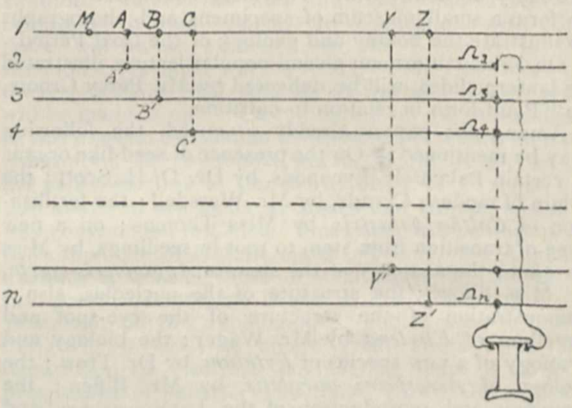


FIG. 3.

the wires are moved forward with the same velocity, then the magnetisations in the various wires—2, 3, 4, . . . n—at points lying in the same perpendicular will be similar; and since all these points will pass at the same instant between the poles of the magnets Ω_2, Ω_3, Ω_4, . . . Ω_n, they will there superpose their effects, and the intensity of the sound in the telephone, T, will be increased in proportion to the number of wires. It seems possible, therefore, with this device to indefinitely increase the loudness of the received message, and with quite a simple arrangement to easily double or treble the intensity of the sound.

There is a second ingenious method by which it is suggested that an increase in loudness can be obtained. In this advantage is taken of the fact, already pointed out, that the strength of the currents induced in the coils of the receiving electromagnet depends on the rate of variation of the magnetic field: it is therefore possible to increase the strength of the currents induced by a field altering from one given strength to another by diminishing the time in which such alteration occurs. If, therefore, we have a steel band on which a magnetic record has been made, we may increase the strength of the currents it will induce in the electromagnet connected to the receiving telephone—and consequently the loudness of the repeated message—by simply increasing the speed at which the band passes between the poles of that electromagnet. But in order to obtain the amplification of the sound in this manner, it is apparent that the band must be moved more quickly when used to repeat the message than it was when used to record it, and thus the increased loudness will be accompanied by an increased quickness, and probably at a sacrifice of clearness due to the alteration in pitch. For if the speed of the band when used for recording be increased, the effect will be merely to spread out the message along the wire, as the intensity of the magnetisation set up in the wire depends only on the strength of the currents transmitted through the telephone, and this strength is determined by the loudness and quickness with which the message is spoken at the transmitting end

The invention of Herr Poulsen may be looked upon as the invention of a magnetic phonograph, and must be regarded as an extremely ingenious and beautiful attempt at the solution of the problem of recording telephonic messages. It possesses many advantages over the combination of the telephone and the wax-cylinder phonograph, especially in the fact that the recording is effected by the immaterial agency of magnetism, and not by the mechanical agency of a style writing on wax, so that the imperfections in the articulation due to mechanical causes should be entirely absent. The method of increasing the loudness by the use of a number of parallel bands appears exceedingly simple, and offers a possible means of making a telephonic relay, and thereby increasing the limits of distance to which sound can be transmitted; it is a method which might be imitated with the ordinary phonograph, by causing the message recorded on the wax cylinder to be repeated to one or more other cylinders, and finally making all repeat their records simultaneously; but in this case the practical difficulties would be very much greater. That Herr Poulsen's invention is still only in an experimental stage may be gathered from the fact that though the instrument itself is on view at Paris, it has been found too difficult at the Exhibition to make the necessary adjustments to exhibit it in operation publicly; but we await with interest its further development, for the introduction of a trustworthy recording telephone would be a benefit to the public, for which it is to be hoped they will not have long to wait.

NOTES.

THE French Minister of War has invited the Paris Academy of Sciences to advise as to the precautions to be adopted in selecting and planting trees in the neighbourhood of powder magazines, in order to secure the best protection from lightning.

THE Chancellor of the German Empire has issued an ordinance to the effect that the Réaumur thermometer will not be admitted to official control after January 1, 1901. This will lead to the exclusive use of the centigrade thermometer in Germany.

THE International Congress of Physics, held in Paris last week, appears to have been a complete success, more than a thousand members, including leading physicists of many nationalities, having been obtained. Lord Kelvin received a grand ovation at the opening meeting, and was nominated honorary president of the Congress.

M. OUSTALET and M. Depousarques are the two candidates who have been nominated by the Paris Academy of Sciences for the chair of zoology in the Muséum d'Histoire naturelle, rendered vacant by the death of Prof. Milne-Edwards. The appointment rests with the Minister of Public Instruction.

THE *Athenaeum* announces that Prof. Virchow has been elected an honorary member of the Mathematical and Natural Science Section of the Vienna Akademie der Wissenschaften, while Prof. Klein, of Göttingen, has been appointed corresponding member of the same section.

THE attention of persons interested in zoological gardens and keeping captive animals should be directed to the passing of the "Act for the Prevention of Cruelty to Wild Animals" (63 and 64 Vict.,.Ch 33), which has just become law. This Act extends the provisions of the "Cruelty to Animals Acts 1849 and 1854" (which related to domestic animals only) to all birds, fishes and reptiles not included in that Act. By Sect. 2 of the new Act, "Any person shall be guilty of an offence who, whilst an animal is in captivity or close confinement, or is maimed, pinioned, or subjected to any appliance or contrivance for the purpose of hindering or preventing its escape from such captivity or confinement, shall, by wantonly or unreasonably doing or omitting any act, cause or permit to be caused any unnecessary suffering to such animal; or cruelly abuse, infuriate, tease, or terrify it, or permit it to be so treated." Any person committing such an offence may be proceeded against under the Summary Jurisdiction Acts, and on conviction is liable to be imprisoned for three months or fined £5.

A REUTER telegram from St. Petersburg states that the Imperial Academy of Science has just received news from the Russian expedition at Spitsbergen stating that in the month of September last the members of the expedition in question had erected, at Horn Sound, observatories for conducting meteorological, magnetic, astronomical and astrophysical researches. On October 20 the sun disappeared for four months, and at the end of October absolute and continuous night set in. The members of the expedition applied themselves constantly to scientific observations after November 17. On February 22 the sun was seen again for the first time. On June 5 and 8 the first boats arrived, ending the complete isolation of the expedition, which had lasted for nine months.

THE annual meeting of the French Association for the Advancement of Science was recently held at Paris. General Sebert, the president, delivered an address on the progress of mechanical industries and the means of developing them. In the course of his remarks he alluded to the value of technical education and research as factors in national advances. "It is noteworthy," he said, "that progress in mechanical industries has always coincided with the development of technical education in the countries in which the industries are carried on. The most rapid progress takes place in the countries where institutions for experiment and research are most numerous. Wherever research laboratories have been established to permit the study of the best conditions of invention, there the most marked advances first take place." The Association's grants for scientific purposes, made at the recent meeting, amounted to 21,241 francs, or about 850*l*.

MR. A. R. HUNT, writing from Torquay with reference to our note (p. 322) on the rumbling sounds heard at Bognor and Torquay on July 18, says: "I happened to go into my garden a few minutes after ten on the date named, and was at once conscious of a very unusual pulsating rumble. My first idea was earthquake, but the sound came steadily from one point, roughly south-east; and at last died away into distinct taps." The observation is interesting in showing how far the individual reports can be heard (see p. 378).

MR. J. STIRLING, Government geologist of Victoria, New South Wales, is at present in London as the mining representative of the Victorian Government, and during his stay here proposes to address some of the scientific, professional and mining organisations of the United Kingdom on matters of original research in Australasia. He will give an address at the Convention of Mining Institutes of Cornwall during August, and subsequently at Manchester, Bristol and other centres.

SOME interesting information as to the actual experience of nations who have adopted the metric system is given in a number of reports from Her Majesty's consular and other officers in Europe, which have just been brought together and published by the Foreign Office. H.M. representatives in twenty-two States were asked to give information upon the following points. (1) The ease or difficulty with which the change of systems was made, the manner of introduction of the metric system, and the time occupied in making the change; (2) How far the metric system is satisfactory in its practical operation, and whether there is any desire to return to former systems; (3) As to the effect the adoption of the metric system has had upon the commerce of the nations adopting it. The answers received to these questions go to show that the best way to introduce the metric system is to make it compulsory after a specified period. The change from the old to the new system is slow in country districts, but as new generations come on familiar with the metric measures the old measures gradually drop out of use. In Turkey, the difficulties of enforcing the system upon an ignorant and illiterate people have proved insurmountable; but in the majority of States from which information has been received, the system is becoming more extensively used every day. Once the system has been adopted there is no desire to return to the old measures, and the effect upon commerce is always beneficial. In fact, the reports greatly strengthen the position of those who urge that the metric system should be adopted in England, if only for the sake of British trade.

IT was mentioned in these columns some time ago that the wire fencing of great sheep farms in some parts of Australia was used as telephone wires. A recent report from H.M. Consul at Philadephia states that this system of communication is being employed by farmers between the towns of Anderson, Pendleton and Ingalls, in Indiana. The top wire of a barb-wire fence is used as the conductor, the continuity of the line being assured by special devices at highways and railway crossings. The line is fourteen miles in length with five stations, two at Anderson, two in Pendleton, and one at Ingalls. Local farmers state that they have used the "fence-line" to converse with friends eight miles distant, and this at a time when the fence posts were still saturated with the morning dew, a condition under which the line is supposed to work with least satisfaction. It is stated that the line has been such a practical success that the farmers of the neighbourhood are organising companies for the purpose of placing themselves in telephonic communication throughout the whole district.

AN excellent article dealing with the photographic side of the suggestions as to analytical portraiture made by Mr. F. Galton in NATURE of August 2 appears in *Photography* of August 9. Illustrations are given of results obtained by combining two portraits of a single person in the same pose, but having different expressions during the two exposures. In one picture the sitter has a normal expression; in the other he is smiling. A transparency was made from the normal negative; and when this positive and its negative were superimposed they neutralised one another. But by placing the positive of the normal expression of face upon the negative of the smiling expression, the two do not, of course, exactly obliterate one another. Certain parts of the features are common to both, and these disappear when the different positive and negative are superimposed, leaving only portions which represent the smile of the sitter's features. In a similar way, by superimposing the positive of a glum portrait upon the negative of a normal expression, it is possible to obtain differences representing an individual's glumness. Readers of "Alice in Wonderland" will remember that the Cheshire cat gradually disappeared and left only its grin behind. This facetious idea has now been realised, for as our enterprising contemporary points out, Mr. Galton's analytical portraiture shows how the factors of a grin or a scowl can actually be discriminated, so that a grin can be obtained without the face upon which it appeared.

A REUTER telegram from Liverpool, dated August 12, makes the following announcement:—The second malarial expedition of the Liverpool School of Tropical Medicine has just wired home from Bonny, in Nigeria, news of a most important discovery—viz. that the parasite which causes elephantiasis has, like that which causes malaria, been found in the proboscis of the mosquito. Oddly enough, the same discovery has just been simultaneously made by Dr. Low in England in mosquitoes brought from Australia, and by Captain James in India. Elephantiasis is a disease which causes hideous deformity in thousands, or rather millions, of natives in tropical countries, and sometimes in European residents. It is due to a small worm which lives in the lymphatic vessels and occludes them. The fact that this worm can live also in the mosquito has long been known, but the discovery of it in the insect's proboscis shows that it enters the human body by the bites of these pests. Europeans in the tropics are indebted to mosquitoes, not only for much discomfort, but for two dread maladies—malaria and elephantiasis; and it is high time that the authorities should begin seriously to consider Major Ross's advice to destroy these insects or their breeding-places wherever practicable.

THE medical papers contain detailed reports of the Thirteenth International Congress of Medicine, which was held in Paris at the beginning of this month under the presidency of Prof. O. M. Lannelongue. Among the representatives of Great Britain were Sir William MacCormac, Sir T. Lauder Brunton, Sir J. Burdon Sanderson, Sir Dyce Duckworth, Sir Felix Semon, and Prof. Simpson. A banquet in honour of Lord Lister was arranged by Prof. Charles Richet and the "Scientia" social society. Speeches expressing admiration of Lord Lister's work, and describing the influence it has had upon various branches of medical and surgical science, were made by Prof. Richet, Dr. Bouchard, Prof. Guyon, Dr. Lucas Championnière, and Dr. Pinard. In his reply, Lord Lister said he regarded the banquet as being in honour of the noble science of surgery and the Royal Society of London, of which he was the president. It showed that the scientific world knew nothing of the misunderstandings between peoples of different nationalities, and that men of science had mutual respect for one another at all times. Lord Lister added: "I have often said, and it gives me pleasure to repeat it this evening, that I owe much to Pasteur. It is true that I was passionately fond of physiology and surgery. The nature of inflammation was the subject of my first investigations. As a surgeon, I deplored the disastrous results which often followed the most skilful operations, and I saw, what many others had doubtless remarked before me, that the most important troubles of a wound were due to changes in the tissues of the body after the operation, and had an external origin. But all my efforts to avoid these complications were unavailing until Pasteur threw a new and strong light upon the subject, and indicated a possible course of action which I have done my best to follow. That is all. If my efforts have been followed by such beneficial results as have been generously described by speakers this evening, the success must, in a great measure, be ascribed to the fortunate chance of my time."

THE report of the Zoological Gardens of Ghizeh, near Cairo, for the year 1899, gives a good account of the progress of this Institution, which, under the rule of its present director, Captain

Stanley Flower, has become a popular place of resort for the European visitors to Egypt, as well as for the Cairenes. The receipts in 1899 were 3033*l.*, of which 968*l.* were for gate-entrances, and the expenditure was 3019*l.* The list of donors includes many well-known names, amongst which we see those of Sir William Garstin, Prince Omar Tousson, Sir F. Wingate and Lord Kitchener. The Government of India presented an elephant. Various new buildings were erected, and others were reconstructed in 1899. The number of animals in the collection on October 1 of that year was 473, against 270 at the corresponding date in 1898. A list of wild birds that inhabit the Ghizeh Gardens, and in many cases breed there, enumerates nineteen species, amongst which is the European song-thrush (*Turdus musicus*). Two proboscis monkeys (*Nasalis larvatus*), presented by the Government of the Netherlands East Indies, unfortunately did not live long. We are informed that since the report was issued Captain Flower has succeeded in bringing to the Ghizeh Gardens from the Sudan a fine young giraffe, presented by the Sirdar.

WRITING from Mashonaland in May, Mr. G. A. K. Marshall raises, in the August number of the *Entomologist*, what appears to be a pertinent question with regard to mosquitoes and malaria. If it be admitted, he observes, that malaria can only be carried by mosquitoes of the genus Anopheles, and that these insects can only acquire the microbes from malarially-infected man, "then we are logically bound to accept the conclusion that if a man, or party of men, free from malarial poison, should penetrate from a healthy area into an unhealthy but uninhabited region, it would be impossible for them to contract fever, however much they might be bitten by mosquitoes. Further, it follows that all uninhabited regions, even of comparatively small size (seeing that the range of individual species of Anopheles is apparently very limited in extent) must be entirely devoid of malaria, even though they may be full of swamps and teem with mosquitoes." Such conclusions are, however, contrary to experience, and if the writer's premises be correct, his difficulty requires an explanation at the hands of specialists.

THE Walcott collection of Hymenoptera, now in the Cambridge University Museum, has yielded to the researches of Mr. R. C. L. Perkins (*Entomologists' Monthly Magazine* for August) a species (*Odynerus tomentosus*) new to the British fauna. Considering that the greater part of the collection was made in the first half of the century, it is not a little remarkable that the species should have escaped notice so long.

THE large scale on which they do things in America has become a proverb. An instance is afforded by Mr. J. B. Smith's description of one hundred new species of moths of the family Noctuidæ in vol. xxii. of the *Proceedings* of the U.S. Museum.

To vol. xxix. No. 13 of the *Proceedings* of the Boston Society of Natural History Dr. H. S. Pratt contributes an important paper on the embryological history of the so-called imaginal discs of the sheep-tick (*Melophagus ovinus*). For the benefit of our non-entomological readers it may be mentioned that these imaginal discs, or folds, are structures in the larva and pupa which do not participate in the general breakdown of tissue at the periodical changes, but undergo continuous development into the corresponding parts of the perfect insect. Hitherto, the author says, these structures have been studied only in the larval and pupal stages; and he for the first time describes their origin and early stages of growth.

FOUR out of the nine papers in Part i. of the *Proceedings* of the Philadelphia Academy for 1900 are devoted to the land and fresh-water molluscs of America. In the first of these Mr. C. T. Simpson describes a number of new or unfigured river mussels (Unionidæ); the second, by Mr. W. H. Dall, treats of the land-shells of some of the Pacific Islands, more especially those of the Galapagos and Cocos groups; in the third, Mr. H. A. Pilsbry discusses the anatomy of the helicoid genus Ashmunella, and in the fourth the molluscs of the Great Smoky Mountains. This last communication is perhaps the one of most general interest, since the author is of opinion that the cleft in the Appalachian chain formed by the valley of eastern Tennessee indicates the boundary between two zoögeographic provinces. The lists of terrestrial molluscs given by him as respectively characteristic of the eastern and western divisions of this portion of the chain seem to bear out his contention as to the existence of two distinct faunas.

THE sixth of the series of physico-mathematical handbooks published by Messrs. Carré and Naud, of Paris, under the title of "Scientia," is a small treatise by M. Fred. Wallerent on crystalline groups and their optical properties. As an introduction to modern crystallography the little volume should be of much use to those interested in other branches of science who are desirous of acquiring a general knowledge of the history and fundamental principles of the subject, and who do not possess the spare time for mastering a larger treatise.

IN a short note contributed to the *Atti del R. Istituto d'Incoraggiamento* (Naples), Prof. E. Semmola discusses the state of our knowledge of the variations of the electrical potential of the air with the altitude. In reference to Le Cadet's result that the potential decreases with the altitude, Prof. Semmola points out that the late Prof. L. Palmieri, in conjunction with himself, had established a similar property previously. Le Cadet found that the potential decreased from 150 to 44 volts in the first kilometre of altitude, and deduced that the potential decreased much less rapidly at greater altitudes. But Semmola thinks that the high potential found at the surface of the earth was at any rate in part due to the obscurity of the superincumbent air.

A SHORT note on the reflection of light in the neighbourhood of the critical angle is given by Mr. J. G. Coffin in the *Technology Quarterly*, the object being to examine more fully than is done in most text-books the consequences of applying Fresnel's formulæ to refraction from a denser to a rarer medium. Tables are calculated by the author and Prof. Pickering, showing the percentages of light reflected at different incidences in passing from a rare to a dense medium and *vice versâ*, and the results are exhibited graphically by curves. The paper thus contains an amplification of the superficial information contained in the majority of treatises on optics.

IN the *Journal of Proceedings* of the Institution of Electrical Engineers, xxix. 142, 1900, Mr. Alexander Russell discusses the question how condenser and choking-coil currents vary with the shape of the wave of the applied electromotive force. Various forms of wave being considered, the author finds that the sine curve wave produces the least effective current when applied to a condenser, and the largest magnetising current when applied to a choking-coil. Similar results are established for the symmetric wave in the case of a family of waves of equal height. The subject is sufficiently interesting to make us wish for a fuller mathematical investigation, Mr. Russell's note being a mere statement of results.

SOME tests of fire retardent materials are described by Mr. Charles L. Norton in the *Technology Quarterly*, xiii. 2, for June 1900. The tests were made on October 5, 1899, and February 3, 1900, by setting up small buildings previously constructed in the Massachusetts Institute of Technology and building a fire of wood and oil inside. Observations of the progress of the fire and of the subsequent state of the wooden backing led to a number of interesting conclusions as to the value of the protection afforded by various retardent materials. Among these we note the comparative value of a wooden and metallic lath; the necessity of applying fire retardent material in at least two thicknesses so as to break joints; the immense superiority of three-ply over two-ply doors; the advantage of the Atkinson composite door as being more gas-tight than a wooden door; the fire-resisting qualities of three-inch plank as compared with one-inch boards, or lath and plaster; the excellency of Mississippi wire glass; and the satisfactory performance of "King's Windsor" cement and "Adamant" plaster.

AN important development of the electron theory has been carried out by Robert Lang in his article on atomic magnetism contributed to the *Annalen der Physik* (No. 7). It may now be said that the phenomena of magnetism have at last been successfully reduced to those of electricity. We know from the work of Thomson and of Drude that an electric current in a wire consists of a stream of very small particles called electrons. These electrons are formed by the splitting up of the metallic atoms into a larger positive and a smaller negative portion. The positive electrons, under the influence of an electromotive force, travel in one direction along the wire, with a velocity of about 1 cm. per second. The negative electrons travel in the opposite direction with the same charge, but with a smaller velocity. The masses are in the ratio of about 9 : 1. Now according to Lang, the negative electrons revolve round the heavier positive electrons in a magnetised metal, like a planet round the sun, and the electric convection currents thus produced are nothing more or less but Ampère's "elementary molecular currents." Lang calculates the speed of the electrons and the diameter of their orbit. The speed is that of light, and the figures obtained lead to conclusions in close agreement with known facts.

AN interesting article, entitled "Cartographie de la Caverne Mammoth," is contributed by Dr. H. C Hovey to the *Bulletin de la Société de Spéléologie*, tome v. 1899. The author gives a short history of the attempts to map the celebrated Mammoth Cave, and points out that, owing to objections on the part of the proprietors, the scientific investigation of these caverns is still incomplete. The paper is accompanied by reproductions of the map by Hovey and Call, and that by C. R. Blackall for purposes of comparison.

A VALUABLE addition to our knowledge of the cretaceous geology of Saxony is furnished by Dr. W. Petrascheck in a paper published in the *Abhandl. der Naturwiss. Gesellsch. Isis* (Dresden, 1900). The author seeks to trace the change of facies developed at various horizons in the cretaceous rocks of this area when followed laterally. He explains, as far as possible, the modifications in the character of the fossil fauna which accompany the changes in petrographical facies. The region discussed comprises the neighbourhood of Dresden and the well known "Saxon Switzerland."

THE August number of the *Journal* of the Chemical Society contains the Friedel Memorial Lecture, delivered before the Society by Prof. J. M. Crafts.

THE second English edition of Prof. Ostwald's "Scientific Foundations of Analytical Chemistry," translated from the second German edition by Dr. George M'Gowan, has been published by Messrs. Macmillan and Co. Since the original work was published in 1894, the principles expounded in it have been steadily gaining acceptance, but, so far as we are aware, no English text-book of chemical analysis has appeared in which the analytical methods and reactions of the laboratory are consistently explained in terms of the theory of ions instead of being represented by the ideal equation-formulæ. As Prof. Ostwald states, the general standpoint of analytical chemistry has undergone but little change; nevertheless, the newer ideas are gradually being applied to laboratory work by lecturers and demonstrators who are in touch with modern chemical theory. The new edition just published will be the means of extending the knowledge of the fundamental principles underlying chemical processes, and will be a source of inspiration to teachers who wish to make analytical chemistry a science as well as an art.

A SIMPLE method of preparing free hydroxylamine is given in a recent number of the *Annalen* (311, 117) by Dr. R. Uhlenhuth. When the phosphate of the base is heated gently under reduced pressure, the base distils over in a state of such purity that the distillate solidifies on placing the receiver into melting ice.

THOUGH the need for a universal standard table of atomic weights is recognised by all chemists, the question whether it shall be constructed upon a basis of $O = 16$ or $H = 1$ has yet to be decided. The *Chemical News* publishes a letter from Profs. Bredt, Erdmann, Fischer, Volhard, Winkler and Wislicenus, members of the International Committee on Atomic Weights, upon this point. It is remarked that if cogent reasons necessitate an alteration of the standard of atomic weights, it would be better to start from an element of which the weight can be conveniently ascertained, such an element, for example, as silver or iodine, which also serves as a practical starting-point in consideration of the sharpness of its reactions in numerous analytical operations. But in the opinion of the writers such cogent reasons for an alteration do not present themselves, for the ratio of hydrogen to oxygen has been established with an exactness which fully suffices for all practical purposes. It is felt that the time for an unchangeable table of atomic weights has not yet come; for each succeeding year brings corrections in the atomic weights of the rarer elements, and at the same time speculations as to their simple or compound nature. Opinions are therefore invited upon the following questions:—(1) Shall the unity of hydrogen be retained as the standard for reckoning atomic weights? (2) Shall the atomic weights be given approximately with two decimal places in which the uncertain figures can be recognised by the type? (3) Shall the International Atomic Weight Commission have the current table of atomic weights edited on this basis? Communications should be sent to Herr Prof. J. Volhard, Mühlpforte 1, Halle-a-S.

THE additions to the Zoological Society's Gardens during the past week include a Lioness (*Felis leo*) from South Africa, presented by the Right Hon. Cecil J. Rhodes; a Black-backed Jackal (*Canis mesomelas*), a Leopard Tortoise (*Testudo pardalis*), a Puff Adder (*Bitis arietans*) from South Africa, presented by Mr. J. E. Matcham; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Mr. W. A. Gillett; a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, presented by Captain G. H. Arnot; a Chinese Quail (*Coturnix chinensis*) from China, two Asiatic Quails (*Perdicula asiatica*) from India, two Sparrow Hawks (*Accipiter nisus*), British, presented by Mr. D. Seth-Smith; a Common Quail (*Coturnix communis*), British, presented by Miss F. E. Burt; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, a Polar Bear (*Ursus maritimus*, ♀) from the Polar Regions, two Black-headed Caiques (*Caica melanocephala*) from Demerara, a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, a Pleurodele Newt (*Molge walti*), a Leopardine Snake (*Coluber leopardinus*), a Vivacious Snake (*Tarbophis fallax*), six European Pond Tortoises (*Emys orbicularis*), South European; two Egyptian Mastigures (*Uromastix spinipes*), an Algerian Tortoise (*Testudo ibera*) from North Africa, four Alligator Terrapins

(*Chelydra serpentina*) from North America, a Leopard Tortoise (*Testudo pardalis*) from South America, two Argentine Tortoises (*Testudo argentina*) from the Argentine Republic, deposited; a Gold Pheasant (*Thaumalea picta*, ♂) from China, two Little Bitterns (*Ardetta minuta*), European, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMET BORRELLY-BROOKS (1900 *b*).—The following elements and ephemeris are furnished by Herr J. Möller in the *Astronomische Nachrichten* (Bd. 153, No. 3654).

Elements.

T = 1900 Aug. 3·298 Berlin Mean Time.

$$\left.\begin{aligned} \omega &= 12^\circ\ 30'\cdot2 \\ \Omega &= 328\ \ \ 1\cdot8 \\ i &= 62\ \ 35\cdot6 \end{aligned}\right\} 1900\cdot0$$

$$\log q = 0\cdot00636$$

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′	Br.
Aug. 16	3 50 8	+75 55·7	0·63
17	4 0 12	77 36·3	60
18	4 12 37	79 10·3	56
19	4 28 4	80 37·7	53
20	4 47 52	81 57·7	50
21	5 13 26	83 9·5	48
22	5 47 9	84 11·4	45
23	6 31 8	85 0·8	42
24	7 26 5	85 34·6	40
25	8 28 54	+85 49·3	0·38

EPHEMERIS FOR OBSERVATIONS OF EROS.—The following is a continuation of co-ordinates computed by Herr F. Ristenpart (*Astronomische Nachrichten*, Bd. 152, No. 3643).

Ephemeris for 12h. Berlin Mean Time.

1900.	R.A. h. m. s.	Decl. ° ′ ″
Aug. 16	2 0 29·40	+27 56 22·5
18	3 19·51	28 38 11·6
20	6 6·71	29 20 17·4
22	8 50·73	30 2 40·0
24	11 31·33	30 45 19·5
26	14 8·25	31 28 16·1
28	16 41·22	32 11 29·5
30	2 19 10·01	32 54 59·5

THE ASTROGRAPHIC CHART CONFERENCE.—The fourth meeting of the International Committee for directing the photographic delineation of the sky has recently been held in Paris, commencing July 19. The first matter taken in hand was the appointment of a sub-committee of nine astronomers to draw up a scheme for the systematic observation of Eros during the coming opposition, for determinations of solar parallax. The reports from the co-operating observatories show that in fifteen of them the work is being vigorously pushed forward; unfortunately, in the remaining three, Rio de Janeiro, La Plata and Santiago (Chili), the work has entirely fallen through.

Dr. Thome, of the Cordoba Observatory, has been enabled, by the generosity of the Argentine Government, to volunteer for the work assigned to La Plata (−24° to −31°), and M. Enrique Legrand stated that he had induced his Government to found an observatory near Monte Video (Uruguay) to carry out the zone (−17° to −23°) allotted to Santiago. It was also suggested that the new observatory at Perth, West Australia, might possibly carry out the work on the remaining zone (−32° to −40°).

Another important item of the discussion was the advisability of publishing the rectangular co-ordinates of the stars as measured, with, of course, the constants of each plate, or delaying the work until these could be transferred to equatorial co-ordinates. It was considered that in the near future the absolute positions of the comparison stars would be much more accurately known than at present. The only drawback to this scheme is that Dr. Scheiner, of Potsdam, has already started the publication of the catalogue giving R.A. and Decl. of the stars.

In connection with the assignation of photographic magnitudes, it appeared to be generally believed that the estimation of diameters by means of a scale is a surer plan than measurement with a micrometer for this particular branch of work, but no definite ruling was given on this point.

The original plan agreed to in 1896 for taking the chart plates with three exposures of 30m. each has not been followed at all the observatories, and it was resolved at this meeting that in future the method of taking the chart plates shall be decided by the individual directors. In the reproduction of these chart plates, it is unlikely that uniformity will be secured; the French observatories have made enlarged copies by heliogravure, but as each observatory would have to expend some 10,000*l.* to do this, the actual method of reproduction is left unsettled.

DETERMINATION OF SOLAR PARALLAX.—A circular has been issued by the special committee appointed by the International Astrophotographic Conference held recently at Paris containing the resolutions passed for systematising the work to be done at all the world's observatories during the coming autumn and winter, when it is hoped, by means of observations of the minor planet Eros, to determine the parallax and distance of the sun with a degree of accuracy previously unattainable. The following is a summary of the suggestions adopted:—

(1) That the determination of parallax of Eros be made by micrometric, heliometric and photometric measurements. (*a*) By observations of the planet east and west of the meridian at the same observatory. (*b*) By the co-operation of the observatories of Europe and North America. (*c*) By the co-operation of the observatories of the northern and southern hemispheres.

(2) During the period of parallax observations the diurnal movement of Eros should be determined as accurately as possible by heliometer, micrometer and photography.

(3) (*a*) Observers determining the parallax in right ascension should make measures each night and morning, profiting by all favourable circumstances to operate with as large hour angles as possible. (*b*) Observers finding parallax by difference of declination in northern and southern hemispheres, should arrange that the mean instants of observation do not vary much from the meridian passage of the planet at the southern station.

(4) It is necessary that special series of photographs be taken of the region traversed by Eros, in order to furnish accurate determinations of the positions of comparison stars.

As the varying atmospheric conditions will play an exceedingly important part in the observations, particularly those away from the meridian, MM. André and Prosper Henry have been asked to prepare suggestions for eliminating these difficulties.

At the time of writing, the following observatories have signified their intention of helping with the scheme:—Algiers, Athens, Bamberg, Bordeaux, Cambridge (England), Cambridge (U.S.), Cape of Good Hope, Catania, Cordoba, Chicago (Yerkes), Edinburgh, Greenwich, Heidelburg, Leyden, Leipzig, Lyons, Marseilles, Minneapolis (U.S.), Mount Hamilton (Lick), Nice, Potsdam, Rome, San Fernando, Strassburg, Tacuboya, Toulouse, Upsala, Vienna (Ottahring), Vienna (Währing), Washington.

THE DISTANCE TO WHICH THE FIRING OF HEAVY GUNS IS HEARD.

IN a discussion which took place in NATURE some time ago on the so-called "Barisâl Guns" and other mysterious sounds, Prof. Hughes suggested that it would be desirable to ascertain how far the firing of guns can be heard (vol. liii. p. 31). In connection with another subject, that of spurious earthquakes (see NATURE, vol. lx. pp. 139–141), I have for some time been collecting notes on this point, and I propose here to describe some of the facts obtained, chiefly with regard to the great naval review at Spithead on June 26, 1897, and the operations of the French fleet at Cherbourg on July 18, 1900.

I will mention first a few cases referring to more or less isolated observations of the reports of distant guns. The firing during the battle of Camperdown on October 11, 1797, is said to have been heard in Hull, the distance between the two places being more than 200 miles. A gentleman, formerly resident at Kertch in the Crimea, informs me that he has heard the sound of the guns fired at Sebastopol, distant 158 miles. During the American Civil War, the roar of the guns at the battles of Malvern Hill and Manassas (or Bull Run) was perceptible at

Lexington in Virginia, the distances being about 123 and 125 miles respectively (NATURE, vol. liii. p. 296). When the *Alabama* was sunk nine miles off Cherbourg on the morning of Sunday, June 19, 1864, the sound of the guns was heard in Jersey, at Clyst St. George, near Exeter (108 miles from Cherbourg), and at Brent Tor, near Bridgwater (about 125 miles). The great naval review at Spithead on July 17, 1867, was held during rough, boisterous weather; but the noise of the guns is said to have been heard at Exeter (105 miles), Morebath, near Tiverton (105 miles), Great Malvern (107 miles), and Castle Frome in Herefordshire (110 miles). In all the above cases the sound was, of course, the aggregate of that of many guns of different sizes fired simultaneously. But, in naval reviews, the charge is very much less than in actual warfare; a 6-inch gun, for instance, would fire a blank charge of 7 lbs., whereas the service charge for the same gun would be 48 lbs. fired with shot.

With regard to the distance to which the report of a single gun can be heard, I have very little information. A 110-ton gun fired at Woolwich made a window shake at Chignall St. James (24 miles), and was heard at Witham (32 miles) as a rumbling sound which seemed to deafen the observer slightly (NATURE, vol. xli. p. 369). Time-guns at Bombay have been often heard at the northern Mahim, distant more than 50 miles (vol. lvi. p. 223). The reports of the heavy guns at the battle of Malvern Hill, mentioned above, could be easily distinguished at Lexington from those of the smaller weapons; and a similar observation is recorded below. The subject is evidently one on which useful contributions to our knowledge might be made by residents near the south coast of England.

Naval Review at Spithead on June 26, 1897.

Shortly before the great naval review held in honour of the Queen's Diamond Jubilee, I wrote to the principal London newspapers and to several published in the south of England, and I have to thank the editors of these papers, and the ladies and gentlemen who replied to my inquiries, for the help they have kindly given me. The points to which I directed attention were the times at which the reports were heard, whether the air-vibrations were strong enough to make windows rattle, the direction from which the sound appeared to come, and the direction of the wind.

The fleet collected on this occasion consisted of 165 vessels of war of all classes arranged in five lines about six miles in length. The position of the flag-ship (H.M.S. *Renown*) was about two miles N. 20° E. of Ryde; and the distances given below are all measured from this point. As the Royal yacht entered the lines immediately after 2 p.m., the first shot was fired from the *Renown*, and was taken up by other ships in turn, each firing a Royal salute of twenty-one guns. "The heaviest gun employed," I am informed by the Secretary of the Admiralty, "was probably a 6-inch breech-loading gun, firing a blank charge of 7 lbs."; but others of different sizes were also used. It produced at first a dull crackling noise, according to a correspondent on H.M.S. *Sanspareil*, but, as ship after ship took up the salute, the firing grew more animated and the roll of the guns louder; until, after about five minutes, the report of the last gun died away.

The atmospheric conditions were fairly favourable for the propagation of the sound. Light, but variable breezes, generally between north-east and south-east, prevailed over most of the south of England. The thunderstorms which occurred on that day followed the salute in most places, but nearly all my correspondents (several being retired military officers) agreed that the sound of the guns could be readily distinguished from that of thunder.

In many of the records which I have received, the time is given so roughly that it is difficult to feel confident that they refer to the salute in question, and in several it is omitted altogether. Under the former heading come records from Honiton (90 miles from Spithead) and Shebbear, near Torrington (135 miles); and under the latter from near Rickmansworth (67 miles) and Great Malvern (107 miles). Excluding all such cases, the number of records is reduced to twenty, from nineteen places.

At very few of these places, and at none more distant than about 28 miles, were the vibrations strong enough to shake windows. Distinct reports were heard at the beginning and end of the salute as far as Farnham (34 miles), otherwise the sound was a dull, continuous roar, with occasional booms from the heavier guns. The sound was heard to the east as far as Framfield (57½ miles), to the north-east at Wimbledon (62 miles), to the north at Bloxham Green, near Banbury (88 miles), and to the west at Wellington in Somerset (93 miles). These are more or less isolated places, but there is a fairly continuous series of observations in a north-westerly direction, extending to Melksham (61 miles), Monkton Farleigh, near Bradford-on-Avon (67 miles), Bath (two observations, 69 miles), and Weston, near Bath (71 miles).

In the evening the fleet was illuminated, and a final Royal salute, similar to that at 2 p.m., was fired on the return of the Prince of Wales shortly after 11 p.m. I have only two accounts which may refer to this salute, one from Cosham in Hampshire at 11.30 p.m., the other from Ashburton in Devonshire (116 miles) at 11.59 p.m. The recorded times differ too widely to give much value to these observations.

Naval Review at Cherbourg on July 18, 1900.

About 10 p.m. a sham fight took place between two portions of the French fleet at Cherbourg in honour of the visit of the President, M. Loubet, to that town. The number of vessels engaged was forty-three, including thirteen of the largest and most modern battle-ships in the world. During the next few days accounts appeared in various English newspapers of a series of supposed earthquake-shocks felt shortly after 10 p.m. at different places along the southern coast, from Torquay to Bognor. The long duration of the disturbances and their apparent transmission through the air being opposed to a seismic origin, I wrote letters to a number of London and south-country papers, and the account which follows is chiefly based on the replies which I received to these letters.

As some doubt has been expressed with regard to the connection between the two phenomena, it may be well to mention the evidence in its favour. (1) With two exceptions, not one of the places (forty in number) from which records have come is more than a mile or two from the coast. There are several from the south of the Isle of Wight, but none from that part of Hampshire shielded from Cherbourg by the higher ground of the island. (2) Though a few persons in the open air assert that a tremor was felt, the great majority state that the sound travelled through the air and not through the ground; windows rattled loudly without there being any movement of the floor, and at Lancing (100 miles from Cherbourg) and Seaton in Devon (97 miles) observers placing their hands on the wall felt it distinctly vibrating; the noise caused a drumming in the ears at several places more than a hundred miles from Cherbourg. (3) The sounds were recognised as those of heavy guns by many persons, and with less hesitation the smaller the distance from Cherbourg. (4) The night was very still, hardly a breath of wind could be felt, and the sea perfectly calm; and the sound was heard to the east and west along the English coast at almost equal distances from Cherbourg. (5) Lastly, heavy guns are rarely, if ever, fired from English ships or forts at so late an hour; whereas more than 24,000 charges are said to have been fired in Cherbourg harbour during almost the same interval in which the sounds were heard in England.

Though the times of occurrence are roughly given, they agree for the most part in placing the commencement of the disturbances just after 10 p.m., and the end shortly before 10.30. Clearer evidence as to the identity of the sounds throughout the whole area affected is provided by the similarity in their relative duration and intensity. The first began about 10.2 or 10.3, and lasted nearly four minutes. Then came a pause of five minutes, when there was another burst of about the same intensity and nearly the same duration. About ten minutes later the third followed, slighter in intensity and of shorter duration, perceived almost as far as the others (at Torquay and Brighton, 101 and 104 miles respectively), though not by all observers.

I have no information as to the size of the guns used on this occasion, but they were probably much heavier than those employed for the salutes at Spithead in 1897. To the west, the sound was heard at Budleigh Salterton, Sidmouth and Torquay (101 miles from Cherbourg), Paignton (102 miles), and Dawlish and Exmouth (104 miles); to the east at Lancing (100 miles), Brighton (104 miles), and near Henfield (107 miles, and seven miles from the sea). At all of these places, and at many between, the air-vibrations were strong enough to make windows shake and rattle, and there are accounts of this or a similar effect being observed at a greater distance than the sound—at Plymouth (123 miles), and Menheniot, near Liskeard (136 miles, and five miles from the sea). At the latter place the sudden rattling of a large window was distinctly heard at about 10 p.m., but it was unaccompanied by any sound. Judging from the intensity of the disturbances at Torquay and Brighton, I see no reason to doubt the connection of the latter observation with the firing at Cherbourg.

It is interesting to notice how the character of the sound changed with the increasing distance from Cherbourg. At St. Catherine's Point (65 miles) and Bonchurch (68 miles), both in the Isle of Wight, the sound was described as exactly like that of heavy guns. At Bournemouth and Muddiford in Hampshire (74 miles) there was a continual rumbling noise, with occasional heavier booms. At greater distances, as far as Lancing, Torquay and Paignton, the prominent reports ceased to be audible, and there was merely a deep monotonous throbbing noise, the pulsations recurring with great rapidity and regularity, resembling a very quick beating of a big drum far away, or the beats of the paddles of a distant and unseen steamer. At very great distances the vibrations (or some of them) do not seem to have attained the requisite strength to be audible to certain observers, one at Lancing (100 miles) referring to a most curious throbbing sensation in the air, and a dull sound like that of a distant train; while another at Brighton (104 miles) remarks that he heard or felt the sound. The rattling of the window and the inaudibility of the vibrations at Menheniot may perhaps be accounted for in this way.

CHARLES DAVISON.

SUBJECTS FOR CONSIDERATION BY ELECTRICAL ENGINEERS.

THE current number (July) of the *Journal* of the Institution of Electrical Engineers contains a list of subjects suggested by the Council as suitable for papers to be read at the meetings or published in the *Journal*. The list is here reprinted, and it should be the means of directing attention to many important problems awaiting solution, as well as eliciting information upon the present position of various branches of electrical engineering.

1. Best methods of generating steam and steam power for variable loads.
2. Comparison of double- and triple-expansion engines for varying load conditions.
3. Automatic handling of fuel in power stations.
4. The present position and applicability of gas or oil engines for electrical power stations.
5. Description of plants for the utilisation of river- or tidal-power in the generation of electrical energy.
6. The present position and prospects of the application of liquid and of powdered fuel in electrical power stations.
7. The utilisation of blast-furnace gases or other waste products of manufactures in the generation of electricity.
8. The application of dust-destructors to the generation of electricity.
9. Electric light and power station chimney shafts; specialities of their construction and equipment.
10. Experiences with vibrations from electric light and power stations.
11. Bearings of shaft and shafting running at high speed.
12. Improvements in dynamos.
13. Comparison of speed and cost of dynamo.
14. Comparison of single and multiple central stations.
15. The wholesale supply of electricity to towns and factories from centres where very large generating units are employed.
16. The distribution of electrical energy from a distant generating station through districts served from a different source of supply, or under a separate local authority.
17. Electrical distribution by constant current, direct or alternating.
18. Examination of relative advantages and disadvantages of direct-current and alternate-current transmission.
19. Examination of relative advantages and disadvantages of two-phase and three-phase transmission.
20. Methods of controlling speed of alternating current motors.
21. Practical methods of measurement in connection with polyphase distribution.
22. Methods for the conversion of direct current into alternate current.
23. Methods of providing for electrical supply during hours of small demand.
24. Utilisation of lighting plant for other work during the hours of small demand.
25. The electrical equipment of large blocks of offices in a city.
26. Economy of design in the manufacture of small electric fittings.
27. Portable electric lamps of the "safety" type, or otherwise.
28. Enclosed arc lamps.
29. Improvements in incandescence electric lamps.
30. Incandescence electric lamps with filaments other than pure carbon.
31. Application of electrical transmission in factories:—
    (*a*) Detailed description, giving sizes of motors and power provided.
    (*b*) Comparison of separate or combined direct- and alternate-current methods.
    (*c*) Combination of lighting and power for such purposes
32. Electricity meters.
33. Description of electrical methods, or comparison of these with other methods, of propelling vehicles.
34. The supply of electrical energy for tramway purposes.
35. The use of electrical methods of traction on railways served by steam-driven locomotives.
36. The economy and design of electrical elevators.
37. The design and economy of electrically driven pumps.
38. The utilisation of electrical energy in mining.
39. The applications of electrical energy in warfare.
40. The use of electricity in the textile and other industries.
41. The application of electricity in musical instruments.
42. Electro-therapeutics.
43. The establishment of public time-services by electricity.
44. Recent advances in telegraphy.
45. Applications of alternating currents in telegraphy.
46. The transmitting capacity and load factor of telegraph circuits.
47. Hertzian telegraphy.
48. Methods, in aërial telegraphy, of restricting signals to selected stations.
49. Recent improvements in telephony.
50. Descriptions of systems tending to simplify the interchange of telephonic communications.
51. The talking capacity and load factor of telephone circuits.
52. The application of electricity to the generation of heat for domestic purposes (cooking, ventilation, heating, &c.).
53. The construction and use of electric furnaces.
54. The application of electricity to the welding or annealing of metals.
55. The application of electrical heating methods in chemical or metallurgical operations.
56. The applications of electricity in metallurgical processes.
57. The applications of electrolysis in the smelting or refining of metals, or in the chemical industries.
58. The electrical equipment of chemical factories.
59. Improvements in primary batteries.
60. Examination of the present position of secondary batteries in electrical engineering.
61. The direct generation of electrical energy from fuel.
62. The economic employment of thermo-generators.
63. Improvements in the apparatus for producing, and in the applications of, kathode and Röntgen rays.
64. The relative suitability and efficiency of the different materials available for any of the requirements of electrical engineering.
65. The electric strength of di-electrics.
66. Recent advance in the manufacture or use of insulating materials.
67. New insulating materials.
68. Electrical applications of aluminium, sodium, &c.
69. The electrical uses of the rarer metals.
70. The treatment, testing, specifications, or uses of iron or steel, or of iron alloys, for magnetic purposes.
71. The manufacture of permanent magnets.
72. The relation of chemical composition and physical condition to the electrical or magnetic properties of substances, considered in its bearing upon electrical engineering practice.
73. High-resistance metals for instruments or resistance coils.
74. New resistance alloys.
75. The protection of laboratories and observatories against magnetic disturbances due to local causes.
76. Recent legislation in its relation to electrical undertakings.
77. The relations between electric lighting or power corporations and municipal authorities.

PRIZE SUBJECTS OF THE PARIS SOCIÉTÉ D'ENCOURAGEMENT.

THE June number of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale* contains the programme of prizes and medals proposed by the Society for 1901 and following years. The questions proposed for solution cover a large field; omitting many which have only a local interest, the chief problems suggested as prize subjects for 1901 are as follows. In Mechanics, prizes of 2000 francs for a motor weighing less than 50 kilograms per horse-power developed; for an important advance in mechanical methods of transmitting energy; and for automobiles suitable for use in towns and in the country respectively, the conditions laid down for the motor car suitable for towns requiring the absence of fumes or smell, and in the case of the one for use in the country, only such fuel to be used as can ordinarily be obtained in country towns. In Chemistry, a prize of 1000 francs for the utilisation of any waste product; of 2000 francs for a publication useful to chemical or metallurgical industry; two prizes of 500 francs each for scientific researches in chemistry, of which the results can be utilised in industrial work; a prize of 2000 francs for an improvement in the manufacture of chlorine; one of 1000 francs for the discovery of a new alloy useful in the arts; and of 2000 francs for a study of the expansion, elasticity, and tenacity of pottery clays and glazes, for a scientific study of the physical and mechanical properties of glass, for a new method of manufacturing fuming sulphuric acid and sulphur trioxide, and for the manufacture of a steel by the introduction of a foreign element possessing specially useful properties. In the Economical Arts, 2000 francs for an invention of new methods allowing of the utilisation for lighting and heating, either for domestic or industrial purposes, of petroleum, density not less than 0·800; 2000 francs for a continuous extractor; 3000 francs for a method of purifying water for domestic use; and 2000 francs for a 2-candle power incandescent electric lamp fulfilling certain special conditions.

Other prizes offered include one of 2000 francs for the best study of the diseases of cider and the means of preventing or arresting their development; of 3000 francs for the invention of a method allowing of the production of an indefinite number of positives in colours either by a direct method or with a Lippmann negative; of 2000 francs for a memoir on the silk industry in the Lyons region; of 1500 francs for a memoir on the cycle industry; and of 3000 francs for a study of commercial syndicates.

According to the general conditions for these prizes, all memoirs must be sent in before December 31, they must be written in the French language, and are open to persons of all nationalities.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

TEACHERS in Schools of Science and Technical Schools will find a Diary and Calendar just issued by Messrs. Philip Harris and Co., scientific instrument makers, Birmingham, a convenient little pocket-book. The diary is for the year commencing on September 1, and ending August 31, 1901. The dates are given of examinations in science and technology, and memoranda referring to the days on which official papers must be sent in are brought together in a calendar. The book is thus a real *vade mecum* for science teachers.

THE following Saturday morning courses for teachers have been arranged by the London Technical Education Board. A course of about ten lectures on the teaching of mathematics will be given by Prof. Hudson at King's College The object of these lectures is to help those who are practically engaged in teaching, and wish to become acquainted with modern methods and improvements in order to render their teaching more effective. A course on physics will be given under the direction of Prof. W. Grylls Adams and Mr. S. A. F. White. The course will consist of practical work in the Wheatstone Laboratory, the object of the instruction being to enable students to obtain an intimate knowledge of the methods employed in physical measurements and familiarity with the use of apparatus. A course of twenty lectures on physiology will be delivered by Prof. Halliburton. The object of the course is to acquaint teachers with the modern methods of teaching physiology by objective methods. A course of ten lectures on the teaching of physical geography, each lecture followed by a class for practical work, will be given by Miss Catherine A. Raisin, D.Sc., at Bedford College.

THE London Technical Education Board makes provision for advanced students as well as for those of elementary grades. During the coming session evening science courses will be held in connection with the Board at University College, King's College, and Bedford College. At University College, Prof. J. A. Fleming, F.R.S., will give a course of ten lectures, followed by laboratory practice, in advanced, electrical measurements. A course of lectures on the electric motor and its application in electric traction will be given by Prof. C. A. Carus-Wilson, each lecture to be followed by an experimental demonstration or by a class for the practical working of numerical examples in connection with the subject. A course will be given by Prof. E. Wilson, at King's College, on direct and alternating currents. In mechanical engineering, Prof. T. Hudson Beare will give a course of ten lectures, at University College, on the theory of steam engines and boilers, with laboratory work on the testing of steam engines and boilers. Prof. Beare will also give a course of five lectures on the theory of gas and oil engines, combined with laboratory work. A course of five lectures on water-tube boilers will be given by Mr. Leslie Robertson. A course will be delivered by Prof. D. S. Capper and Mr. H. M. Waynworth in the mechanical engineering laboratories of King's College. The course will consist of about twenty demonstrations upon steam and gas engines and general laboratory work. The latter portion of each evening will be devoted to experimental and practical work in the engineering laboratory in illustration of the lectures. A course on civil engineering will be delivered by Prof. Robinson. The methods of producing artificial cold will be the subject of a course of lectures to be delivered at University College by Dr. W. Hampton. At the same college, Mr. E. C. C. Baly will deliver eight lectures dealing with the methods of spectroscopy, especially in connection with the photography of the spectrum.

HER MAJESTY'S Commissioners for the Exhibition of 1851 have made the following appointments to Science Research Scholarships for the year 1900, on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of 150*l.* a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result in work of scientific importance. The new scholars and their nominating institutions are as follows:—C. E Fawsitt, B.Sc. (University of Edinburgh), V. J. Blyth, M.A. (University of Glasgow), J. Moir, M.A., B.Sc. (University of Aberdeen), W. M. Varley, B.Sc. (Yorkshire College, Leeds), J. C. W. Humfrey, B.Sc. (University College, Liverpool), S. Smiles, B.Sc. (University College, London), N. Smith, B.Sc. (Owens College, Manchester), L. L. Lloyd (University College, Nottingham), Alice Laura Embleton, B.Sc. (University College of South Wales and Monmouthshire, Cardiff), J. A. Cunningham, B.A. (Royal College of Science, Dublin), W. S. Mills, B.A. (Queen's College, Galway), J. Patterson, B.A. (University of Toronto), W. C. Baker, M.A. (Queen's University, Kingston, Ontario), J. Barnes, M.A. (Dalhousie University, Halifax, Nova Scotia), J. J. E. Durack, B.A. (University of Sydney). Seventeen scholarships granted in 1898 and 1899 have been continued for a second year on receipt of a satisfactory report of work done during the first year. The names of the scholars and the places where they are studying are as follows:—J. C. Irvine, B.Sc. (University of Leipzig), H. L. Heathcote, B.Sc. (University of Leipzig), Winifred Esther Walker, B.Sc. (University College, London), F. W. Skirrow, B.Sc. (University of Leipzig), C. G. Barkla, B.Sc. (Cavendish Laboratory, Cambridge), Harriette Chick, B.Sc. (Thompson-Yates Laboratories, University College, Liverpool), F. A. Lidbury, B.Sc. (University of Leipzig), W. Campbell, B.Sc. (Royal College of Science, South Kensington), L. Lownds, B.Sc. (University of Berlin), J. T. Jenkins, B.Sc. (University of Kiel and Biological Institution, Heligoland), R. D. Abell, B.Sc. (University of Leipzig), W. Caldwell, B.A. (University of Würzburg), W. B. McLean, B.Sc. (Owens College, Manchester), B. D. Steele, B.Sc. (University of Breslau), E. J. Butler, M.B. (University of Freiburg), J. W. Mellor, B.Sc. (Owens College, Manchester), L. N. G. Filon, M.A. (King's College, Cambridge). Four scholarships granted in 1898 have been exceptionally renewed for a third year. These scholars and their places of study are :—Dr. A. H. Reginald Buller, B.Sc. (University of Munich), H. T. Calvert, B.Sc. (University of Leipzig), R. L. Wills, B.A. (Cavendish Laboratory, Cambridge), E. H. Archibald, M.Sc. (Harvard University).

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxii. No. 3.—On continuous binary Λ linearoid groups, and the corresponding differential equations and Λ functions, by E. J. Wilczynski. In a previous paper (vol. xxi. 2) the writer has shown that, corresponding to every group of the form

$$\eta_i = \sum_{k=1}^{m} \phi_{ik}\,(x\,;\ a, \ldots a_r)\, y_k\,(1),$$

where the r parameters a_i are essential, there exists a system of differential equations of order r, whose general solutions are given by (1), if $y_1, \ldots y_n$ form a fundamental system. The functions ϕ_{ik} were supposed to be uniform functions of x, and it was found that, if the parameters a_i were properly chosen, ϕ_{ik} were uniform functions of the parameters also. In the present paper he discusses these groups, the corresponding differential equations, and their solutions for the case when $n=2$. Dr. Lovett, in his note on a property of lines in n-dimensional space, working on the lines of Cesàro's "Lezioni di Geometria Intrinseca," shows that a line of multiple curvature cuts its osculating space of highest dimensions, or lies wholly on one side of that space, according as the number of dimensions of the space necessary to the existence of the curve is odd or even. —Concerning the cyclic sub-groups of the simple group G of all linear fractional substitutions of determinant unity in two non-homogeneous variables with coefficients in an arbitrary Galois field, by Dr. L. E. Dickson (read before the Chicago section of the Mathematical Society, December 1899), leads to a generalisation to the GF[p^n] of results due to Prof. W. Burnside ("On a Class of Groups defined by Congruences," *Proc.* of London Math. Soc. vol. xxvi.). Variations from Burnside's method of treatment are introduced, partly to avoid the separate treatment of the cases $d=1$ and $d=3$, and to take in the exceptional cases $p=2$ and $p=3$, and to reduce the calculations; and further, on the other hand, to amplify some of the proofs. A few errors are also pointed out and amended.—On some invariant scrolls in collineations which leave a group of five points invariant, by V. Snyder. The writer gives numerous references to memoirs in which the quadric surfaces which are left invariant by cyclical collineations have been exhaustively treated. There is another simple series of scrolls, viz. those contained in a linear congruence, which have not been considered, except one form noticed by Ameseder. The writer confines his attention to such surfaces. There are six collineations which are of essentially different type, which project a set of five points into themselves without leaving every point invariant. In the notation of substitution-groups these may be thus represented:

$$T_2 \equiv (A_1A_2)(A_3)(A_4)(A_5),$$
$$T_3 \equiv (A_1A_2)(A_3A_4)(A_5),$$
$$T_4 \equiv (A_1A_2A_3)(A_4)(A_5),\ T_5 \equiv (A_1A_2A_3)(A_4A_5),$$
$$T_6 \equiv (A_1A_2A_3A_4)(A_5) \text{ and } T_7 = (A_1A_2A_3A_4A_5).$$

—On the reduction of hyperelliptic integrals ($p=3$) to elliptic integrals by transformations of the second and third degrees, by W. Gilespie. The point of the paper is an application of cubic involution to the problem of the reduction to elliptic integrals, of hyperelliptic integrals of genus $p=3$ and of the first kind, by a rational transformation of the third degree. It is a continuation of Prof. Bolza's researches on the cubic transformation ("Die Cubische Involution und Dreitheilung, &c.," and "Zur Reduction Hyperelliptischer Integrals, &c.," *Math. Ann.*, Bd. 50, pp. 68 and 314).—The closing paper, by Dr. E. H. Moore, was read before the American Mathematical Society at the Buffalo meeting of the summer of 1896, and is entitled "The Cross-ratio Group of n! Cremona Transformations of Order $n-3$ in Flat Space of $n-3$ Dimensions."

Bulletin of the American Mathematical Society, July.—Some remarks on tetrahedral geometry, by Dr. Timerding, is a paper read at the June meeting. Several properties of a tetrahedral complex are given, viz. the pole curves of such a complex of lines form again another such complex among the cubic space curves circumscribed about the fundamental tetrahedron, the complex curves of such a complex of lines form another tetrahedral complex, &c.—Prof. H. B. Newson's paper on singular transformations in real projective groups was read at the April meeting. It treats of transformations in real projective groups which can not be generated from the real infinitesimal transformations of certain continuous groups. The discussion, which is limited to one and two dimensions, can be readily extended to three and higher dimensions.—Miss Schottenfels, in a paper read at the June meeting, writes on groups of order 8!/2, and gives a simple proof of a correspondence established by Dr. Dickson (*Proc.* of London Math. Soc., vol xxx.).—Prof. F. S. Woods continues his notes on Lobachevsky's geometry.—Prof. Pierpont reviews H. Burkhardt's "Functionen-theoretische Vorlesungen" (vol. ii. "Elliptische Functionen").—A "correction," notes, new publications, list of papers read before the Society, with references to the places of their publication, and a full index, complete the sixth volume of the second series.

Annalen der Physik, No. 7.—Dispersion of electricity in air, by J. Elster and H. Geitel. Since the sun's rays contain ultra-violet light before they impinge upon the atmosphere, this light must ionise the upper strata, and the ions produced will be gradually distributed through the whole of the atmosphere by diffusion and convection. Hence the atmosphere will contain stray ions of both signs, but chiefly negative ones in the lower strata, owing to their superior mobility. The presence of these ions can be made evident by an electroscope.—Influence of slight impurities upon the spectrum of a gas, by P. Lewis. Very small quantities of hydrogen and nitrogen considerably affect the spectra of helium and argon, but the reverse is not the case.—Fluorescence and phosphorescence in the electric discharge through nitrogen, by P. Lewis. When nitrogen prepared from ammonium nitrate and sulphate, and purified over hot copper is pumped through an H-shaped vacuum tube, the whole wall of the tube shows a brilliant fluorescence lasting a few seconds, which extends for a length of about a yard into the supply and exhaust tubes. The light can be made permanent by keeping the pump at work and thus supplying a continuous stream of fresh nitrogen. Spectroscopic examination shows that the fluorescence is dependent upon the presence of a number of bands in the extreme ultra-violet, due to a combination of nitrogen with a trace of oxygen.—Production of very high notes by Galton's whistle, by M. T. Edelmann. The author gives tables for the pitches of pipes of various dimensions, and instructions how to test the pipes by Kundt's dust figures. He has succeeded in constructing a pipe of only 2 mm. diameter, which gives the enormously high pitch of 170,000 complete vibrations per second, or over two octaves beyond the extreme limit of audibility.—The magnetic force of the atoms, by R. Lang. Magnetism is accounted for by the revolutions of negative about positive electrons.—The air thermometer at high temperatures, by L. Holborn and A. Day. The authors further investigate the properties of the air thermometer consisting of a platinum-rhodium vessel filled with nitrogen, and compare its indications with that of a platinium-iridium thermo-couple, paying particular attention to the irregular expansion of the vessel. The corrected value for the melting point of gold is 1064·0° C.—Difference of temperature between the surface and the interior of a radiating body, by F. Kurlbaum. A method is given of determining this difference of temperature by means of two bolometers exposed symmetrically to different surfaces of the same black partition.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 14.—"Data for the Problem of Evolution in Man. V. On the Correlation between Duration of Life and the Number of Offspring." By Miss M. Beeton, G. U. Yule, and Karl Pearson, F.R.S., University College, London.

According to the Darwinian theory of evolution the members of a community less fitted to their environment are removed by death. But this process of natural selection could not permanently modify a race if the members thus removed were able before death to propagate their species in average numbers. It then becomes an important question to ascertain how far duration of life is related to fertility. In the case of many insects death can interfere only with their single chance of offspring; they live or not for their one breeding season only. A similar statement holds good with regard to annual and biennial plants. In such cases there might still be a correlation between duration of life and fertility, but it would be of the indirect character, which we actually find in a case of men and women living beyond sixty years of age—a long life means better physique, and better physique increased fertility. On the other hand, there is a direct correlation of fertility and duration of life in the case of those animals which generally survive a number of breeding seasons, and it is this correlation which we had at first in view when investigating the influence of duration of life on fertility in man. The discovery of the indirect factor in the correlation referred to above was therefore a point of much interest. For it seems to show that the physique fittest to survive is really the physique which is in itself (and independently of the duration of life) most fecund.

The data dealt with in this paper consists of four series, the first three collected and reduced by Miss M. Beeton, and the fourth series by Mr. G. U. Yule.

Mothers. Length of Life and Size of Family.

Series I.—Taken from the "Whitney Family of Connecticut," a well-known history of an American Quaker family.

Series II.—Taken from purely English Quaker records. The data for this series were drawn from a great variety of histories and records of the Society of Friends.

Fathers. Length of Life and Size of Family.

Series III.—The great bulk of the data was extracted from the American Whitney Family.

Series IV.—Extracted from Burke's "Landed Gentry."

The following are some of the chief results obtained from the reduction of these series:—

Table of General Results.

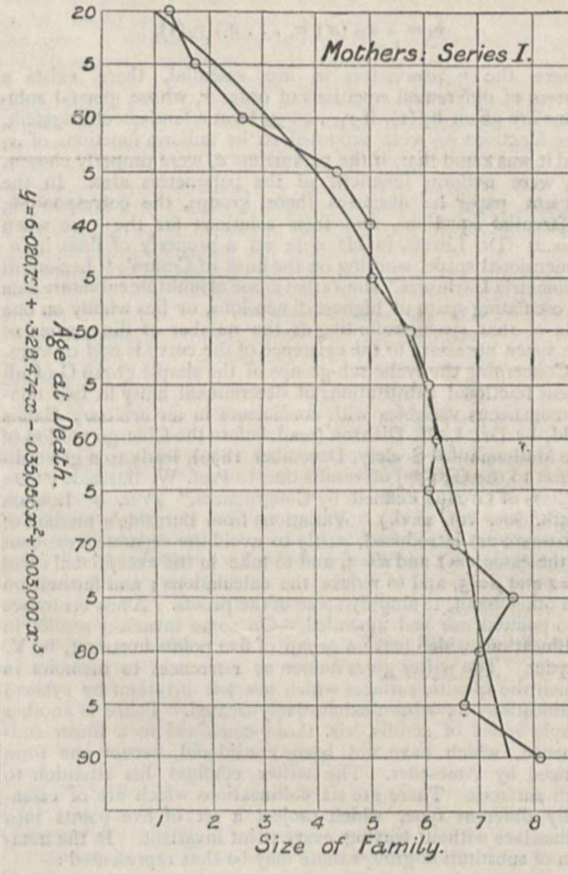
Series.	Parent.	Mean age at death.	Mean size of family.	Correlation fertility and duration of life.
I.	Mother	53·292	5·269	0·4943
II.	Mother	61·183	5·811	0·2340
III.	Father	58·086	5·469	0·4764
IV.	Father	63·577	5·336	0·2010

It is shown that the peculiar physique in both men and women which leads to longevity is also associated with greater fecundity. Of two women who both live beyond fifty years, the longer lived is likely to have had before fifty the larger family. The association is, however, much greater for American than English parents, although the American parents dealt with are, in the great majority of cases, of Anglo-Saxon race. Climate, mode of life, in general selection and environment, seem to be differentiating in this respect the English and the Anglo-American. The English Friends, we should suppose, would be as a class very comparable with the American Friends; yet their average life is longer, their fertility greater, and there is less association between longevity and fecundity. In both cases our algebraical formulæ show that American men and women are more alike, and English men and women are more alike than the women to the women or the men to the men of the two races. This is the more remarkable, as the English Friends as a class are by no means identical with the Landed Gentry.

In order to represent the *continuous* change in the regression, which cannot be done by two straight lines, which only enable us to distinguish the fecund and non-fecund periods of life, the statistics were fitted with cubical parabolas. The regression line at any age in life may then be looked upon as the tangent to the cubical parabola at that age. An inspection of the diagram given below for American mothers shows what an excellent expression such parabolas are for these statistics

For American mothers and fathers we see dy/dx consistently positive throughout life, and we have a most excellent graphical demonstration of the physical characters which tend to longevity being also associated with fecundity.

Weismann has suggested that it may be an advantage to a species that its duration of life should be shortened. This is not, *a priori*, confirmed by the case of a man in the American series: the longer the parents live, the greater the number of their offspring. But if we can lay any stress on a bend-in for the English mothers, and on a similar, but less marked, tendency for the English fathers, we might argue that reproductive selection was possibly in England working against extreme longevity, although favouring parents living till sixty-five or seventy. Indeed, those who rush rapidly to brilliant, but not



over-stable, conclusions might emphasise Weismann's views by showing how in an old community, with much greater pressure on the material resources, there is a tendency to reduce the fertility of the long-lived parents; while in a new community, with plenty of food and occupation for all, the longest-lived parents are the most fertile! However, all that we can safely say is that there is a marked difference between English and American parents, and that this distinguishing characteristic is almost equally visible if we take opposite sexes of such diverse classes as English Friends and English country gentlemen. We would leave to further investigations its true interpretation.

Admitting a substantial correlation between length of life and fertility, it is of great interest to investigate what effect, other things being equal, reproductive selection would have in modifying the duration of life.

The following table gives the mean length of life of parents taken singly and of parents weighted with their offspring :—

Mean Duration of Life of Parents in Years.

Series.	Unweighted parents.	Weighted parents.	Progression.
I.	53·292	59·920	6·628
II.	61·183	63·839	2·656
III.	58·086	63·082	4·996
IV.	63·577	65·510	1·930

Now these are substantial differences even in the case of the English parents, but they are very large differences in the case of the American parents. If we suppose no assortative mating on the basis of characters tending towards longevity, then it is easy to measure by a rough approximation the effect of reproductive selection in modifying the duration of life.

The increased duration of life would be about two years per generation from the American data, and about 9 to 9·5 months per generation from the English data.

The result for the American series shows us how an especially low expectation of life, due possibly in this case to some family character, will be rapidly raised by reproductive selection, if there be no opposing factor of evolution. The English results on the other hand show us a small, but sensible, tendency in reproductive selection to prolong the duration of life. Allowing three generations to a century, we might expect the duration of life to be raised about two years in a century by this factor of evolution.

A somewhat widespread view of evolution stops at the survival of the fitter without discussing the mode whereby the less fit leave no, or fewer, offspring than the fit. Of course, if the unfit are exterminated before adult life, there is no chance of their reproducing themselves. It has been shown in "Data for the Problem of Evolution in Man (II.)" that a selective death-rate exists for adults, so that the whole work of selection does not take place before the reproductive stage is reached. But Miss Beeton's data for the correlation of duration of life in the case of brethren dying as minors seem to show that the selective death-rate for children is rather less, not greater, than its value for adults.[1] Hence, for the reduction or extermination of stock unsuited to its environment, we should have to look largely to selection in the adult state. In the present paper we have made what we believe to be the first quantitative determination of how a selective mortality reduces the numbers of the offspring of the less fit relatively to the fitter. In the case of life under wild conditions, the correlation between fertility and power of surviving would probably be far greater. But for such life it is almost impossible to get statistics of this nature; we are thrown back upon measuring the effect in man, and thus obtaining what may well be considered as a minimum value of the influence under discussion.

In the course of our investigations we have found that the relationship between fertility and duration of life does not cease with the fecund period. We thus reach the important result that characters which build up a constitution fittest to survive are also characters which encourage its fertility. This result is of great value from the standpoint of the differentiation of type, where it is absolutely necessary that the fittest to survive should also be the most fertile. On the other hand, we note that duration of life is a character capable of modification by reproductive selection, and we suggest that a considerable part of the increased expectation of life observed in recent years may be due to this cause. In the case of the American statistics, we see at once how reproductive selection can replace a remarkably short-lived stock by a longer-lived stock, for the bulk of the offspring come from the longer-lived members.

PARIS.

Academy of Sciences, July 30.—M. Maurice Lévy in the chair.—On the observatory at Mount Etna, by M. J. Janssen. Remarks on local difficulties due to climatic disturbances and to the peculiar situation of the observatory.—New processes of vaccination against symptomatic carbuncle of the ox by means of preventive serum in association with vaccines, by M. S. Arloing. A continuation of former experiments on the subject.—On the age of the sea-shore sands of Dunkirk, by M. J. Gosselet. The formation of these deposits is considered to have commenced since the fourth or fifth centuries.—M. Duhem was elected a corresponding member for the section of mechanics.—Observations of Borrelly's comet (July 23, 1900) at the Paris Observatory, by M. G. Bigourdan.—Provisional elements and ephemerides of the Borrelly-Brooks' comet (July 23, 1900), calculated by M. G. Fayet.—On the spectral images of the chromosphere and protuberances obtained with the prismatic chamber, by M. Georges Meslin. A description of the results obtained with the apparatus previously described.—On two surfaces related to every Weingarten's surface, by M. A. Demoulin.—On artificial radio-active barium, by M. A. Debierne. Many substances become radio-active when brought into intimate contact, by solution or simultaneous precipitation, with radio-active compounds. Artificial radio-active barium chloride, intermediate in character between barium and radium, has thus been obtained.—On the thermo-electricity of steels, by M. G. Belloc. A comparative study of the thermo-electric properties of soft iron, soft steel, and hard steel.—On a means of weakening the influence of industrial electric currents on the terrestrial field in magnetic observatories, by M. Th. Moureaux. An account of the methods whereby the disturbances caused by electric tramways in the neighbourhood of observatories may be removed or corrected for.—On the electrolysis of concentrated solutions of hypochlorites, by M. André Brochet. The electrolysis of hypochlorite resembles, in its later stages, that of alkaline chloride solutions, and tends towards the same limits. There is, therefore, little hope of obtaining concentrated solutions of hypochlorites by the direct electrolysis of chlorides.—On gadolinium, by M. Eug. Demarçay. A study of the spectrum of gadolinium.—On diphenylcarbazide as a sensitive reagent for some metallic compounds, by M. P. Cazeneuve. The conversion of diphenylcarbazide into diphenylcarbazone by the action of salts of copper and mercury and the persalts of iron, as recently described, furnishes a delicate test for these metals. The latter unite with the carbazone to form coloured compounds.—Preliminary study of the chemism of the encephalon, by M. N. Alberto Barbieri. Experiments on the chemical changes occurring in the brain of animals when left for twelve to eighteen hours at a temperature of 45°.—On the dissolution of the nitrogenous constituents of malt, by MM. P. Petit and G. Labourasse. Experiments relating to the existence of a proteolytic enzyme in malt.—Action of the liquid from the external prostate of the hedgehog on the liquid of the seminal vesicles; nature of this action, by MM. L. Camus and E. Gley.—On some properties and reactions of the liquid from the internal prostate of the hedgehog, by MM. L. Camus and E. Gley. This and the previous paper form a continuation of the authors' researches on the coagulation of the secretion of the seminal vesicles by that of the external prostate, or Cooper's gland, and the coagulation of the latter secretion by that of the internal prostate.—On some Alpheidæ of the American coasts, by M. H. Coutière. An account of some specimens in the collection at the United States National Museum, Washington.

August 6.—M. Maurice Lévy in the chair.—The menstrual function and rut in animals. Function of arsenic in the economy, by M. Armand Gautier. The author has found that the quantities of arsenic and iodine, which in normal blood are hardly estimable, are largely increased during menstruation, the total amount of arsenic eliminated during one period of menstruation representing the whole amount usually present in the thyroid gland. The arsenic and iodine which accumulate in the thyroid gland are eliminated in the male by the hair and nails, and by epithelial desquamation. In the female, this excess is either eliminated by the genital organs or utilised by the growing fœtus.—Observations of the star Capella, considered as a double star, made at the Greenwich Observatory, by Mr. W. H. M. Christie. The independent discovery by Campbell and Newall, by spectroscopic observations, that Capella is a double star, has been confirmed by direct observation with the large Greenwich equatorial. The star appears distinctly elongated in one direction, the distance of the two components being estimated at 0·1 second. Observations of the direction of this elongation, taken between April 4 and July 20, confirm

[1] The point is still under investigation.

the period of revolution deduced spectroscopically by Newall.—The comet (1900 *b*) discovered July 23 at the Observatory of Marseilles, by M. Borrelly. The comet is visible to the naked eye as a star of 6th to 7th magnitude.—Observations of the comet 1900 *b* (Borrelly-Brooks) made at the Observatory of Besançon, by MM. A. Sallet and P. Chofardet.—Observations of the Borrelly-Brooks comet, made at the Toulouse Observatory with the 25 cm. equatorial, by M. F. Rossard.—On circuits formed uniquely by electrolytes, by MM. Camichel and Swyngedauw. From the experiments described with circuits consisting wholly of liquid electrolytes, the authors conclude that an electrolyte may be traversed by a current without decomposition.—On the coupling up of alternators from the point of view of the harmonics, and of the effect of synchronised motors, by M. A. Perot.—On the boiling points of zinc and cadmium, by M. Daniel Berthelot. The metals were boiled in an electric furnace specially constructed to avoid the errors due to superheating and radiation from the walls, the temperature being measured by the interference refractometer method previously described by the author. Zinc boiled at 920°, and cadmium at 778°.—On the atomic weight of radiferous barium, by Mme. Curie. First attempts at determining the atomic weight of the metal in radiferous barium chloride gave 146 as against 138 for pure barium chloride. As the result of prolonged fractionations, a product has now been obtained in which the atomic weight is as high as 174. This, however, is certainly too low, as the chloride analysed still contains an unknown amount of barium.—On the electrolytic estimation of cadmium, by M. Dmitry Balachowsky. The metal is deposited upon a dish previously covered with copper. The solution is slightly acidified with nitric acid, and the deposition carried out at 60° under conditions of electromotive force and current density specified.—On some new spectra of rare earths, by M. Eug. Demarçay.—On the blue oxide of molybdenum, by M. Marcel Guichard. The hydrated blue oxide of molybdenum has been isolated in a pure state and analysed, and proved to have the composition $MoO_2.4MoO_3,6H_2O$.—On the normal proportions of iodine in the organism, and its elimination, by M. P. Bourcet. The author, in conjunction with M. Gley, having previously shown the presence of a trace of iodine in normal blood, has now determined the amount of this element in various parts of the body. The quantities found vary from 0·00 mgr. in fat, pancreas and bladder, to 0·18 mgr. per 100 grams of liver and 1·8 mgr. per 100 grams of hair. The quantities found are small compared to the amount present in the thyroid gland. About 0·33 mgr. of iodine is taken into the human system daily in food; the thyroid gland contains only about 4 mgr.; hence it becomes necessary to discover the means of elimination. This is shown to be chiefly effected in man by the skin and epidermal products, sweat, skin, hair and nails; in women, by the menstrual blood, which contains 0·8 to 0·9 mgr. of iodine per kilogram, as against 0·02 mgr. per kilogram in normal blood.—On the nitrogenous substances in malt, by MM. P. Petit and G. Labourasse.—On the origin of the secondary calcareous breccia of Ariege, and results drawn from the point of view of the age of the lherzolite, by M. A. Lacroix.—On some temperatures observed in the park of St. Maur, by M. E. Renou.

NEW SOUTH WALES.

Royal Society, June 6.—The President, Prof. Liversidge, F.R.S., in the chair.—On the relation, in determining the volumes of solids, whose parallel transverse sections are n^{ic} functions of their position on the axis, between the position and coefficients of the section and the (positive) indices of the function, by G. H. Knibbs.—On the amyl ester of eudesmic acid occurring in eucalyptus oils, by Henry G. Smith. In a paper read before this society, July 1898, on the stringy-bark trees of New South Wales, R. T. Baker and the author show that an ester was present in the oil of *Eucalyptus macrorhyncha*. Since then esters have been found to be present in several eucalyptus oils. The author shows that esters are present in fair amount in the oils of *E. botryoides*, *E. Saligna*, and *E. rostrata*, and that an aromatic alcohol, either linalool or geraniol, is present in the oil of *E. patentinervis*, over 16 per cent. of free alcohol being proved. The saponified oil of *E. patentinervis* has a fine odour. Citral also occurs in this oil, proved by its characteristic reactions.—Note on a new meteorite from New South Wales, by R. T. Baker. The meteorite described in this paper was found early in January of this year, two miles from Bugaldi, a postal town fifteen miles north-west of Coonabarabran. It is pear-shaped and is nearly five inches long and three inches wide at the broadest part. It belongs to that class of meteorites known as siderites, and is probably composed of iron and nickel. It has a well-defined, closely adhering "skin" of black magnetic material, while the metal immediately beneath this coating is silvery-white in appearance. On the smooth portion at the extremity of the larger end can be seen very distinctly Widmanstatten's figures. The specimen has an exceedingly new appearance, as if it had only just arrived upon the earth, and shows no signs of oxidation.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), Part i. for 1900, contains the following memoirs communicated to the Society.

February 3.—L. Krüger: Compensation of errors by means of equations of condition in geodetic determinations of points.

March 3.—E. Marx: Fall of potential and dissociation in flame-gases.—W. Nernst: On the question of the hydratation of dissolved substances, Part 1.—H. Lotmar: The same, Part 2.—C. C. Garrard and E. Oppermann: The same, Part 3.—H. Minkowski: Theory of the units in algebraic *Zahlkörper*.

March 16.—W. F. Osgood: On a theorem of Schönflies relating to the theory of the functions of two real variables.—F. Bernstein: On the same theorem.—H. E. Timerding: On linear systems of conics.

Among the official reports of the Society are one (by Prof. F. Klein) on the publication of Gauss's works; and one on the progress of the Encyclopædia of Mathematics.

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