THURSDAY, DECEMBER 8, 1904.

## THE MILLAIS BRITISH MAMMALS.

*The Mammals of Great Britain and Ireland.* By J. G. Millais. Vol. i. Pp. xx+363; illustrated. (London: Longmans, Green and Co., 1904.) Price 6 guineas net.

IN two important features this magnificent work, of which the first volume is now before us, may lay claim to special preeminence. First, the illustrations, alike in number, size, truthfulness to nature, and artistic excellence, are unrivalled; and secondly, as regards the main and most important part of the subject, namely, the habits and local distribution of the various species, the work is in no sense a compilation, but the result of long and patient personal observation on the part of the author. Indeed, the only matter for regret connected with the work is that its price puts it out of the reach of a large percentage of field naturalists; bearing in mind, however, the style in which it is got up and the wealth of illustration, it is difficult to see how it could have been offered to the public at an appreciably lower figure.

As an author of a work like the present, Mr. Millais has one incomparable advantage over the great majority—if not, indeed, over all—of his fellow-naturalists in this country, namely, that he is a great painter. In this double capacity of artist and naturalist he is consequently able to present the public not only with exquisite artistic pictures of the animals he describes, but also with portraits which emphasise and bring into prominence their special generic and specific characteristics. It is, indeed, this judicious blending of the artistic with the zoological aspect that confers on the coloured illustrations in this work such peculiar value. Too often in paintings of this description we find either zoological details more or less completely sacrificed to artistic effect or the former brought into undue prominence to the destruction of all that is really artistic and pleasing. In hitting off the happy medium between these extremes, Mr. Millais and the other two artists who have assisted in the work have been remarkably successful. In addition to the coloured pictures, there are a number of sketches, and in some cases photographs, showing the various animals in characteristic attitudes, in pursuit of their prey, &c., which illustrate their natural history almost without the necessity for letter-press. Nor is this all, for there are several sketches illustrative of the mammalian life of our island in prehistoric times; and although some of the details of form and colour assigned to certain of the extinct forms may be open to criticism, these certainly convey a good idea of the richness of this fauna as compared with that of the present day. No illustrations are given in the text of either skulls or teeth, which is perhaps somewhat to be regretted, as the latter receive mention in the text.

As regards the amount of time and labour the author has devoted to the work, it may be mentioned that, according to a statement in the preface, he made four successive expeditions, during as many years, in order to acquire a full knowledge of the grey seal alone, and that the best part of five years has been spent on the task in general.

The present volume contains the preface and introduction to the entire work, together with the text and illustrations relating to the orders Chiroptera, Insectivora, and Carnivora exclusive of the Mustelidæ. The relegation of the latter to the second volume is rather a pity, as it involves the intercalation of the seals and walruses between the bears and the weasels, which somewhat mars the systematic arrangement. The author states, however, that he found it impossible to complete his account of the Mustelidæ in time for it to come in its proper place.

In his introduction the author takes a cursory survey of the history of the British Islands during the prehistoric and later Tertiary periods, and as he is not a professed palæontologist he may perhaps be allowed a little license here, especially as it does not affect the general subject of the work. The statement as to the occurrence of ungulates in the Cretaceous (perhaps due to the author having been misled by a certain South American writer) is, however, open to exception, while the alleged first appearance of marsupials and Insectivora at the same time is perhaps an error in the opposite direction. The assertion that many types of mammals have been but little altered since the (Lower) Eocene might also be modified.

While on the subject of errors, it may be mentioned that the author (and quite justifiably) is very much "down" on other writers on British mammals for their various sins of omission and commission—whether trivial or otherwise. He must therefore take it in good part if similar slips of his own are brought to notice. For example, we fancy Sir Archibald Geikie will feel somewhat surprised to find himself described as a distinguished palæontologist and zoologist. Again, the initials of Dr. Smith Woodward are not A. B., neither is Dr. R. Ball (p. 238) the designation of the late director of the Dublin Museum, while Hermann, and not Herman, is the proper designation of the author of the name *Sorex vulgaris* (p. 141). Lack of classical knowledge seems to be implied in the translation of Chiroptera as "hand-bearers" (p. 12). More serious is the discrepancy between the number of teeth in Rhinolophus as given in the text (p. 23) and in the formula (p. 24), while another error of the same nature occurs on p. 143, where the number of premolars in the shrew is given as 2/4 instead of 4/2. Exception may also be taken to the statement (p. 230) that bears, as a whole, are a more primitive type than dogs, and the fact that the plate of the walrus is lettered *Trichechus rosmarus* while the creature is described in the text as *Odobaenus rosmarus* is another instance of want of care.

Reverting to the merits of the volume before us, attention may be directed to the value of the work accomplished by Mr. Millais in regard to the bats. Although the distinctive features of the various British representatives of the group can be gleaned by a careful study of technical treatises, the nature of the illustrations given in previous works on British mammals rendered it very hard for the amateur (to say

nothing of the professed) naturalist to identify such specimens as might come under observation. All such difficulties vanish with Mr. Millais's life-sized coloured figures as a standard for comparison, the distinctive features of each species being brought clearly before the reader both in the text and in the plates. Much important work has also been done with regard to the local distribution of several of the species, notably as to the occurrence of the lesser horseshoe bat and the noctule in Wales. Whether Mr. Millais has been well advised, at all events in a work of this nature, in generically separating the noctule and Leisler's bat from the pipistrelle may, however, be open to question. Moreover, seeing that the author refuses to admit "*Myotis myotis*" into the British list, the propriety of assigning a separate heading to this species may perhaps likewise be doubtful.

Among the Carnivora, the account of the wild cat is of special interest, largely owing to the fact that the author does not endorse the views of the late Dr. Hamilton as to the practical extermination of this species in the British Islands. Not that it is anywhere common, even in the wilder parts of Scotland, where in many districts it has long since been killed off. At the present day, owing to a special cause, west Ross-shire appears to be its main stronghold. As to the extermination of the wolf and the bear from our islands, the author has much to say—and all that he says is worth reading. Very interesting, too, is his account of two distinct types of the fox in Scotland, namely, a dark and grey form in the mountains, and a smaller red or pale form in the lowlands. Apparently, however, he does not allude to the "greyhound fox" of the Lake District, which Cumberland sportsmen insist is entitled to be regarded as a distinct local race.

The most original and therefore the most valuable part of the section on the Carnivora is that relating to the British seals, of the characteristics and habits of which Mr. Millais has made himself thoroughly master as the result of personal observation in their native haunts; and no longer will naturalists find any difficulty in distinguishing between the common and the grey seal at all ages. Special interest attaches to the recognition of four distinct colour-phases in the adult male of the grey seal, although, since every intermediate stage between these may occur, and they are found together, they cannot be regarded as local races. Even more interesting is the statement that the young hooded seal is not, as commonly reported, white, but of the same mottled colour as the adult. It is, however, to be wished that the author had given the full reasons for this assertion.

The author has expressed the hope that his work may be found a fitting companion, as regards illustration, to Lord Lilford's volumes on British birds. So far as he has gone at present, he may be congratulated on having attained his ambition, and there is every reason to expect that the second and third volumes will be fully equal in this respect to the one before us. For many years this splendid work will probably remain one of the standard authorities on British mammals, and in the matter of illustration it will most likely be always without a rival. R. L.

## FIRE RISKS.

*Fire and Explosion Risks.* By Dr. von Schwartz. Translated by C. T. C. Salter. Pp. xxi+357. (London: Charles Griffin and Co., Ltd., 1904.) Price 16*s.* net.

IN estimating the risks of fire due to the storage of goods of varying descriptions, the insurance companies are met by the difficulty that the knowledge necessary to gauge the comparative safety or otherwise of the materials present is of so technical a nature that but few possess it, and in many cases substances of apparently the most innocuous character become active sources of danger under conditions likely to escape the notice of any but those who have made a special study of the subject. As a result risks are often taken at far too low a premium, whilst the distrust born of the loss incurred afterwards leads to excessive charges in utterly wrong directions, very few insurance offices being fortunate enough to possess inspectors or assessors with the necessary knowledge to safely guide them in the adjustment of their scale of fees.

In Germany several works by such authorities as Dr. Richter, Prof. Hapke, and Dr. von Schwartz lend valuable aid to the scientific side of the question, but in England, with the exception of some valuable little works compiled by Mr. W. A. Harris, the able secretary to the Phœnix Fire Office in Liverpool, the literature of the subject has been entirely neglected, although the fact that on an average 10,000,000*l.* is annually paid by British fire insurance companies on fire claims alone, whilst the loss probably is nearly double this amount, suggests that the subject is well worth the deepest consideration.

Under these conditions it is a matter for congratulation that Mr. C. T. C. Salter has now given us an excellent translation of Dr. von Schwartz's valuable book on "Fire and Explosion Risks," a handbook which deals in a thoroughly practical way with the investigation, detection, and prevention of dangers arising in the manufacture and storage of the most widely used chemico-technical substances.

The author has had a very wide experience as a consulting chemist and factory inspector, and has brought his almost unique experience in manufacturing methods to bear upon the various risks which they entail, with the result that he has produced a work in which practice is so blended with theory as to make the book of the utmost value, not only to chemists, but also to those who, without much chemical knowledge, yet wish to master the mysteries of a very intricate branch of technical application.

In dealing with the various substances the raw material is fully described in each case, its origin, physical character, and behaviour under all conditions is freely discussed, whilst cautions and suggestions for the safe manipulation and storage of each are clearly stated.

The arrangement by sections of those bodies likely to react on each other is particularly useful, and the works chemist and insurance surveyor can find the information he seeks in relation to the particular class of goods with the minimum of trouble.

Taking the book as a whole, the reader's interest is fully sustained, and although one finds instances of duplication of cautions, this is evidently the result of the sectional arrangement and so unavoidable.

In so excellent a work detailed criticism is a somewhat thankless task, but it might be suggested that in discussing the risks attendant on the use of petroleum lamps, some notice might be taken of the views of Sir James Dewar, Dr. Boverton Redwood, and the late Sir Frederick Abel, as to increase of the flash point not being so complete a solution of the trouble as the author leads one to believe.

It might be well to note in a future edition that barium peroxide, which on p. 117 is said to become dangerous at 800° C., may also give rise to fire at atmospheric temperatures when exposed to friction with organic matter.

On p. 187 it is stated that one pound of calcium carbide furnishes 4 to 4½ cubic feet of acetylene, which is perfectly true of the inferior carbide made on the Continent, but with material of the quality until recently made at Foyers the yield rarely fell below 5 cubic feet per pound.

Occasionally one finds slight discrepancies in the statement of temperatures in different parts of the book, the temperature at which lead fuses being given at p. 291 as 325° C., whilst in the appendix, p. 343, it is stated to be 334° C. Such details as these, however, detract but little from the value of a book which is an important and most valuable addition to the technical literature of the day.

## THE DETERMINATION OF MINERALS.

*Mineral Tables—for the Identification of Minerals by their Physical Properties.* By Arthur S. Eakle, Ph.D. Pp. 73. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1904.) Price 5*s.* 6*d.* net.

STUDENTS of mineralogy, miners, prospectors, and others interested in the determination of minerals by methods which do not involve the use of elaborate apparatus, will find this little book a useful addition to the literature of the subject.

The tables, though forming a volume of only 73 pages, include nearly 250 minerals, comprising all the commonly occurring ores, veinstones, and rock-formers, as well as a few species of more restricted occurrence. They are designed for the identification of unknown minerals by the examination of their physical properties alone; blowpipe reactions are not employed at all in the scheme. It is claimed by the author that the determination of minerals by blowpipe analysis is less apt to become merely mechanical if it has been preceded by practice in identification by physical properties. This is no doubt true; and if, as is often the case, the beginner is tempted to rely upon blowpipe analysis alone, that intimate acquaintance with minerals which is only gained as the result of the systematic observation of their physical properties, and which is so valuable for their ready recognition in the field, is either missed entirely or is only very imperfectly acquired. Indeed, in most cases blowpipe reactions are best employed by the determinative mineralogist in confirming conclusions already arrived at from the evidence of physical properties. They are, however, so invaluable for this purpose, and afford such an indispensable aid to identification by physical properties, that any determinative scheme from which they are entirely excluded must be in a sense deficient. The author would have greatly added to the value of the tables by including for each species a brief statement of its distinctive blowpipe reactions, and we venture to suggest this extension of the scope of the work to him for future editions.

As in all tables of this kind, the identification of an unknown mineral is effected by a process of elimination. The minerals dealt with in the book are first divided into categories according to their colour in the powdered condition; these groups are then subdivided into minor groups according to the colour of the mineral in mass; and finally, the species in each of these divisions are arranged in order of hardness.

In general plan the tables are similar to those of Weisbach; but they differ from them in certain respects, notably in their greater simplicity, and in the abandonment of that indefinite and unsatisfactory property lustre, as an important means of discrimination. The tables are preceded by an "analytical key," by reference to which it is possible, after preliminary observations of streak and colour, to see at a glance in which table the mineral under examination will be found; it is then only necessary to determine the hardness and one or two other characters, such as crystalline form, structure, cleavage, specific gravity, and so forth—all of which are described in columnar form in the tables—to complete the identification.

The omission of the great majority of those rare minerals which the ordinary student or prospector is scarcely likely to meet with, and which by their insertion render so many books of this kind dear and unnecessarily complicated, is to be commended. The tables are certainly to be regarded as among the most satisfactory that have yet appeared.

## OUR BOOK SHELF.

*Die Sinnesorgane der Pflanzen.* By G. Haberlandt. Pp. 46. (Leipzig: Barth, 1904.) Price 1 mark.

THIS little book, which is appropriately dedicated to the memory of Darwin, was given as a lecture before the recent Versammlung deutscher Naturforscher und Aertzte at Breslau. The author devotes the chief part of his space to a semi-popular account of the various types of structures, such as bristles, hairs, papillæ, which serve for the perception of mechanical stimulus. This is necessarily, to a large extent, a recapitulation of his own interesting work on the subject, and is followed by an account of the *statolith* theory—the hypothesis independently put forward by himself and Němec as explaining the sensitiveness of plants to the force of gravity. The most interesting part of the lecture is, however, Haberlandt's concise discussion of his recent theory of the mechanism by which the direction of incident light is perceived by plants. He believes that the epidermic cells are, so to speak, the eyes of the plant. Thus, according to his view, when light strikes a leaf at right angles to the surface it results, from the plano-convex form of the epidermic cells, that the inner wall of each cell is illuminated

more brightly in the centre than at the periphery. This makes it possible for the leaf to orientate itself in regard to light. Thus, suppose the plant to be moved so that the light now strikes the leaf obliquely, the bright patches of light on the inner cell walls will no longer be central. This change may be believed to constitute a stimulus calling forth a curvature of the leaf stalk by which the leaf is brought again to its normal position at right angles to the incident light. Thus the leaf moves when the bright patch is not central, and comes to rest when each of its epidermic cells is centrally illuminated. This attractive theory cannot be said to be as yet established, and botanists will look with interest to its further development by its author. The appendix of six pages is devoted to the literature of the subject and to short discussions of points which probably seemed too technical for the text of the lecture.

*Electricity in the Service of Man.* By R. M. Walmsley. Pp. viii+1208. (London: Cassell and Co., Ltd., 1904.) Price 10*s.* 6*d.* net.

WHEN the first edition of this book was published in 1888, it was doubtless a comparatively easy matter to write a treatise covering all the practical applications of electricity to the service of man. As each successive edition appeared the task must have become one of increasing difficulty, and now that the fourth has been reached Dr. Walmsley no longer finds it possible to condense all his material into one volume. He has therefore wisely confined himself to certain branches, and left the others for treatment in a supplementary volume. The book before us is divided into two parts, the first being more or less theoretical, dealing with the principles, and incidentally with the history, of the subject, and the second dealing with the technology of electricity. The first part is clearly written, and forms a good introduction to the study of electricity and magnetism which should be valuable to the beginner or to the amateur interested in scientific progress. The second part is confined in the present volume to generators and motors, with a chapter on measurements. The writer is of opinion that these more advanced subjects are best studied by means of the many very excellent treatises specially devoted to them; but still, there can be no doubt that a general review such as the one before us appeals to a large class of readers and serves a useful purpose. The book is plentifully illustrated with drawings and diagrams, which are for the most part good, though several, especially in the earlier part, are rather crude and out of date. M. S.

*The Flora of the Presidency of Bombay.* By T. Cooke. Vol. ii. Part i. Compositæ to Boraginaceæ. Pp. 216. (London: Taylor and Francis, 1904.) Price 9*s.*

THIS volume begins in the middle of the series *inferae* belonging to the gamopetalous division. The indigenous species of Compositæ are numerous, but for the most part are not so important as the introduced composites, of which a list is given. In the series *heteromerae* the cohort Ericales is unrepresented, but the orders Myrsineæ, Sapotaceæ, and Ebenaceæ include several interesting genera. Under Bassia Dr. Cooke explains how the synonym Illipe has been erroneously introduced. Illipe is the Tamil name for *Bassia longifolia*, and is applied commercially to the fatty product obtained from the fruit; this species replaces in southern India the better known mahua tree, *Bassia latifolia*, of which the flowers furnish a favourite food, also a spirit to the natives of Central India. The province is rich in species of Diospyros, amongst them *ebenum*, *melanoxylon*, the calamander-like *oocarpa*, and *crumenata*. The author agrees with Hiern in uniting *D. ebenum* and *D. assimilis*, but separates *D. cordifolia* and *D. montana*. The Apocynaceæ include *Cerbera Odollam* of the salt marshes, an endemic Beaumontia, and a species, also endemic, of Ervatamia, a genus cut off by Dr. Stapf from the original genus Tabernæmontana. Another dominant order is that of the Asclepiadaceæ, which furnishes mostly twining shrubs or climbers, and of which a good many, as, for instance, the four species of Hoya, and seven species of Ceropegia, are confined to the western side of the peninsula. This part gives every indication of the same care and accuracy which distinguished the first volume.

*Quadratic Partitions.* By Lieut.-Colonel Allan Cunningham, R.E. Pp. xxiv+266. (London: F. Hodgson, 1904.) Price 12*s.* net.

THIS contains a complete list of primes $p$ up to 99991, with the factors of $p-1$, and resolutions of

$$p=a^2+b^2=c^2+2d^2=A^2+3B^2=\tfrac{1}{4}(L^2+27M^2);$$

of $p=e^2-2f^2$ up to $p=24977$; together with other resolutions of the type $mp=x^2\pm Dy^2$ for selected values of $m$, D, and all primes $p$ up to a certain limit. Besides this, there are tables relating to the Pellian equation, and others directly connected therewith. The introduction explains the nature and use of the tables, and gives an account of their preparation. Though some of the contents have already been published (as explained in the introduction), a substantial part appears for the first time in print; the whole forms a varied as well as extensive series of arithmetical records which will be found of great value by those who are interested in the theory of numbers, especially in connection with the theory of residues and of quadratic forms. Great care has been taken to ensure accuracy, and the appendix contains lists of errata detected in various preceding tables. The new part of the work represents a very large amount of labour, which is henceforth spared to those in search of material for induction, and the grants made by the Royal Society towards the expenses of computation and publication have been worthily bestowed. It may be added that the paper and type used are satisfactory; in the case of tables this is a matter of real importance. All serious students of the theory of numbers ought to procure this work, as well as Lieut.-Colonel Cunningham's "Binary Canon," for, independently of their use in solving special problems, these tables may suggest or confirm new theorems of real importance.

*Advanced Hand-camera Work.* By Walter Kilbey. Pp. xvii+98. (London: Dawbarn and Ward, Ltd., 1904.) Price 1*s.* net.

IN this series of photographic books already published the present author is responsible for the popular volume on "Hand Colour Photography," which is now in its second edition. In the issue before us he deals with the higher flights of hand-camera work, more especially in connection with its use with the focal plane shutter. The subject-matter treats of the selection of apparatus, the behaviour and efficiency of the focal plane shutter, and practical work with the camera, the last mentioned consisting of hints on focusing, exposing, and the treatment of moving objects. No less important are the subjects of the last two chapters, which concern the plates and developers suitable for such work, and the employment of hand cameras in telephoto, stereoscopic, and orthochromatic photography. A great number of excellent and appropriate illustrations from the author's own negatives accompany the text.

The easy and clear style of the author, and his thorough acquaintance with the subject he is treating, render the book not only delightful to read, but a valuable guide to those who wish to work successfully with hand cameras.

## LETTERS TO THE EDITOR.

*[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.]*

### The Definition of Entropy.

THERE is, I fear, a difficulty in drafting Prof. Bryan's definition so as to be clear as well as accurate. This arises when the definition is first given with reference to the entropy of the working substance, because the non-available energy is not necessarily a portion of the energy of the substance. The terms available energy, free energy, bound energy, and non-available energy are continually used loosely in thermodynamics as if they referred to portions of the energy of the working substance. I know from experience the difficulty of defining the entropy of the working substance in terms of dissipation or degradation, without reference to the state of things outside the substance, and in a paper on the factors of heat I adopted the notion of reduction of "transfer credit," so that increase of entropy went with lessening of capacity for transforming heat into work with change of volume. In my book on "Entropy" the whole treatment is essentially from the dissipation or degradation point of view, but entropy is first defined in connection with the irreversible increase of entropy in an isolated system. It is thus defined: "Increase of entropy is a quantity which, when multiplied by the lowest available temperature, gives the incurred waste."

May I say that I am exceedingly glad to find Prof. Bryan treating the subject from the same point of view, as it is strong evidence that my treatment is essentially right.

41 Palace Court, W. J. SWINBURNE.

MR. SWINBURNE has directed attention to an obscure point in my letter of November 10 which is calculated to produce quite the contrary impression to what I intended. In defining available energy relative to a given temperature, it was not my intention to exclude work that the system was capable of producing by expansion or otherwise without using the reversible engines, and instead of "maximum amount of energy" I meant maximum amount of *work*. By work I refer to ordinary mechanical energy as opposed to what Mr. Swinburne calls "waste energy." The point to which I wished to direct attention was the desirability of basing a definition of entropy on non-available energy, and the use of the term "relative" in this connection, or at least some equivalent language (as implied in my words, "The definition may be stated *somewhat* as follows").

So far as I am able to judge, both from Mr. Swinburne's book and from some correspondence with the author, it would appear that the conclusions to which I am being led by independent working in regard to entropy agree closely in many substantial points with those at which he has arrived. Since the controversy referred to there have been one or two papers published on the subject by other writers with which I altogether disagree. G. H. BRYAN.

### Craniology of Man and the Anthropoid Apes.

IN reading Mr. Macnamara's Hunterian oration of February, 1901, I find these words:—

"Prof. Deniker in his work on the embryology and development of the anthropoid apes has shown that *in consequence of the early closure* of the anterior sutures of the skull of these animals the fore part of their brain does not increase beyond the size it had attained at the end of the first year of life; but in man these sutures do not consolidate until a much later period, so that the anterior lobes of his brain are enabled to expand, and actually become far more perfectly developed than the corresponding lobes among anthropoid apes."

This being so, I ask:—

(1) Has the experiment ever been tried of keeping the sutures of an infant ape open by artificial means? And if it has,

(2) Has the brain been found to expand and become more perfectly developed?

For if so we should expect the ape to manifest an intelligence not far short of that of a man. A. T. MUNDY.

IN answer to Mr. A. T. Mundy's questions, it seems to me that it would be impossible in a young living ape, by artificial means, to prevent his frontal suture from closing, and if we could succeed in keeping it open I question if any marked increase in the size of the animal's frontal lobes would augment his intellectual capacity. It is not only the great size of man's cerebrum as compared with that possessed by anthropoid apes which gives him greater intellectual power, but, as I have stated in the passage quoted by Mr. Mundy from my Hunterian oration, the frontal and parietal lobes of the human brain are "far more perfectly developed than the corresponding lobes among anthropoid apes." This is especially the case with respect to those motor and psychical areas of man's cerebral convolutions which control his power of intelligent speech; these areas of the brain are deficient in the anthropoid apes. It is probable that man's ability to make use of articulate language, and through this means to think, has led to the great development of the psychical elements of his brain. A comparison of the size and conformation of the cranium of Tertiary man with that of existing Englishmen is an indication of the length of time it has taken for the human cerebrum, and therefore intellect, to reach its present stage of evolution. Man and anthropoid apes we hold to be derived from a common ancestral stock; the former, under the action of natural selection and other causes, including, I think, not only an inherent capacity of cerebral but also of cranial growth, have gradually developed, whereas anthropoid apes, from arrest of cranial and cerebral growth, have not reached the standard attained by human beings; the difference between these two orders of beings, however, is one of degree, and not of kind. N. C. MACNAMARA.

November 26.

### Pinnipedia a Sub-order of Cetacea!

ONE is so much accustomed to encounter strange assertions in regard to zoology in the non-scientific Press that one takes little notice of them; but when one reads under the head of "Science," as may be read in this day's *Athenaeum* (p. 767), a reviewer of Mr. Millais's "Mammals of Great Britain and Ireland" complaining of that work that "Nowhere is it stated, as it should be, that the Sub-order Pinnipedia belongs to the order Cetacea," one is tempted to ask to what end have writers on classification laboured, if such an assertion as this is to pass unchallenged? If, by a slip of the pen, "Cetacea" was written for "Carnivora," one can sympathise with the reviewer, for all are liable to such unhappy accidents; but the general drift of his remarks seems to forbid that charitable construction, for in the preceding paragraph it is expressly stated that the Carnivora, except the Mustelidæ, are dealt with in the volume. F. Z. S.

December 3.

### The Late Mr. Assheton Smith.

THE man of ample means, and who is a lover of living creatures, has a great opportunity. Mr. Assheton Smith had this opportunity, and he used it not only to gratify his own pleasure, but to share it with others. There was nothing that he liked better than to go the round of his park with a guest, and to point out and discuss the characters and habits of the animals which he had gathered together from various quarters of the globe. With the late squire such a ramble was no ordinary treat. One felt, too, that in this man the beasts had a true friend, that he had studied them and knew their ways, and that he would do his utmost to make their lot as happy as possible. To such a man science owes a great debt. Not only does he afford the student an opportunity of studying animals in favourable circumstances, but he is able to place material at the disposal of the laboratory and museum when these animals have paid nature's last demand. For a number of years I have had the good fortune to act, as it were, as prosector to his menagerie, and both my students and I have been able to carry out not a few studies in comparative anatomy. Sometimes, playfully, he would accuse me of possessing the "evil eye," as he said that an animal was not likely to survive long should I express a desire to have it eventually

for the college museum. I am grateful that my liking for natural history brought me in touch with him. It is in the small actions of life that one can best read character. A gentleman to the core, he was never fearful of giving himself away by showing the utmost courtesy to the humblest. An unfastened door or gate, a watertap left trickling he would not abide. Everything at the park must be precision and finish to the smallest details. Over his many acts of private charity he ever kept the veil tightly drawn. A few of them have incidentally come to my knowledge, and they reveal the vastness of his sympathy. His many zoological donations, and his gift to the college of a site on the Menai Straits for a biological station for the study of marine life, bear eloquent testimony to his desire to advance science. May the pile to be raised on this fine site—let us hope at no distant date—be at least one grateful tribute to his memory. PHILIP J. WHITE.

University College, Bangor, November 28.

### The Leonid Meteors of 1904.

FROM results of observations of this shower as published in NATURE of November 24 it seems that Leonids were found to be somewhat numerous on the night of November 14. It is to be regretted that those observers who were able to count so many shooting stars on this night had not the following night equally clear, as at Dublin both November 14 and 15, though not to the same degree, proved favourable for observations, and it was on the latter night that the maximum occurred. Owing to the unsuitable weather that appears to have prevailed in many places on November 15, some details of the observations made on the successive nights of the epoch at the same place may prove interesting.

The night of November 14 turned out ideally fine here, the temperature also being very mild for the season. During a watch on this date from 10h. 15m. to 13h. 45m. (Dublin time) 16 meteors were counted, of which 7 or 8 were referred to the Leonid radiant. The meteors, especially the Leonids, did not appear very bright, only 1 of the first and 2 or 3 of the second or third stellar magnitudes having been seen. No particulars of their paths were noted, as doing so might have interfered with the observations of other meteors. Shooting stars were more numerous in the early part of the watch than after midnight, 5 having been counted between 10h. 45m. and 11h., of which 2 shot from the direction of Leo. Another, though feebler, maximum occurred about 13h.; but, as it was considered from the declining meteoric rate that the anticipated miniature shower of this night was already over, observations were discontinued shortly before 14h.

The night of November 15 began very inauspiciously; clouds in the early evening covered the heavens, totally concealing both moon and stars. Subsequently, however, the sky partially cleared at intervals, and when observations were begun at 10h. 15m. passing clouds in the east left clear tracts of considerable area. Though the seeing was thus far from good, yet meteors were considered to be rather scarce, only 1 shooting star, a third magnitude Taurid, having been seen during a watch extending over nearly an hour. About 11h. the clouds passed off, leaving the eastern sky clear until nearly 14h. Meteors now began to be more numerous. A fine Taurid at 11h. 25m. passed down straight towards Leo, which, however, was partly invisible in a bank of fog along the horizon. When about twenty minutes later the "Sickle" emerged clear in the heavens, a succession of fine Leonids left no doubt as to the superior character of the coming display.

From 11h. to 13h. 30m. 32 meteors were counted; at 14h. 55m. the number had increased to 50 meteors, the total result at 16h. 45m. amounting to 60 meteors. But owing to clouds observations were greatly hindered from 13h. 45m. to 14h. 15m., and a second interruption of nearly equal length, arising from the same cause, occurred about 15h. During the last hour of the watch the sky was fairly clear, and it was noted that the meteor shower was now rapidly declining. The majority of the meteors were observed to emanate from Leo as soon as the latter had become visible near midnight.

The shower was also observed at the Paris Observatory on the night of November 15 with the following results[1]:—

From 10h. 30m. to 13h. 15m. ... 21 meteors observed
,, 13h. 15m. ,, 16h. 30m. ... 29 ,, ,,
,, 16h. 30m. ,, 17h. 35m. ... No shooting star seen

[1] The results are of course given in Paris mean time.

As no mention is made of the state of the weather, it seems the display terminated very abruptly at Paris, slightly more so than in Dublin or elsewhere, as Mr. T. R. Clapham, on November 15, from 15h. 45m. to 17h. 45m. counted 19 Leonids with 3 three doubtful ones, notwithstanding two brief interruptions from clouds, this result, it may be added, indicating a meteoric rate almost exactly equal to that of the preceding night as given by Mr. Hector Macpherson, who on November 14, from 15h. to 18h., recorded 35 meteors (*English Mechanic*, November 25, p. 365). The rate on the latter night seems, however, to have been even higher than this to judge from some results, but more observations are, no doubt, desirable. JOHN R. HENRY.

Dublin, November 29.

### Blue-stained Flints.

Two years ago I found large patches of an intense blue colour, with some black spots, on flints on the quay at Great Yarmouth. I looked for a possible cause, and discovered other patches similar in all respects but colour. The latter patches were black, and had been made by tar spilt by fishermen when tarring their fish skips. I kept some pieces, both black and blue, in a box until some months ago, and no appreciable change had taken place, so I came to the conclusion that the blue colour was produced by the action of the tar on the flint when exposed to sunlight.

This occurrence is interesting in view of the action noticed by Dr. Allen between gas-lime and flint, and points to the action on the flint of some substance common to the tar and gas-lime.

May I suggest to your former correspondent that the blue flints seen at Bournemouth were produced from the black, and not *vice versâ*. THOMAS L. D. PORTER.

County School, Ilford, Essex.

## "FIND" OF ROYAL STATUES AT THEBES.

THE "land of surprises and paradoxes," as Egypt has well been called, has once again justified its reputation, and out of the ruins of one of its most ancient cities there has come to light a mass of historical evidence which, if we mistake not, will be found to be of more importance the more it is studied. It will be remembered that for many years past M. G. Legrain has been carrying out a series of repairs of a very far-reaching character on the mass of buildings of various styles and ages which is commonly known as the "Temple of Karnak." In the course of this work he has collected a number of important facts which, when duly arranged, will be of considerable use to the student of ancient Egyptian architecture, and, side by side with these, he has brought together a considerable amount of information of value historically. It is not our purpose even to outline the broad facts of the works of restoration which he has carried out, and we therefore pass on to state briefly the facts which relate to his last "find" of monuments at Karnak.

Early in the present year M. Legrain was continuing the excavation of a portion of the temple precincts near one of the great walls when he accidentally came upon a large pit or well which, it was evident, had been filled up by the ancient Egyptians. Soon after he began to dig out the well the workmen came upon a layer of statues made of hard stone of various kinds, and when the mud was removed from them many of them were found to be inscribed. Beneath this layer of statues was a layer of earth, and beneath the earth was another layer of statues, and the clearing out of the pit showed that it was filled with layers of statues and earth, arranged alternately. The statues were usually found face downwards, and it thus became

clear that they had been so placed in order that their faces might be protected by the soft earth and mud in which they were buried. The total yield from the pit or well was about 450 statues.

As soon as the pit was emptied M. Legrain began to examine the objects which he had found, and he saw that many of the statues were royal, and that, speaking generally, the oldest belonged to the second or third dynasty, and the latest to the twenty-sixth dynasty. The greater number of them were, of course, made for high officials, generals, architects, priests, &c., and we may be certain that from first to last they represent the men who, during a period of about 3500 years, were the principal benefactors of the great temple of Amen-Rā, the "king of the gods," at Thebes. The question which naturally arises is, How came these statues to be in the place in which they were found? The answer is not far to seek. We know that it was a custom among the Egyptians for the kings and their nobles to dedicate statues of themselves to the temples of the god or gods whom they loved to worship, and they did so with the idea that, after death, their spirits would come from their graves and inhabit them, and would enjoy in their new existence the worship which had been their delight when upon earth. As the spirits of the gods also dwelt in the statues which were dedicated to them in the temples, the spirits of the kings and their nobles would thus dwell in divine company, and would participate in the happiness which disembodied spirits were believed to derive from the chants and hymns of the faithful, and the offerings and incense which were offered up by the priests. How these statues were arranged is not quite clear, but it is pretty certain that they were placed in niches or on pedestals in the chambers adjoining the sanctuary. As time went on, chamber after chamber would become full, and at length it would be as difficult to find a site for a new statue as it is to find a site for a monument to some illustrious dead person in our own Westminster Abbey.

It has been the custom to say that the temple of Amen-Rā at Karnak was founded by the early kings of the twelfth dynasty, about B.C. 2500, but it is clear from the statues which M. Legrain has brought to light that a temple to Amen must have existed at Karnak at least some 1500 years earlier. Some archæologists, basing their opinion on the evidence derived from religious texts, have always maintained that the twelfth dynasty temple of Amen was merely a new foundation, and not the original temple, and this was the view which Sir Norman Lockyer, K.C.B., arrived at in his investigations of the systems of the orientation of Egyptian temples. We now know that so early as B.C. 4000 an important temple of Amen stood at Karnak, and that even in that early period it was already so old that kings held it to be one of the highest honours attainable to have their statues included among the monuments of the "glorious and mighty dead" who were commemorated there. The temple of Amen represented the roll of fame for the Egyptians, and M. Legrain's "find" helps us to understand why Karnak was declared by the priests to be the "throne of the two lands" (*i.e.* Egypt), and the "seat beloved of the heart of the god." Now the fortunes of the god Amen and of his temple varied with those of the king, and the glory of his sanctuary waxed and waned according as the prosperity of the country increased or decreased. During the fourth, fifth, and sixth dynasties the chief centre of power lay between Heliopolis and Memphis; from the twelfth to the twentieth dynasty it rested at Thebes, and the temple of Amen between B.C. 2500 and B.C. 1050 was the greatest in the land, just as Amen himself was the greatest of the gods.

Between B.C. 1000 and B.C. 650 evil times came upon Thebes, and the formerly wealthy capital became poverty-stricken. A serious trouble between the priests and the people resulted in the departure of the former to Nubia, and in consequence the temple of Amen fell into a state of decay. Worse than all, soon after his accession, B.C. 668, Ashur-bani-pal, King of Assyria, invaded Egypt, and, marching up the country, plundered Thebes and its temples. This blow the city seems never to have recovered, and for about 300 years it held a position of no importance in the country. Under the Ptolemies some attempt to rebuild certain portions of the Temple of Amen was made, and it is probable that the work was begun under the wise rule of that astute ruler Ptolemy I. It was, of course, impossible to restore the worship of Amen to its original glory, and the extent of the buildings of the god must have been considerably curtailed.

Whilst the work of restoration was going on, the question of the disposal of the statues which M. Legrain has unearthed came up for decision. It was felt that to destroy the statues would be a sacrilegious and profane act, and therefore an old well was chosen in which to bury them; as we have seen, they were carefully placed in layers of earth or mud, and it is entirely to the religious instinct of the restorers of the temple of Amen that we owe the preservation of such a unique series of statues. In his "Notes prises a Karnak," recently published in the *Recueil*, M. Legrain directs special attention to the statues of three kings, of whom previously no monuments have been known; these are:—Mer-hetep-Rā, Mer-sekhemRā Mer-ānkh-Rā. It is early yet to attempt to assign exact places to these kings, but the discovery of their monuments is a striking contradiction of the assertion which has been made recently to the effect that our knowledge of Egyptian history is complete, and that there are no more important discoveries to be made in Egypt. Already M. Legrain's examination of the statues from Karnak enables us to correct our views on Egyptian history, and we must be prepared to admit that the kings of Egypt were considerably more in number than the king-list of Manetho would lead us to suppose, and that some of the dynasties were contemporaneous. M. Legrain's "find" also proves beyond all doubt the futility of limiting dynastic history to a period of 3000 years, as some of the German *savants* have done, and the evidence which is accumulating rapidly all goes to show that the assertions concerning the great antiquity of Egyptian civilisation made by Herodotus and other Greek writers, and the opinions of modern experts like Mariette, Chabas, and our own Hincks, are generally correct.

The statues recently found belong to all the dynasties which are most famed for the production of fine artistic efforts in sculpture and statuary, and many of them may well be considered to represent with great fidelity the features of the men they commemorate. Nearly all the great kings of Egypt took care to have their portrait-statues added to the Karnak collection, and down to the Ptolemaïc period the lover of antiquity in Egypt could look upon contemporaneous portraits in stone of the kings of the Archaic period, of Cheops, the builder of the Great Pyramid, of the great warriors of the eleventh, twelfth, and eighteenth dynasties, of the bombastic Rameses II., and of the Nubian king Tirhakah, who, to his credit be it said, left the shrine of Amen at Karnak uninjured, and humbly worshipped in that great symbol of the solar worship of the ancient Egyptians. It is greatly to be regretted that the Ptolemies did not cause portraits of themselves and their queens to be included among the statues of the great kings and priests of the country over which a strange fate called them to rule.

## COMPULSORY GREEK AT OXFORD AND CAMBRIDGE.

THE statute enabling students of mathematics and natural science to proceed to a degree at Oxford, without previously passing in Greek, has been rejected in the larger house by 200 votes to 164. At an earlier stage the proposal was adopted in the smaller assembly by the narrow majority of two votes. The discussion accorded to the statute was brief, for the voters had probably made up their minds; but it revealed the fact that, while the familiar arguments as to culture and the humanities held sway with those who have "learned nothing and forgotten nothing," some condemned the proposal, at least ostensibly, because it was too narrow. It would shut up school boys with a bent for mathematics or science to a "premature specialism," if they alone had to be segregated, years before the university stage, from their happier fellows on the "classical side."

The Cambridge proposals avoid at least this latter objection. They recognise that the examination which admits to the university should be one, in the sense that it allows the student who has passed it to enter any faculty or department of the university. He need not, while still at school, decide finally as to his special subject or subjects; and if he changes his mind as to the course he desires to pursue he need not retrace his steps, and begin to "get up" a new set of "little-go" subjects after he has entered the university. For three days high debate on the new scheme was held in the Cambridge Senate House, and so far as argument goes the impression produced is that the *placets* have the best of it. The official defenders of compulsory Greek spoke, naturally and properly, of the ennobling influence of Greek literature and philosophy. They scornfully derided the lack of culture disclosed by the false quantities of the mere man of science who is Greekless. But they failed to make clear the connection between the paltry rudiments, half grammar and half "crib," by which Greek is now represented in the previous examination, and humanistic culture or literary training of any sort. It was practically admitted that half the boys, even from classical schools of the straitest sect, might spend eight formative years over Greek and be no Hellenists in the end. But the conclusion was that time must be given for the improvement of school-teaching in classics, and that, in order to secure this improvement, the artificial support of the subject afforded by the present regulations is a necessity. The monopolists asked for more protection that they might mend their machinery.

One or two headmasters pleaded their helplessness before the uncultured parent if the shelter of academic compulsion were denied them, and the inconvenience they would suffer if they had to rearrange their time-tables to make room for science and modern languages, with all their complexity. Greek for all who aspire to enter the university is so much simpler than French and German and science for some, mere "modern-siders," and Greek and Latin for others, the "pick of the school." "If compulsion is done away with, schools will soon give up Greek altogether; in ten years it will be as dead as Hebrew," was the cry of these despairing headmasters. There were not wanting others to answer them, no less distinguished as scholars and teachers. The masters of Trinity and Christ's, the president of Queens' and Dr. Jackson, and other Grecians of established fame had such faith in the vitality of Greek—in its undying charm and its unrivalled power over the human spirit—that in their opinion it needed no such paltry prop to hold it upright. To force upon students of another bent the wasteful drudgery of six months' cramming in Greek accidence and the perfunctory conning of a set book with the help of a translation, was not only an educational blunder, but a grave moral wrong. It was bad for the student, it was bad for the master, it was bad for the university, and it was worst of all for the cause of Greek learning itself. It was breeding a race of students who, able and brilliant and influential in other paths, cherished a positive hostility to the distasteful subject that had raised itself as a needless obstacle in their way. But for compulsion they might have remained at worst indifferent, at best distant admirers of Greek. Now their only thought of it was associated with grievance and injustice. Times had changed, were changing fast; new methods of education were afoot in the schools. The bifurcation of studies—classical and non-scientific on the one hand, modern and scientific on the other—had become an accomplished fact. It was for the university frankly to recognise the change, and to give equal opportunity for both curricula. Cambridge had amply provided for the needs of the modern and scientific student once the barrier of the classical previous was passed. Why should the student, whose school and university course alike bore in one and the same direction, say towards natural science, be obliged to deviate during the last months of his school-time in order to pass through a wicket that lay straight in the path of his classical comrade, but far out of his own? True, a great teacher, a Porson or an Arnold or a Gow, might make even "Little-go Greek" a thing of life and light for his pupils; but what of the schools the head of which was a "mere Newton or Darwin"? Must the many be sacrificed for the few?

Then another issue was raised by the clerical members of the Senate, an issue on which, seeing the actual composition of the register, more will ultimately turn than on the educational question. If Greek is not compulsory, it will cease to be taught to and cease to be learned by candidates for ordination. The bishops of the Church of England will no longer be able to require a knowledge of the Greek Testament from the aspirant to holy orders. It is admitted that the Presbyterian Church exacts both Greek and Hebrew as a condition of admission to its theological schools. But the heads of the Anglican Church are weaker than the General Assembly; the university must reinforce them, whatever the consequences to sound learning and unfettered research.

Grave warnings were uttered that the *non possumus* of the Senate on this question would not be the final word. Revolution, in other words a Royal Commission, would be the inevitable Nemesis of reform denied. And there is no doubt that this thought will weigh with some waverers, who love learning and fear for its displacement by modern studies, but who love the university more and dread the changes which a liberal government might impose on it from without.

The report of the syndicate will doubtless be referred back for reconsideration of details in the light of the discussion. But the principle that modern subjects shall be recognised will certainly be retained, and on this principle issue will be joined early next term. The result no man can predict, for it lies with the silent voters who will flock from the country to the poll. But the debate has cleared the air, and the reformers are sanguine that this time something will be done.

## PROF. KARL SELIM LEMSTRÖM.

AS has already been announced, Prof. Karl Selim Lemström, whose name is known to our readers by his investigations on the aurora borealis and the influence of electricity on plant growth, died on October 2 after a short illness.

He was born in 1838 not far from Helsingfors, and entered the university in 1857, where he devoted himself to studies of physics and mathematics. His first scientific work, published in 1868, was founded on experiments made in Stockholm under the guidance of the late E. Edlund, the celebrated physicist, and dealt with the intensity curve of induction currents in relation to time, the intensity of the inducing current, &c. A summary was published in French in the *Proceedings* of the Swedish Academy of Sciences in 1870.

Lemström joined the late Baron A. E. Nordenskjöld's expedition to Spitsbergen in 1868 as physicist. In the two following years he worked in the laboratory of V. Regnault in Paris; in 1871 he made a journey to Lapland; in 1872 he continued his researches on the induction currents at the St. Petersburg Academy of Sciences. His papers during these years are printed in the *Proceedings* of the Swedish Academy and of the Finland Society of Sciences.

During the journey to Spitsbergen Lemström was engaged in observations on atmospheric electricity, terrestrial magnetism, and the aurora borealis. These observations, continued in Lapland, suggested to him a new theory of the last named phenomenon, so enigmatic even after the investigations of De la Rive, Loomis and others. This theory he expounded in a dissertation entitled "The Electrical Discharge in the Aurora and the Auroral Spectrum" (1873).

His next work, on the causes of terrestrial magnetism, was published in 1877. Starting from Edlund's well known theory on the nature of electricity, he argued that the rotation of the earth in an atmosphere of non-rotating ether causes the electric currents of which the terrestrial magnetism is a manifestation, and he described several experiments in confirmation of these views.

Appointed in 1878 professor of physics at the Helsingfors University, he continued his investigations on the aurora borealis in Lapland in 1882–4, where he organised two stations for taking part in the international polar exploration of these years. The investigations carried on by this expedition were published in a large work, "Exploration internationale des Régions polaires, &c.," of which vol. iii. (1898) contains his auroral researches.

One very interesting work by Lemström is devoted to the study of night frosts and the means to prevent their devastations, so frequent in Finland. Lemström emphasised the nocturnal radiation of heat as the principal cause of the night frosts, and showed that in calm and clear summer nights the air, cooled by the radiating soil and plants, must remain at the surface of the earth, and, flowing like water, gather on lower grounds, which generally are most exposed to frost. He proposed to prevent the radiation by artificial clouds of smoke, and invented for this purpose "torches" or tubes of peat (described in *Acta Societatis Scientiarum Fennicae*, Tome xx.).

Moreover, Lemström made important experiments on the influence of electricity on growing plants, on which subject he read a paper before the British Association at Bristol in 1898. The influence in question was found by exposing the plants to electric tension from a metallic wire net, provided with points and connected with the positive pole of a Holtz machine, the negative pole being conducted to the earth.

His frost experiments directed attention to the prevention of frost damage in several countries, and also gave rise to new scientific investigations (for instance, by Th. Homén). It is to be hoped that further work may be devoted to this important subject as well as to the electrocultural question, which have both but very little advanced from the point to which they were brought by the warm-hearted, indefatigable pioneer, Selim Lemström. ARTHUR RINDELL.

## NOTES.

IT was announced last week that the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee prize for 1900–4 to Sir James Dewar, F.R.S. We now learn that the following additional awards have been made:—the Keith prize for 1901–3 to Sir William Turner, K.C.B., F.R.S., for his memoir entitled "A Contribution to the Craniology of the People of Scotland," and for his "Contributions to the Craniology of the People of the Empire of India": the Makdougall-Brisbane prize for 1902–4 to Mr. J. Dougall for his paper on an analytical theory of the equilibrium of an isotropic elastic plate; the Neill prize for 1901–4 to Prof. J. Graham Kerr for his researches on *Lepidosiren paradoxa*.

A VALUABLE collection of specimens illustrative of the fauna of the deep sea has recently been received at the British (Natural History) Museum as a gift from H.M. the King of Portugal. The collection is reported to include a number of deep-sea fishes, among which are sharks of considerable size, captured during His Majesty's recent cruise in Portuguese waters. Several of these may prove to have been previously unrepresented in the British Museum collection. King Carlos, like the Prince of Monaco, is much interested in the fauna of the deep sea, of which he himself has done much to increase our knowledge. The collection sent to the museum is also stated to contain a series of contributions to our knowledge of the deep-sea fauna from the pen of His Majesty.

THE sale of Chartley Park, Staffordshire, the hereditary seat of Lord Ferrers, involves also a change of ownership of the remnant of the celebrated herd of white cattle which have been kept there for the last 700 years. It is much to be regretted that the cattle could not have gone with the park, and have been maintained there by the new owner; but as this is not to be, it is to be hoped that they will be given a safe home elsewhere, where they will flourish and increase. It was long considered that the herds of wild cattle in various British parks were direct descendants of the wild aurochs, but it is now generally admitted (largely owing to the writings of Mr. Lydekker) that they are derived from domesticated albino breeds nearly allied to the Pembroke and other black Welsh strains, some of which show a marked tendency to albinism. This view, as pointed out by a writer in the *Times* of November 29, is strongly supported by the fact that the Chartley cattle frequently produce black calves. The theory advocated by a later writer in the same journal that the British park cattle are the descendants of a white sacrificial breed introduced by the Romans rests upon no solid basis. The Chartley cattle, believed to be reduced to nine head, are to be captured by the purchaser—no easy task.

THE anniversary dinner of the Royal Society was being held last week as we went to press. In proposing the toast of the Royal Society, Mr. Arnold-Forster said that every day he has lived in a public office he has been more and more impressed with the need for a greater knowledge in our

public life of what men of science are thinking, what they are doing, and what they hope and mean to accomplish in all the great departments of scientific life throughout the globe. There is absolutely infinite opportunity for the work of trained minds in that important department of our national life, the public service. Even in his short official life he had lived to see some progress made in the direction in which he wished to see this nation travel. Sir William Huggins responded; and among other speakers were Lord Strathcona, Sir J. W. Swan, Mr. W. Bateson, and Mr. Leonard Courtney.

THE annual dinner of the Institution of Electrical Engineers was held on Thursday last, December 1, Mr. Alexander Siemens, the president, being in the chair. In proposing the toast of the institution, Lord Alverstone remarked that its high standing among scientific organisations was due to the fact that it had kept pace with the times, had been the first to promulgate and promote among its members all the information about electrical science that could be obtained, had been willing to welcome electricians from all parts of the world, had kept its students and its members acquainted with every modern development, and had given them the means of cultivating the technical knowledge of their science to the highest extent. In the course of his response to the toast, the president announced that telegrams of congratulation and sympathy had been received from the Belgian and Italian Societies of Electrical Engineers. In their visits to foreign countries the international character of electrical engineering had come out, and it was this which had contributed not a little to the development of electricity throughout the world.

THE death is announced of Dr. T. M. Drown, president of Lehigh University, and previously professor of chemistry at Lafayette College and the Massachusetts Institute of Technology.

IT is reported in the *Pioneer Mail* that the Secretary of State for India has sanctioned the creation of the appointment of electrical adviser to the Government of India, with headquarters at Calcutta. The present post of electrical engineer to the Government of Bengal will be abolished.

ACCORDING to the correspondent of the *Daily Chronicle* (November 25) the German Commission that is investigating tuberculosis has come to the conclusion that two distinct forms of tubercle bacilli exist, the human and the bovine. Out of fifty-six cases of human tuberculosis examined fifty showed human bacilli only, five (three being children) showed bovine bacilli, while the remaining one showed both human and bovine bacilli.

A MOVEMENT has been initiated in Denmark for the erection of a monument to the late Prof. Finsen, the inventor of the light cure for lupus. It has been thought that many outside Denmark would desire to join in doing honour to one who did so much for his fellow-men, and a British committee has been formed for the furtherance of the scheme. The Hon. Sydney Holland, Sir Francis Laking, Sir Frederick Treves, and Mr. Malcolm Morris, members of this committee, announce that subscriptions may be paid to the Finsen Memorial Fund at the National Provincial Bank, 112 Bishopsgate Street, E.C.

THE Bradshaw lecture was delivered at the Royal College of Surgeons on December 1 by Mr. Mayo Robson, who took for his subject the treatment of cancer. He pointed out that in many instances, perhaps in all if we only knew it, there was a pre-cancerous stage in which operation ought to be performed, and would be the means of saving many lives. In early operation with complete removal of disease, together with a wide margin of healthy tissue, our hope of cure must depend. Medical treatment could not cure, and could do little to prolong life. There was hardly any situation in the body in which an operation for removal could not be performed provided the disease were recognised sufficiently early, and the results of surgical treatment were by no means so hopeless as generally supposed.

WE learn from the *Athenaeum* that M. Paul Tannery, whose death is announced, was born at Mantes on December 20, 1843, was president of the Congrès d'Histoire Générale des Sciences held at Paris in 1900, and had written extensively on philosophical subjects since 1876. His principal works include "Pour l'Histoire de la Science Hellène," 1887, and "Recherches sur l'Histoire de l'Astronomie Ancienne," 1893; he edited with M. Ch. Henry the works of Fermat, and with M. Ch. Adam an edition of Descartes.

PRINCE ROLAND BONAPARTE has resumed the presidency of the committee of the Aëro Club of Paris, which he had previously to relinquish on account of ill-health. At the meeting of the club on November 28, the report of the St. Petersburg congress was read. The suggestion was made to ask the Government to lend a torpedo-boat for experiments in starting sounding-balloons over the Mediterranean when the scientific congress meets at Algiers next April. In connection with proposed ascents during the solar eclipse of August 30, 1905, it is unfortunate that one of the towns having the best situation on the line of totality—from Philippeville to Sfax—Batna, with a population of 6000 or 7000, is lighted by electricity, and there is no gas reservoir. It will therefore be necessary for the aëronauts to manufacture hydrogen on the spot, or else to bring it from a distance.

THE following are among the lecture arrangements at the Royal Institution, before Easter:—a Christmas course of lectures (experimentally illustrated and adapted to a juvenile auditory) on ancient and modern methods of measuring time, by Mr. Henry Cunynghame; Prof. L. C. Miall, adaptation and history in the structure and life of animals; Prof. Karl Pearson, some recent biometric studies; Prof. W. E. Dalby, engineering; Mr. A. H. Savage Landor, exploration in the Philippines; Prof. W. Schlich, forestry in the British Empire; Mr. J. J. H. Teall, recent work of the Geological Survey; Prof. H. H. Turner, recent astronomical progress; Prof. R. Meldola, synthetic chemistry (experimental); Mr. D. G. Hogarth, archæology; Prof. J. J. Thomson, electrical properties of radio-active substances; and Lord Rayleigh, some controverted questions of optics. The Friday evening meetings will begin on January 20, when a discourse will be delivered by Sir James Dewar on new low temperature phenomena; succeeding discourses will probably be given by Dr. E. A. Wilson, Mr. Cecil Smith, Mr. J. W. Gordon, Prof. H. Marshall Ward, Chevalier G. Marconi, Prof. J. J. Thomson, Prof. G. H. Bryan, Prof. J. Wright, Prof. T. Clifford Allbutt, Lord Rayleigh, and other gentlemen.

THE new board of anthropological studies in Cambridge is now organised, and commenced work last October with nine courses of lectures. Sir Richard Temple, Bart., C.I.E., delivered an inaugural address at Cambridge in the museum of archæology and ethnology on "The Practical Value of Anthropology." In the course of his most interesting and suggestive address he said:—"Now, when we are started on a new line of research, when we add a new course of studies to a university curriculum, there is a question that

we cannot help facing—a question, in fact, that ought to arise—What is the good of it all?" From his long experience as an administrator in the East, Sir Richard Temple drew, from facts that had come under his own observation, examples of the desirability, one would like to add the necessity, of a knowledge of ethnology for those who are brought into contact with alien peoples, and he dealt severally with merchants and planters, administrators and magistrates, and missionaries. He also pointed out that stay-at-home critics require training and information, as by their ignorant criticism they are liable to do a great deal of actual harm. "But mischievous as uninformed criticism is, there is nothing of greater value and assistance than the criticism of the well informed." He alluded to the value of anthropological study to history, and after dealing with the value of an early anthropological training to a man in his work, he pointed out the value it is in his private life, even if it is pursued merely as a hobby. "Not only will it enable the student to do the work of the world and to deal with his neighbours and those with whom he comes in contact, throughout all his active life, better than can be otherwise possible, but it will serve to throw a light upon what goes on around him, and to give an insight into human affairs, past and present, that cannot but be of benefit to him, and it will provide him with intellectual occupation, interest and pleasure, as long as eye can see, or the ear can hear, or the brain can think." The address is printed in full in the *Cambridge Reporter* (vol. xxvi., No. 643).

ACCORDING to "Notes for Visitors to the Gezira Aquarium," issued by the Public Works Department of Cairo in November, the tanks at that establishment contained specimens of no less than twenty-nine species of native fishes, including the Nile perch, the electrical catfish, and the elephant-fish (Mormyrus).

WE have received from the author, Dr. W. G. Ridewood, two papers on the osteology of the skull in some of the more generalised families of bony fishes, the one published in the *Proceedings* of the Zoological Society, and the other in the *Journal* of the Linnean Society. Some remarks on the general morphology of the skull are appended to the former paper.

THE *Emu* for October contains reproductions of two very interesting photographs, the first showing the "run" or "play-house" of the great bower-bird (*Chlamydera nuchalis*), and the second a flight of bare-eyed cockatoos (*Cacatua gymnopis*), estimated at between sixty and seventy thousand in number. Considerable interest attaches to a note on bird-sanctuaries in New Zealand, where, it appears, all the surviving flightless species are now protected by Government. The want of such sanctuaries, both for birds and mammals, in Australia forms the subject of comment in another paragraph.

TO vol. lxxviii., part ii., of the *Zeitschrift für wissenschaftliche Zoologie*, Mr. A. Voss, of Dusseldorf, contributes the first instalment of an essay on the comparative anatomy and mechanics of insect structure, especially in relation to flight, commencing with the thorax of the house-cricket in relation to the attachment of the wings and their movements. The other articles include one by Dr. P. Dugener on the scent-organ of the butterfly *Phassus schamyl* and the function of the same; a second, by Dr. H. Jordan, on the digestive organs of the sea-mouse (*Aphrodite aculeata*); a third, by Mr. L. von Graff, on the marine turbellarian worms of Orotava and the coast of Europe; and a fourth, by Dr. S. Gross, on the perineal sac and its glands of the guinea-pig.

IN the *Zoologist* for November Mr. O. V. Aplin announces that the black-necked grebe (*Podicipes nigricollis*) should be added to the list of birds nesting in the British Islands. It appears that during the past summer several pairs of these grebes successfully reared their young within our islands, but for obvious reasons neither the locality where this interesting event took place nor the name of the observer by whom it was recorded are revealed to the public. Pennant, it seems, stated that the black-necked grebe nested in the Lincolnshire fens near Stamford in his time, and the late Mr. E. T. Booth had a pair of nestlings brought to him by a marshman; but the observations of this year form the first definite record of the nest having been actually seen. A second article in the same journal is devoted to notes on natural history made during the cruise round the world of Lord Crawford's yacht *Valhalla* in 1902–3 by Mr. M. J. Nicoll. Among new forms obtained during the voyage, the author refers to *Pyroderees crawfordi*, belonging to the Microlepidoptera, and the fish *Corvina crawfordi*. He also records his own observations on the flight of flying fish, and is one of those who believe that they move their "wings."

THE Danish Commission for the Study of the Sea, which is charged with carrying out the Danish portion of the cooperative international investigations, has issued the first memoirs of its report, which is published under the title "Meddelelser fra Kommissionen for Havundersøgelser." The report, which is to be written in English or German, and is issued in quarto form, uniform with the *Bulletin* of the Central Bureau of the International Council, is divided into three series, dealing respectively with fisheries, with hydrography, and with plankton. Of the fisheries series one memoir is now published, viz. C. G. Joh. Petersen, on the larval and post-larval stages of the long rough dab and the genus Pleuronectes (with two plates); of the hydrographic series three memoirs, Martin Knudsen, on the organisation of the Danish hydrographic researches, H. J. Hansen, experimental determination of the relation between the freezing point of sea-water and its specific gravity at 0° C., Niels Bjerrum, on the determination of chlorine in sea-water and examination of the accuracy with which Knudsen's pipette measures a volume of sea-water; and of the plankton series two memoirs, Ove Paulsen, plankton investigations in the waters round Iceland, C. H. Ostenfeld, on two new marine species of Heliozoa occurring in the plankton of the North Sea and the Skager Rak. The memoirs are of interest as being amongst the first fruits of the international scheme of cooperative research. They are, however, all short memoirs, dealing with what may be considered as side issues of the main investigations, the reports upon which must be looked for at a later date. The Danish Commission, which is appointed by the Danish Board of Agriculture, consists of Prof. C. G. Joh. Petersen (chairman), C. F. Drechsel, C. H. Ostenfeld, and Martin Knudsen (secretary).

THE important preliminary results of the National Antarctic Expedition have already been utilised by Mr. W. Krebs in the communication of a useful paper to *Das Weltall* (vol. iv., Heft 24). By comparison of the yearly temperature at the English, German, and Swedish stations during the year 1902–3, he finds that the average decrease of temperature amounted to 0°·5 C. for each degree of latitude; and by applying this value to the results obtained by the five stations established round the Antarctic Pole during the

years 1898–1903, he has constructed approximate isotherms between 50° and 80° S. latitude, and thus made an important addition to the valuable yearly isothermal charts published in Dr. Hann's "Handbook of Meteorology." Dr. Hann's southernmost isobar is 4° C., just below Tierra del Fuego; Mr. Krebs continues the isotherms for each 4° C. as far as −16°, which runs near the 70th parallel between longitude 60° E. and 60° W. He also draws portions of the isotherm of −20° C., reaching nearly to the 80th parallel.

THE *Times* of November 29 contains an interesting article on London fogs; although it deals principally with the most elementary physics of the atmosphere, and with the part played by aqueous vapour, the subject is very ably handled and is made both attractive and instructive. The author points out the well known facts that the amount of invisible vapour in the air varies directly with the temperature; by whatever process the cooling of the air takes place, the capacity of the vapour to remain invisible diminishes until the "dew point" or "saturation point" is reached; any further cooling produces cloud or fog. He states that it is more than twenty years since it was shown that the vapour molecules cannot of themselves combine to form cloud or fog particles, but that solid nuclei of dust, or other impurities, are necessary, on which the vapour molecules can condense. Taking this for granted, it is seen at once why fogs in London (or other large towns) are so much denser than in the open country. For instance, at an elevation of 6000 feet, say on the Alps, the number of dust particles per cubic centimetre may amount to less than 200, while in towns the number may reach 100,000 or 200,000. The vapour in the country, condensed on a few particles of dust, will result in a coarse grained form of condensation, whereas in town the same quantity of vapour being distributed over a very large number of dust particles, there results a fine grained fog. The author points out that it is not the large-sized visible dust that does the damage, but the infinitely small, ultra-microscopic particles produced by combustion of fuel and light; that, in fact, experiments have shown that it is possible for cloudy condensation to take place in the absence of dust. In 1897 (*Trans.* Roy. Soc. Edin., vol. xxxix.) Mr. Aitken stated that dust particles are not absolutely essential for the production of fog, but that, as the air is full of dust and condensation takes place on these by preference, therefore practically all our cloud particles have dust nuclei. The author concludes, justly, we are afraid, that London will always be liable to fogs, owing to its situation and meteorological conditions; all that can be hoped for is a reduction in the more disagreeable constituent elements; there seems to be, so far, no way of appreciably reducing their frequency or their bad effects. We hope that the experiments begun by Sir Oliver Lodge, with a view to their possible ultimate dissipation by electricity, will be energetically continued.

THE *Revue Scientifique* (Nos. 20 and 21), in continuing its inquiries as to the existence of the *n*-rays, publishes a letter from M. Blondlot stating that the photographic exposures, the results of which he considers prove the reality of these radiations, were made by a laboratory assistant who was ignorant of the effects he ought to obtain, and was therefore not unconsciously biassed. The obvious rejoinder is made that the results obtained in this way are less to be trusted than if they were due to M. Blondlot himself. M. Lambert claims that his experiments showing that the *n*-rays exist were made in a manner excluding subjective phenomena. On the other hand, MM. Cailletet, Lippmann, Berget, Turpain, and Perrin have all failed to obtain experimental proof of their existence.

PART x. of the *Transactions* of the Royal Dublin Society contains a continuation of the researches of Messrs. W. F. Barrett, W. Brown, and R. A. Hadfield on the physical properties of a series of alloys of iron. It is shown that a remarkable similarity exists between the diminution of the electrical conductivity and the change in the thermal conductivity of iron, which are caused by the addition of other elements. Not only is the general order of the electrical and thermal conductivities the same for all the alloys, but equal increments of any given element appear to produce a corresponding diminution of conductivity for both heat and electricity. It is remarkable that the effect of alloying iron with another element, even a better conductor, is always to reduce both the thermal and the electrical conductivities. The ratio of the two conductivities is, however, not exactly the same for all alloys; on plotting the electrical against the thermal conductivity, a fairly smooth parabolic curve is obtained showing that the ratio increases in magnitude as the conductivity of the alloys increases.

THE October part of the *Physical Review* contains an account by Messrs. C. W. Waidner and G. K. Burgess of a number of measurements which they have made by photometric methods of the temperature of the electric arc. Wien's law of the distribution of energy in the spectrum was assumed as a basis of calculation, and three distinct types of photometers, namely, those of Holborn and Kurlbaum, of Wanner, and of Le Chatelier, were employed. The values obtained for the "black body" temperature of an arc of pure graphite by the three methods agreed within 30° C., the average being about 3700° abs. The true temperature of the arc must be higher than this by an amount depending on the departure of the radiation from true "black body" radiation, and may possibly be between 3900° and 4000° absolute. Contrary to the usually accepted view, the temperature of the arc does not appear to be independent of the current, and it is undoubtedly influenced by the degree of purity of the carbons forming the arc. With impure carbons, the temperature is lower by 40° C. than in an arc of highly purified graphite. Such variations would appear to preclude the suggested use of the brightest part of the positive carbon of the electric arc as a standard source of light.

THE second number of the *Extensionist*, which is a record of the University Extension Guild, has reached us. In addition to numerous descriptive notes on the work of the guild, this issue contains addresses by Sir Arthur Rücker, F.R.S., Mr. Hilaire Belloc, and Mr. Banister Fletcher.

THE Infants' Health Society has published a pamphlet entitled "The Present Conditions of Infant Life, and their Effect on the Nation," which directs attention to the almost complete failure of our present method of rearing the infants of the working class. In the poorer parts of the larger towns and cities it is not uncommon for nearly *half* the children born to die in infancy. The dominating cause of this appalling mortality is the improper feeding of the infant.

MESSRS. A. AND C. BLACK have published the 1905 issues of three useful annuals—"Who's Who," "Who's Who Yearbook," and the "Englishwoman's Yearbook." "Who's Who" has been enlarged again this year, nearly a hundred pages having been added, bringing the total up to 1796. Due prominence is given to men of science and their work, not only of those in this country, but in other parts of the world. There is a want of uniformity in the

amount of detail given concerning the careers of the notabilities included, and something might be done with advantage to reduce the lengths of some of the biographies, and thus to keep the volume of a convenient size. The "Who's Who Yearbook" contains the tables which were formerly included in "Who's Who" itself. "The Englishwoman's Yearbook" will in its revised form continue to lighten the labours of women sharing in the useful work of the world.

## OUR ASTRONOMICAL COLUMN.

RE-DISCOVERY OF TEMPEL'S SECOND COMET.—A telegram from the Kiel Centralstelle announces that Tempel's second comet was re-discovered by M. Gavelle at Nice on November 30, and that the observation showed the daily ephemeris published in No. 3971 of the *Astronomische Nachrichten* to be nearly correct.

The following is an extract from the above named ephemeris, which was published by M. J. Coniel :—

12*h*. *M.T. Paris.*

| 1904 | α (app.) h. m. s. | δ (app.) ° ′ | log Δ | $1:r^2\Delta^2$ |
|---|---|---|---|---|
| Dec. 8 ... | 20 7 38 ... | −24 19 ... | 0·29671 ... | 0·126 |
| ,, 10 ... | 20 15 4 ... | −24 8 ... | 0·29913 | |
| ,, 12 ... | 20 22 26 ... | −23 56 ... | 0·30161 ... | 0·122 |
| ,, 14 ... | 20 29 47 ... | −23 42 ... | 0·30414 | |
| ,, 16 ... | 20 37 4 ... | −23 28 ... | 0·30672 ... | 0·117 |
| ,, 18 ... | 20 44 19 ... | −23 12 ... | 0·30936 | |
| ,, 20 ... | 20 51 30 ... | −22 55 .. | 0·31206 ... | 0·113 |

PARALLAX OF A LOW METEOR.—Whilst exposing on the Andromeda nebula with two Voigtlander objectives on August 12 Herr P. Götz, of Heidelberg, photographed on each plate the trail of a remarkably low Perseid. From measurements of the trail on the two plates it was possible to determine the parallax of the meteor at definite points in its flight where the trail was considerably strengthened. The result showed a mean parallax of 28″·12, whilst for six distinct points on the trail the following parallaxes were determined :—

28″·26, 37″·31, 27″·78, 25″·20, 17″·14, 10″·0.

The base of the triangle Meteor—Voigtlander I.—Voigtlander II. measured 68 cm., and it therefore follows that the distance of the meteor at each of these points was 4·98, 3·78, 5·05, 5·57, 8·27, 14·03 kilometres respectively, the coordinates of the meteor at each point being respectively :—

α = 0h. 28·2m., 0h. 22m., 0h. 19·2m., 0h. 16·8m., 0h. 10·7m., 0h. 7·7m.

δ = +43° 13′, +42° 1′, +41° 28′, +40° 58′, +39° 47′, +38° 59′.

The path of the meteor was apparently rectilinear, but the observations indicated that it described a sharp curve in the third dimension with the convex side towards the observer.

The path of the meteor extended from α = 0h. 33·6m., δ = +44° 17′ to α = 23h. 52·2m., δ = +35° 28′ (*Astronomische Nachrichten*, No. 3975).

DATE OF THE MOST RECENT SUN-SPOT MINIMUM.—From a discussion of the observations of solar phenomena made at the Roman College Observatory during the period November 25, 1900, to January 4, 1902, Signor E. Tringali deduces the date of the latest sun-spot minimum to have been June 15, 1901, or 1901·45.

In Table i. of the communication the relative daily frequencies of spots, &c., are given for the years 1878–9 and 1888–1903, and it is seen that the frequency of days without spots during 1901 was greater than obtained during the previous minimum (1889), but less than in the 1878 minimum. The numbers given for 1878 and 1901 are 0·76 and 0·73 respectively (*Memorie della Società degli Spettroscopisti Italiani*, No. 8, vol. xxxiii.).

OBSERVATIONS OF PERSEIDS, 1904.—In No. 9, vol. xxxiii., of the *Memorie della Società degli Spettroscopisti Italiani*, Prof. S. Zammarchi, director of the meteorological observatory at Brescia, gives in tabular form the results of the observations of Perseids made at that observatory during the nights of August 9–14.

531 Perseids were seen, and the observations are recorded in the order of the appearance of the objects, the time, the points of appearance and disappearance, and the general characteristics of each meteor being given.

THE ORBIT OF SIRIUS.—In No. 3981 of the *Astronomische Nachrichten* Prof. Doberck gives the results of a discussion of the observations of Sirius and its faint companion, and includes a set of elements, an ephemeris for the period 1903·2–1917·2, and a table showing the differences between the observed and calculated values of position angle and distance. Owing to the great difference between the magnitudes of the two components, the systematic errors of observation are unusually large.

The following are the elements determined from the discussion :—

| | |
|---|---|
| Ω = 225° 49′ | P = 49·49 years |
| λ = 29° 54′ | T = 1894·28 |
| γ = 43° 20′ | a = 7″·513 |
| *e* = 0·5871 | |

The orbit is referred to the equinox of 1900. The motion is retrograde, and the anomalies are considered as positive before and negative after periastron.

The consideration of the errors of observation shows that they are inversely proportional to the aperture of the object glass employed.

HARVARD OBSERVATIONS OF VARIABLE STARS.—Part ii., vol. xlvi., of the Harvard College Observatory *Annals* is devoted to the observations, chiefly of variable stars, made by Prof. E. C. Pickering with the meridian photometer during the years 1892–8.

The first chapter gives the results of the observations of short-period variables, and then discusses the phases of the light-variations and the corrections to their ephemerides. Chapter ii. deals similarly with the observations of variables of the Algol type, chapter iii. collates the observations of various miscellaneous objects, and the fourth chapter gives, and discusses, the observations of planets and asteroids. The early observations of variable stars, at Harvard, are collected into tables in the fifth chapter, whilst the last chapter discusses the observations of long-period variables, and describes the eight light-curves given on the two plates at the end of the volume.

CORRECTION OF THE LONGER TERM IN THE POLAR MOTION.—In a previous communication to the *Astronomische Nachrichten* Mr. Kimura, of the Mizusawa International Latitude Station, showed that the cycle of the polar motion might be approximately represented by two principal terms of 365 and 438 days.

In No. 3981 of the same journal, however, he discusses the latter term more fully, from observations made during the period 1890–1904, and finds that it is probably a day or two too long. Taking the two periods 1890–1896 and 1896–1902, he derived the value 437·1 days, whilst from the periods 1892–1898 and 1898–1904 the value 436·6 days was obtained. The latter value, Mr. Kimura thinks, is likely to be the more correct, and consequently the cycle is not exactly six years as was indicated by the former discussion.

The values given in the paper show that for the years 1890 and 1891 the radius of the circular motion was especially large, but from 1892 to last year it remained nearly constant.

ARC SPECTRA OF THE ALKALI METALS.—In No. 9, vol. xl., of the *Proceedings* of the American Academy of Arts and Sciences Mr. F. A. Saunders, of Syracuse University, gives the results of a series of researches on the arc spectra of lithium, sodium, potassium, rubidium, and cæsium.

The salts were vaporised on nearly pure carbon poles, and the spectra were taken with a grating camera, special arrangements being made to photograph the spectra well up into the red.

Several new lines, which fit into the respective series, were discovered, and in the lithium spectrum Mr. Saunders believes that the dual character of the lines is real and not simply due to reversals as has been supposed by Hagenbach and other spectroscopists.

A comparison of the arc spectra with spark spectra of the same substances showed no relative enhancement of any of the lines in passing from the conditions of the arc to those of the spark.

## INVAR AND ITS APPLICATIONS.

*Preliminary.*

*DESCRIPTION of Phenomena.*—A new material requires a new name; that of "*invar*" has been adopted, on the suggestion of Prof. Thury, to avoid the periphrase "steel containing about 36 per cent. of nickel, which is characterised by possessing an extremely small coefficient of expansion or by the fact that its specific volume is practically invariable when considered as a function of the temperature." The name has been universally adopted, and the title of this article is thus justified.

The discovery of invar, as is the case with most discoveries, was preceded by observations indicating the direction of the researches from which it had its origin. As early as 1889 the late Dr. John Hopkinson noted the singular fact of the existence of a ferro-nickel containing about 25 per cent. of nickel, the density of which was found to have diminished by about 2 per cent. after cooling to the temperature of solid carbon dioxide; and in 1895 M. J.-R. Benoît, director of the Bureau international des Poids et Mesures, having to determine the length of a metre scale composed of an alloy of iron with 22 per cent. of nickel and 2 per cent. of chromium, was extremely surprised to find that his measurements, made with an extreme range of temperature of about 2 degrees C., gave concordant results only on assuming for the alloy a totally abnormal coefficient of expansion, equal to that of brass, and consequently half as

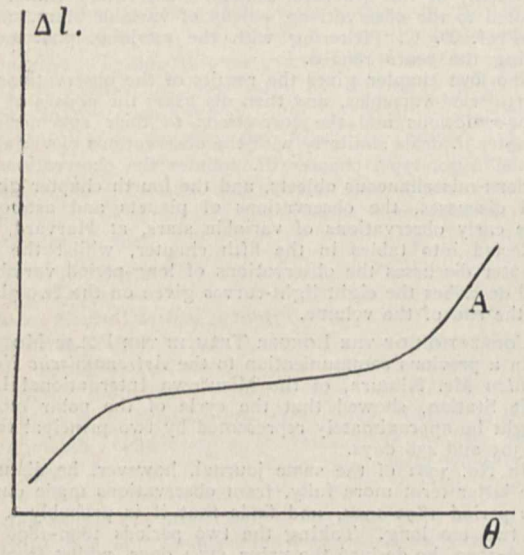


FIG. 1.—General form of the expansion curve for a reversible nickel-steel.

great again as that required by the law of mixtures generally applicable to such cases. This alloy was not magnetic, and thus resembled Hopkinson's alloy before cooling, although the latter after exposure to a low temperature became endowed with magnetism.

It was natural to coordinate these two anomalies and to consider the non-magnetic iron of the second alloy as being very expansible. At the time I considered that the alloy, after being rendered magnetic by cooling, would possess a normal coefficient of expansion; but as the alloy studied by M. Benoît did not become magnetic either in carbon dioxide or in liquid air, I was forced provisionally to renounce this hypothesis. For the liquid air I was indebted to the kindness of Sir James Dewar at a time when liquid air was not obtainable in Paris. I did not, however, abandon this research, and it was in seeking for alloys capable of a transformation similar to that observed by Hopkinson that I was led to examine alloys possessing a negatively abnormal coefficient of expansion. I may add that I was able later perfectly to reproduce Hopkinson's discoveries and to extend them in various directions, but I am unwilling to linger over the details in an article of a practical character, these discoveries having hitherto been fruitless of industrial applications. It will be sufficient to consider later in a brief manner the common cause of the anomaly observed by Hopkinson and of the phenomenon which I have studied.

*Reversible Alloys.*—The alloys of iron and nickel which contain more than 25 per cent. of the latter metal may or may not be magnetic, according to the temperature at which they are studied. The passage from one state to another is gradual, the magnetism declining continuously as the temperature is raised, whilst on lowering the temperature the reappearance of the magnetism follows the same curve. The temperature at which the magnetism totally disappears depends on the composition of the alloy. For alloys containing from 26 per cent. to 27 per cent. of nickel it is little above 0° C.; as the proportion of nickel increases it rises very rapidly until a maximum, corresponding with 70 per cent. of nickel, is reached at a temperature fixed by M. Osmond at 550° C., when the curve falls to the transformation point of nickel at 340°. This curve of variation is, so to speak, an *indicatrix* of the properties of the alloys; above the curve the expansion is abnormally great, but at the moment of crossing it with descending temperature the rate of the contraction diminishes, and a region is soon reached in which the anomalous negative expansion exists. Subsequently at a much lower temperature the normal state is reached. The curve given in Fig. 1 shows the general character of the variation for alloys of this class; its phases are more or less elongated, the different regions more or less inclined, but the curve always consists of a region of negative abnormality with two confluent curves, one side being characterised by large expansions at high temperatures, the other by a normal expansion. The abnormal region covers generally several hundred degrees.

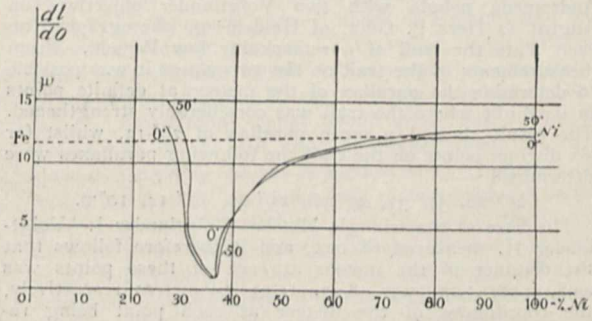


FIG. 2.—Coefficients of expansion at 0° and 50° C. of the various reversible nickel-steels.

The temperature indicated by the abscissa of the point A corresponds sensibly with the ordinate of the indicatrix in question at the point belonging to the same alloy; in other words, it is at this point that the magnetism finally disappears as the temperature rises.

Curve 1 shows that it is impossible to assign a general value to the expansion of a particular nickel-steel; the value chosen must always apply to a definite region and to a more or less extensive range of temperature. If we consider, for instance, the temperatures 0° and 50° C., the two curves of Fig. 2 can be traced, representing at these two temperatures the inclination of the tangent to curve 1 for all the reversible alloys of iron and nickel. It is the minimum of this curve which corresponds with invar, strictly so-called. This minimum will be displaced toward the left for alloys considered at lower temperatures and conversely.

It should be noted that beyond the minimum the curves cross; we are then in the region corresponding to the left-hand side of curve 1, where the true expansion diminishes with rising temperature. This result of the measurements is of interest because, independently of its being observed for the first time, it has given rise to an interesting application.

*Theoretical Views.*—Without entering into the details of a theory for the development of which I may refer to an article in the *Revue générale des Sciences* (July 15 and 30, 1903), I will indicate at least the source of the phenomena which have been described.

In the two transformations which take place successively

in iron in passing from the α condition to the β and γ conditions of Osmond, the metal undergoes different apparent changes, of which the most characteristic are the transitions, in two distinct stages, into the non-magnetic state and a

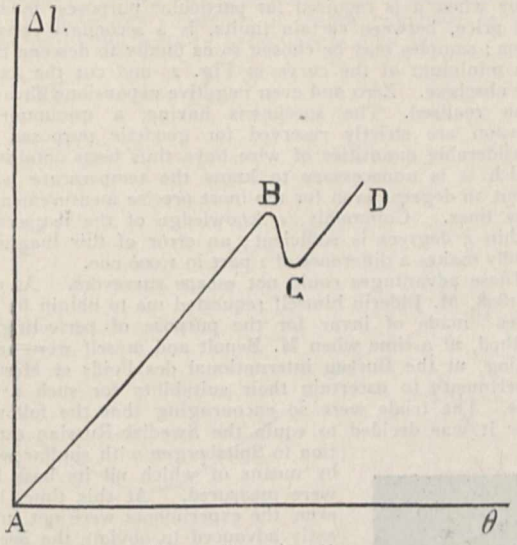


FIG. 3.—Expansion of iron.

sudden diminution of the specific volume of the iron at the moment it reaches the higher condition. The expansion of iron up to high temperatures is indicated by a curve such as ABCD, Fig. 3. The addition of a little carbon modifies this curve considerably, as was observed especially by M. Le Chatelier and MM. Charpy and Grenet. The addition of nickel begins to separate the change more and more into two inverse transformations, which commence at very different temperatures (Hopkinson's phenomenon); as the proportion of nickel increases, the change again becomes simple, but instead of being sudden, as with pure iron, it is spread out over a wide interval of temperatures, at each of which the reciprocal solution of iron in its two extreme states and of nickel strives to attain a stable equilibrium. For the greater part the attainment of equilibrium is practically instantaneous; it is much more rapid, for example, than that which is observed in an aqueous solution in which large crystals are placed, and resembles rather that which would occur in a saturated solution containing an infinite number of crystalline nuclei of the same density as the solution. In a medium thus constituted equilibrium is reached almost instantaneously. The perfect dissemination of iron throughout the nickel or the converse is evidently a very important factor of the phenomenon. For Hopkinson's phenomenon the same transformation is still produced, but with an enormous thermal hysteresis.

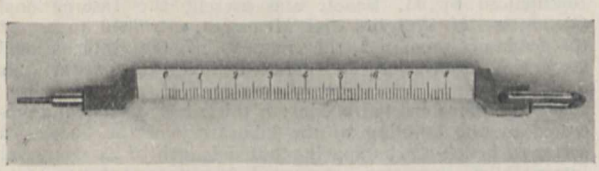

FIG. 4.—Scale at the end of a wire (the divisions are millimetres).

It is necessary to mention, however, a retardation in a minor part of the change which follows very slowly the principal instantaneous phenomenon. This retardation, due perhaps to a migration of some of the molecules engaged in the change, is rendered visible in the case of invar, strictly so-called, by a gradual elongation with time. It is enormously accelerated by heating the alloy, for example, at 100° C.[1] Nevertheless, when a bar of invar has been heated thus it still increases in length very slightly after several years at the ordinary temperature. At the end of five or six years the total elongation is nearly 1/100 mm. per metre, but the subsequent lengthening each year does not exceed a fraction of a micron.

This phenomenon is of theoretical interest. Practically it restricts the use of invar, and although, by systematic heating, a much smaller limit of variation can be reached than that above indicated, such a change prevents the alloy from being employed in the preparation of *standards of the first order*. It is necessary to point this out before proceeding to consider the apparatus in which invar has introduced decided elements of progress. For a consideration of other qualities which may render it valuable I will refer to information already given in this Journal.[2] I can describe here only a few of the uses of invar, and will choose three of the most typical.[3]

*Applications.*

*Standards of Length.*—If the slight defect of stability referred to above prevents the employment of invar in the preparation of fundamental standards, the requirements of which are infinite, a wide field of application still remains in the construction of standards which can be referred from time to time to fundamental units, and during these intervals are employed at temperatures which are not readily ascertained, as is the case with the majority of measuring instruments which cannot be maintained in a liquid bath. With a brass scale, for instance, an uncertainty of 0·1 degree C.

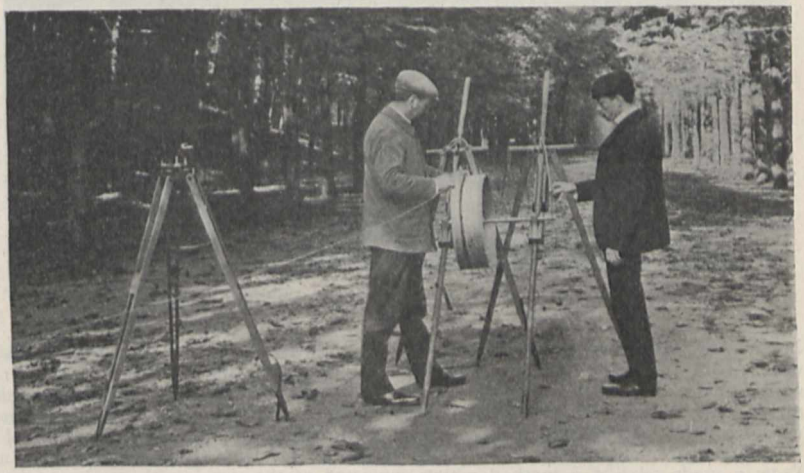

FIG. 5.—Rolling of a 2 km. wire on an aluminium drum.

in the temperature introduces an error little less than 2μ per metre of length. But a rod of invar, thoroughly annealed and aged, will not change to the same extent in an interval of three years. The interpolation of definite values up to five or six years can be made with even less uncertainty. Measurements in which the instability of invar will introduce an unacceptable error are very rare; in the case of standards prepared with the usual metals they would correspond with errors of temperature which are exceeded in nearly all ordinary measurements.

But the greatest claim that invar can make to utility is in its application to geodesy; working in the open air under extremely variable atmospheric conditions makes the deter-

[1] The variation of the rapidity of the change with temperature seems to follow van 't Hoff's law of geometrical progression.

[2] NATURE, No. 1822, September 29, vol. lxx. p. 527.

[3] A more complete description will be found in my recent work, "Les Applications des Aciers au Nickel."

mination of temperature very uncertain, and, on the other hand, a control on returning, by means of a standard of reference in a geodesical or metrological establishment, is always possible. With this idea M. Benoît and myself, at the request of General Bassot, have designed for the use of the Geographical Service of the French Army a scale of 4 metres which is made of invar, and has been found so practical by the surveyors that four other scales of the same type have been constructed for other countries.

This scale has an H-section with a side of 40 mm.; its direction lies in the plane of the neutral fibres, and it has such rigidity that the flexure is quite admissible in an accurate standard supported at only two points. As a consequence, the scale can be placed on a light support which is subjected to no especial conditions of rigidity, since it has not, as in most of the older apparatus, to assure the rigidity of the standard. The support which we have adopted is an aluminium box that completely envelops the scale and protects it from shocks, dust, and accidents of all kinds, as well as from rapid changes of temperature. The complete apparatus weighs 56 kg., whilst the old form of Brunner, consisting of two scales and a rigid support, weighs 72 kg., and affords no protection for the standards.

For direct employment in the field, especially when the apparatus has to be carried to great distances (the scale will, in the near future, be used in the Andes), the facilities introduced, compared with those existing in older apparatus, are considerable, and if they constituted the sole progress in geodesy they would deserve serious consideration. But the use of invar has permitted a more complete transformation in the measurements of bases. Twenty years ago M. Edw. Jäderin made trial of a method which consisted of the use of long wires stretched under a constant load and serving the purpose of fixing between two limits of the base the distance of a series of movable bench-marks, ranged between these limits. The advantage of this method, the rapidity of measurement, lightness of material, and facility in the choice of ground, will be readily appreciated, but it will also be recognised that the uncertainty of the temperature of the wires made the method doubtful in cases where greater accuracy was required than that usual for the ordinary requirements of topography or land-surveying. M. Jäderin has diminished these uncertainties by employing two wires of brass and steel respectively, by means of which each of the ranges was successively measured. The difference observed for the two wires was taken as an indication of their common temperature, whence the temperature of the steel wire, considered as the principal standard, was deduced. Without going into the details of the calculations necessary to the method, it is easy to see that small inevitable errors influence the result; the real difference of temperature of the two wires at the time of the measurements and errors of reading reappear in the result, multiplied by factors of a variable nature, but all greater than unity.

FIG. 6.—Reading the position of the end scale of the wire against a movable mark.

These uncertainties disappear completely with a wire made of invar, especially as the greatest care can be given to the manufacture of comparatively small quantities of the alloy when it is required for particular purposes in which the price, between certain limits, is a secondary consideration; samples may be chosen so as finally to descend below the minimum of the curve in Fig. 2 and cut the axis of the abscissæ. Zero and even negative expansions have thus been realised. The specimens having a minimum expansion are strictly reserved for geodetic purposes, and considerable quantities of wire have thus been obtained of which it is unnecessary to know the temperature within about 10 degrees even for the most precise measurements of base lines. Commonly, a knowledge of the temperature within 5 degrees is sufficient; an error of this magnitude hardly makes a difference of 1 part in 1,000,000.

These advantages could not escape surveyors. As early as 1898, M. Jäderin himself requested me to obtain for him wires[1] made of invar for the purpose of perfecting his method, at a time when M. Benoît and myself were undertaking, at the Bureau international des Poids et Mesures, experiments to ascertain their suitability for such a purpose. The trials were so encouraging that the following year it was decided to equip the Swedish-Russian expedition to Spitsbergen with similar wires, by means of which all its base lines were measured. At this time, however, the experiments were not sufficiently advanced to obviate the need of taking many precautions, and the expedition acted very wisely in not considering the wires as standards of length. The true standards were two iron bars, previously verified at the Bureau international, which served to measure the short bases (the Swedish base was 96 metres long) on which were standardised the wires of 24 metres, which subsequently served to measure the true bases of several kilometres in length. This was the first practical trial of invar in the field, and, according to the reports which I have received from several members of the expedition, notably from M. Jäderin, the success exceeded every hope. Two independent measurements of the Swedish base showed a difference of 19 mm. per 10 kilometres, that is, of 1/500,000 *without introducing any correction for the temperature.*

The same sense of safety in the employment of these wires is felt after reading the report by M. Backlund, of the Russian expedition, and of Commandant Bourgeois, on the measurements of the French Survey in the territory of the Republic of Ecuador. The difference in the measurements of a base made in 1901 with a bimetallic scale and with a wire of invar was 1/3,300,000; the agreement is so good that it must be attributed partly to chance, but such chances are rare when the systematic elimination of errors has not been pushed to extremes.

In any case a more complete study of the wires of invar became necessary, and, on the ground of the studies already commenced by M. Benoît and myself, the International Committee of Weights and Measures entrusted to us, at the end of 1900, on the request of the International Geodetic Association, a detailed investigation of this question.

We therefore erected against a thick basement wall, protected by the building of the laboratory of the bureau, a series of bench-marks spacing out a length of 24 metres at intervals of 4 metres, measured by means of an invar standard. On the outside of the last uprights are two pulleys on ball bearings over which pass two cords that carry weights of 10 kilograms and are attached to the wire on which observations are to be made at the distance of

[1] These wires were manufactured at the steel works of Imphy belonging to the Société de Commentry-Fourchambault and Decazeville, by whose collaboration I was enabled to carry out the work described in this article.

the extreme marks. These wires carry at their extremities scales of invar, having the form represented in Fig. 4, with their edges in the same line as the axis of the wire. This arrangement, somewhat complicated in appearance, is necessary to ensure constancy of length, whatever be the inclination of the scale in a transverse direction.

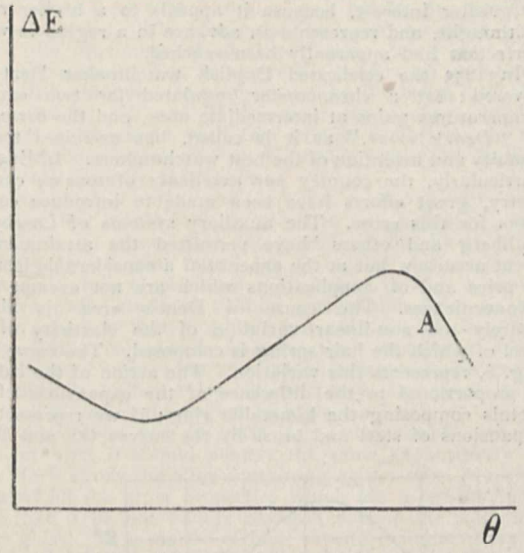


FIG. 7.—General form of the curve of change of Young's modulus for a reversible nickel-steel.

During four years measurements have been made weekly with a great number of wires which have been submitted to different treatment. Owing to the complexity of the subject, more than a hundred thousand comparisons between the wires and the base were necessary to elucidate all the questions relating to the stability of the wires and the precision that they guarantee. After four years, and after the method of treatment of the wires has been gradually modified so as to ensure the greatest possible degree of stability, we can emphatically assert the excellence of the method of measurement by wires constructed of invar. When a wire of the usual diameter of 1·65 mm. is stretched by loads varying from an insignificant weight to that of 20 kilograms, the permanent elongation which it undergoes is not measurable; moreover, it can be rolled as often as desired on a drum (Fig. 5) of sufficient diameter (at least 50 cm.), or kept rolled for months without showing on subsequent measurement a variation greater than that due to errors of observation. Several wires which were measured at the bureau were returned after use in the field; in the beginning, variations in the length of the order 1 in 200,000 were observed in several instances, but recently the constancy of the length has become much more decided. Whilst reserving the results obtained by long trials in severe climates, it may be concluded from the results obtained in the laboratory that a surveying expedition equipped with several wires constructed of invar and subject to mutual control will be able to measure several long bases without fearing a departure from accuracy in the wires greater than that permissible in such measurements, assuming, of course, that the wires are always handled with due care.

The considerable increase in the accuracy of geodetic measurements, caused by the substitution of wires of invar for those of steel or brass, necessitated a corresponding improvement in the apparatus. We have therefore proposed certain new principles which have been realised in instruments constructed with the aid of M. Carpentier, of which a provisional model has been already mentioned in NATURE.[1] A description of the final types which have been adopted would carry me too far; Fig. 6, which indicates one of the measures, may take its place. It will be sufficient to add that, thanks to the new material which has been discovered, the measurement of a base by means of wires answers all the needs of a surveyor; the relative error of the base has fallen below that of the angles; bases can be measured across broken ground, cultivated land, streams and rivers. Above all these advantages, the complete staff, including auxiliaries, need not exceed ten men for a rate of progress of 5 kilometres per day. This arrangement, compared with that by which ten years ago fifty men using rules and microscopes could advance 500 metres a day, exhibits an economy of 98 per cent.! To-day the measurement of a base with all the accuracy required in geodesy costs little more than chaining, and the proof has been so thorough that the French Survey finds its advantageous to measure all its bases by the new method.

The advantages of measurements by wires have been quickly recognised by surveyors. Several departments of survey have requested the Bureau international to standardise wires suitable for base measurements; we have thus had the satisfaction of examining the apparatus for use by the Argentine Republic, Australia, Cape Colony, France, Germany, Japan, Mexico, Roumania, Russia, Servia, and Switzerland.

This simplification in the fundamental measurements of the survey will lead to a reversal in the future of the respective positions of the base and angular measurements. In the old method of surveying measurements of bases were reduced as much as possible and angles multiplied indefinitely; in the new geodesy angles will be controlled by frequent measurement of numerous long bases. This general plan has already been introduced in the United States in the fine work carried out during the determination of the length of the 98° meridian.

*Horology and Chronometry.*—The possibility of constructing a compensated pendulum with its rod of invar is so obvious that it is hardly necessary to emphasise it. It will be sufficient to observe that the slight change which invar undergoes is not for this purpose a serious defect. As it is necessary to determine the rate of a clock at frequent intervals, variations in the daily rate of the order

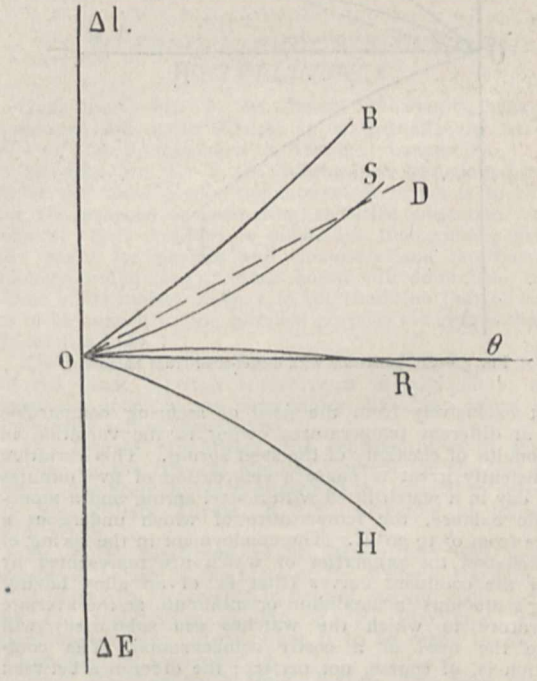


FIG. 8.—Diagram of the compensation of a chronometer with a steel-brass balance.

of a few hundredths of a second in a year will be merged in the variation of the longer period, and will give rise to an error hardly to be feared; but other applications will need some explanation.

In order not to prolong the preliminary part of this article, I omitted to mention a singular property of the nickel-steels,

[1] June 2, 1904, vol. lxx. p. 104.

which for ordinary watch-making is of prime importance. To resume those considerations. At the end of 1896 I found that when an alloy containing 24 per cent. of nickel passes from the non-magnetic to the magnetic state, its modulus of elasticity undergoes a diminution of 10 per cent. This change is the more remarkable inasmuch as the limit of elasticity is simultaneously raised, as was shown by Hopkinson. I was intending to study the same change in invar when M. Thury at Geneva and M. Paul Perret at La Chaux de Fonds, after my first publication, established for the alloy the singular fact of a positive variation of Young's modulus with increasing temperature. A systematic investigation of the change by M. Perret and myself led us to results which, completed by the theoretical views which were developed, permitted me to assign to the total variation of the modulus of a nickel steel endowed with reversible properties a course indicated by the curve in Fig. 7. Point A has the same significance as in the curve of Fig. 1, and two regions of variation in a normal sense are shown, between which lies a region of abnormal variations connected with the first by two confluent curves.

The existence of these confluent curves has a great importance for horology. The necessity of fitting good watches with a bimetallic compensation balance arises

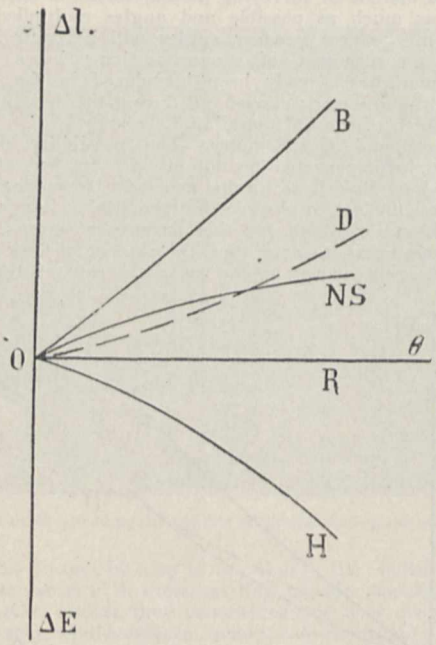


FIG. 9.—Compensation with nickel-steel-brass balance.

almost exclusively from the need of securing comparable rates at different temperatures owing to the variation in the modulus of elasticity of the steel spring. This variation is sufficiently great to cause a retardation of five minutes in the day in a watch fitted with a steel spring and a monometallic balance, the temperature of which undergoes a change from 0° to 30° C. The employment in the spring of a nickel-steel the properties of which are represented by one of the confluent curves (that is, of an alloy having Young's modulus a maximum or minimum at the average temperature to which the watches are submitted) will obviate the need of a costly compensation. The compensation is, of course, not perfect; the difference between the form of the curve and a straight line, and still more, the difficulty of obtaining an alloy passing through a maximum or minimum at ordinary temperatures, limit the application of these springs to ordinary watches, and preclude their use in accurate chronometers. But in their own province they represent a real advance, as they reduce the error of an uncompensated watch by 90 per cent., and the cost of watches which were approximately compensated by a rough balance by 6*d.* in the shilling. The trade of watchmaking gains as much by direct economy as from an increase in quality; the annual saving is certainly 10,000*l.*, and is likely to become 20,000*l.* or 30,000*l.* Competition, moreover, is so keen in the trade that a diminution of prices passes at once from the manufacturer to the consumer, so that the public gains the whole advantage of it.

Another application in chronometry, although its advantages from a monetary aspect are insignificant, seems to me of greater interest, because it appeals to a higher range of thought, and represents an advance in a region in which perfection had apparently been reached.

In 1833 the celebrated English watchmaker Dent discovered that a chronometer regulated for two extreme temperatures gains at intermediate ones, and the correction of "*Dent's error*," as it is called, has exercised the ingenuity and invention of the best watchmakers. In England particularly, the country *par excellence* of marine chronometry, great efforts have been made to introduce corrections for this error. The auxiliary systems of Loseby, of Kullberg and others have permitted the attainment of great accuracy, but at the expense of a considerable increase in price and of complications which are not exempt from inconveniences. The cause of Dent's error is almost entirely the non-linear variation of the elasticity of the steel of which the hair spring is composed. The curve OH, Fig. 8, represents this variation. The action of the balance is proportional to the difference of the expansions of the metals composing the bimetallic ring; if we represent the expansions of steel and brass by the curves OS and OB it

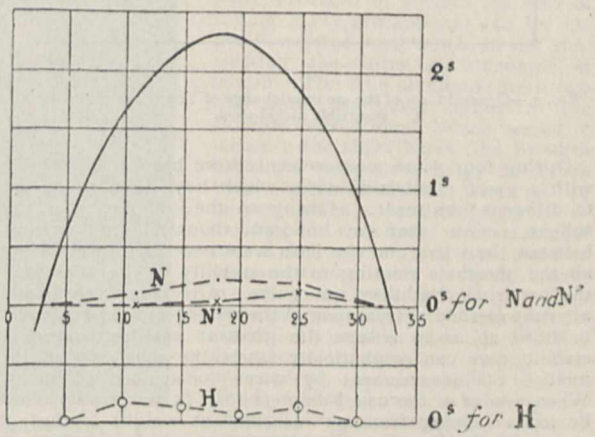


FIG. 10.—Results obtained at Neuchâtel and Hamburg with Nardin chronometers fitted with nickel-steel-brass balances.

will be seen on referring to the numerical formulæ whence these curves are obtained that, whilst their average inclination is very different, the variation of this inclination is nearly the same. The variation of the difference of inclination is therefore nearly zero, and the curve giving the difference of the expansions practically becomes the straight line OD. The rate of the chronometer at different temperatures is given by the algebraical sum of the ordinates of the curves OH (natural variation) and OD (corrective function), that is, by the curve OR. Such is the reason of Dent's error, which has been corrected hitherto by adding to the natural corrective function of the balance a term of great curvature given by an auxiliary system.

But the same result would be attained by substituting for one of the metals of the double ring another metal or alloy of which the increase of expansion is much greater than that of brass, if that metal is rejected, or much less than that of steel, and preferably negative, if the brass is retained. The curve of Fig. 1 offers in this respect numerous possibilities. Practical reasons lead one to retain the brass and to associate with it an alloy having an expansion which is a retarded function of the temperature. Fig. 9, in which the curve OS belonging to steel has been replaced by ONS referring to nickel-steel, shows a curve OD that can be rendered symmetrical with regard to OH; the sum OR of the curves is then always zero, and the problem has a practical solution.

I had established this theory in the year 1899, when two

of the principal Swiss watchmakers, M. P. Nardin, of Le Locle, and M. P. Ditisheim, of La Chaux de Fonds, expressed a wish to make a trial of the new balance. The first attempt gave so perfect a result that the balance has not since been modified; its adoption by Swiss watchmakers was very rapid, and to-day it is employed in the majority of their best timepieces. It was with a pocket chronometer fitted with this balance that M. P. Ditisheim beat in 1903 all records at Kew with a total of 94·9 points, the previous best being 92·7. The compensation was awarded 19·7 points, the maximum of ideal perfection being 20. The dark-lined curve of Fig. 10 shows the theoretical variations of a perfect chronometer compensated by the usual method; the curves N, N′, and H represent the average results obtained at Neuchatel with two groups comprising in all sixteen chronometers, and at Hamburg with six chronometers, all made by M. Nardin.

*Incandescent Lamps and Crookes's Tubes.*—In conclusion, a few words may be given to an application, less scientific in its nature than the preceding, but likely to be welcomed by all who regret the systematic destruction of the world's store of platinum. The curve in Fig. 2 shows that two nickel-steels of definite composition have an expansion equal to that of glass; but only one of these can be practically considered, namely, that containing about 45 per cent. of nickel; the alloy which contains 29 per cent., at a slightly higher temperature passes the point A of Fig. 1 and enters the region of high expansion.

For a metal to fuse in glass it is indispensable, but insufficient, that it should possess the same expansibility as glass; fortunately the alloy containing 45 per cent. of nickel possesses all the other properties which are necessary, provided that it be not unduly oxidised during the softening of the glass. As a matter of fact, several manufacturers of incandescent lamps have adopted, under the name *platinite*, this welcome substitute for platinum, thereby economising several hundred kilograms of the precious metal. If this economy spreads, a ton of platinum may be saved annually for science and those industries in which its use is indispensable.

*Conclusions.*

It is time to conclude this over-long article. The applications which have been described are not the only ones which might be predicted or have been attempted with these curious alloys, the properties of which for a time seemed so paradoxical that a number of physicists and metallurgists refused to believe in their existence. All the applications which to-day give new resources to science and new economies, representing large sums, to industry arise from a peculiar phenomenon of equilibrium in the mutual solution of two isomorphous metals; that is one interesting side of the question. There is another on which I would insist in concluding; it is that these results have been obtained as a sequel to a long series of delicate measurements in which the thousandth of a millimetre was the ordinary unit, and without which no discovery in this domain would have been possible. CH. ÉD. GUILLAUME.

## *SHOWER OF ANDROMEDIDS FROM BIELA'S COMET (?)*

WHAT certainly appears to have been a well defined shower of Andromedids occurred on November 21 and following nights to November 28. Yet this display, if it really represented the débris of Biela's comet, like the meteors seen in November 1872, 1885, 1892, and 1899, was not true to its time, for no return was to be expected, in ordinary circumstances, until 1905 or 1906. The period is about 6·7 years, and if the shower displayed itself this year it must mean that the swarm has been much disturbed, or that the meteors are rapidly distributing themselves round the orbit, and will soon form a continuous stream, visible annually as the earth intersects it in the third week of November.

Dr. Schulhof and Prof. Abelman (*Astr. Nach.*, 3516) pointed out some years ago that a convulsion of the orbit-motion of the Andromedids would occur in 1901, as Jupiter would approach the group to within 0·5 of the earth's distance from the sun in March of the year named. The effect would be a displacement of the node to the extent of 6°, which would bring the maximum on November 17, or ten days earlier than in 1872 and 1885.

The Rev. W. F. A. Ellison, of Enniscorthy, Ireland, writes me that the most remarkable meteoric shower he witnessed in November was furnished by the Andromedids. He was extremely surprised to find the radiant of this stream very active on November 21. At 7 p.m. he counted 8 meteors in fifteen seconds, and although this rate was not maintained, he continued to observe numerous Andromedids until midnight. From 7h. to 8h. 24 were seen, from 8h. to 9h. 22, after which the number decreased. Until November 28 meteors continued to fall from this radiant, and many of them were objects of remarkable brilliancy, quite equal to the Leonids, but the motions were slower and the paths shorter. The prevailing colour was pure white, the trains being greenish. The radiant seemed further north than Mr. Ellison expected to find it, the position being at about 21°+50°.

The following are some of the larger meteors recorded by Mr. Ellison:—

Nov. 21. 8h. 2m. G.M.T. = Vega. From a point a little above α Cygni exactly across δ and about 15° further, directed precisely from Vega.
,, 21. 8h. 49m. = ♀. Low down in west where no stars could be seen to fix the path, but evidently Andromedid.
,, 21. 9h. 8m. = ♃. From 337°+7° to 329°−7°.
,, 21. 9h. 16m. = ♃. From 354°+30° to 348°+18°.
,, 26. 7h. 35m. = ♀. From 52°+27° to 64°+8½°. Duration 2 sec., vivid flash at end.
,, 28. 8h. 50m. > ♀. From about 215°+50° to 215°+46° Very short path, swift and flashing. Impossible to fix path accurately.

It seems desirable to inquire whether any other observers noticed an abundance of meteors on about November 21, and if so whether their paths were directed from the usual radiant point of the Andromedids.

W. F. DENNING.

## *UNIVERSITY AND EDUCATIONAL INTELLIGENCE.*

CAMBRIDGE.—Mr. J. H. Jeans, of Trinity, has been appointed university lecturer in mathematics in the place of Prof. Macdonald, now of Aberdeen University.

The late Mr. G. T. B. Wigan has bequeathed to the university some 9000*l.*, the interest of which is to be used for the purpose of promoting scientific education and research. It is proposed to divide the fund equally between the board for physics and chemistry and the board for biology and geology. Each board will administer the income of its moiety subject to the condition that no portion is to be applied to one specified purpose for longer than five years at a time.

The name of the late Frank McClean, F.R.S., the founder of the Isaac Newton studentships in astronomy, and a generous donor to the observatory, has been added to the university roll of benefactors.

Dr. Donald MacAlister, the representative of the university on the General Medical Council for the last fifteen years, has been elected president of the council in succession to Sir William Turner, K.C.B., principal of Edinburgh University.

Mr. F. F. Blackman, of St. John's, has been appointed reader in botany in the place of Mr. Francis Darwin.

A university lectureship in botany, stipend 100*l.*, is vacant by the resignation of Mr. F. F. Blackman, recently appointed reader. Application is to be made to the Vice-Chancellor by December 17.

Prof. E. Waymouth Reid, F.R.S., has been approved for the degree of doctor of science.

Prof. Woodhead has obtained from friends resident in or connected with Huddersfield a sum of more than 1600*l.* for the endowment of a Huddersfield lectureship in special pathology. The general board proposes that the gifts be gratefully accepted by the university, and that the lectureship be forthwith established.

The museums and lecture rooms syndicate reports that

the zoological collections have outgrown their present accommodation, and suggests that a new zoological museum should be arranged for on the site recently acquired from Downing College, in the neighbourhood of the new Sedgwick Geological Museum.

A new diploma is proposed in mining engineering for students who have resided nine terms and have attained a prescribed standard in certain subjects of the natural sciences and mechanical sciences tripos.

The board of geographical studies has published a report submitting regulations for the special examination in geography for the ordinary B.A. degree, and for the diploma in geography. The range of subjects is comprehensive, and the standard contemplated is obviously high. The regulations are given at length in the *University Reporter*, pp. 301–3. Dr. D. MacAlister and the Right Hon. Sir G. D. T. Goldie, K.C.M.G., have been appointed members of the board.

The memoir of Mr. A. Wood, advanced student of Emmanuel College, on the spontaneous ionisation of air in closed vessels, and its causes, has been approved as qualifying for the certificate of research.

The Rev. Francis Bashforth, second wrangler 1843, formerly fellow of the college, and distinguished for his researches in ballistics, has been elected to an honorary fellowship at St. John's College.

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LORD REAY will distribute the prizes to the students of the Northampton Institute, Clerkenwell, on December 9.

PROF. HELE-SHAW has accepted the post of principal organiser under the Transvaal Technical Council for one year, and has in consequence resigned the chair of professor of engineering at Liverpool.

THE registrar of the University of Leeds announced, at a Mansion House meeting held at York on November 30 in support of the university, that 61,825*l.* has been subscribed toward the 100,000*l.* required to make the necessary additions to the buildings and to increase the endowment of the university, so as to satisfy the financial requirements laid down by the Committee of the Privy Council.

LORD LONDONDERRY will receive a deputation from the Association of Chambers of Commerce of the United Kingdom on Monday next, when the following resolution on commercial education will be submitted:—"That in order to retain our industrial positions and to introduce into this country such further industries as may be profitably developed it is absolutely necessary to establish or acquire public secondary schools of the highest standard, and to provide sufficient inducements by bursaries, exhibitions, scholarships, or otherwise to make the efficient boys stay long enough to take full advantage of the provisions made for higher technical and higher commercial education."

THE third annual meeting of the North of England Education Conference will be held in the St. George's Hall, Liverpool, on January 6 and 7, 1905. The subject to be discussed on the first morning is "Leaving Certificates." Lord Stanley of Alderley will preside, and papers will be read by Mr. G. Alexander, Mr. Owen Owen, and the Rev. J. B. Lancelot. The discussion will be opened by Sir Oliver Lodge and Mr. G. Sharples. In the afternoon of the same day there will be three separate conferences dealing respectively with "Manual Training," the "Teaching of Geography," and "Child Study." Principal Reichel will read a paper on the first subject, Mr. Mackinder on the second subject, and Prof. Sherrington on the third. The subject for discussion by the conference as a whole on the morning of the second day is "Scholarships, with Special Reference to the Coordination of Education." Sir William Anson will take the chair, and papers will be read by Miss S. A. Burstall and Dr. T. J. Macnamara. Messrs. Gore and Edwards will open the discussion. In the afternoon the conference will be divided into three parts to discuss the "Teaching of Domestic Science," "School Games, with Special Reference to Day Schools," and the "Teaching of English." Domestic science will be dealt with in papers by Miss Fanny Calder and Miss E. Pycroft, school games by Messrs. J. L. Paton and F. W. Augell, and the teaching of English by Miss E. Drummond and Mr. G. C. Steel. An exhibition of geographical appliances, apparatus, maps, books, &c., will also be held on the days during which the conference meets.

FROM a long list of recent appointments in such journals as the *Physikalische Zeitschrift*, *l'Enseignement mathématique*, and similar sources, we extract the following professorships, mainly mathematical and physical:—Germany, Austria, &c.—S. A. Arrhenius (Stockholm) for meteorology and cosmical physics at Berlin; H. Battermann for astronomy, and directorship of observatory at Königsberg; K. Cranz (Stuttgart) at technical college, Charlottenburg, Berlin; O. Eggert (Berlin) for geodesy at technical college, Danzig; Dr. Furtwangler for mathematics at agricultural college, Bonn-Poppelsdorf; Grassmann (Halle) at Giessen; L. Hefter (Bonn) at technical college, Aachen; G. Landsberg (Heidelberg) extraordinarius for mathematics at Breslau; K. Oertel for astronomy at Munich; R. Prantl (Hanover) extraordinary at Göttingen; Rohn (Dresden) for descriptive geometry at Leipzig; C. Runge (Hanover) at Göttingen; K. Schreber at Greifswald; J. Sommer for mathematics, technical college, Danzig; P. Stäckel (Kiel) at technical college, Aachen, to replace Prof. van Mangoldt, who is transferred to Danzig; Vahlen (Königsberg) at Greifswald; Wellenstein (Giessen) extraordinary for mathematics, Strassburg. France.—Cartan for calculus at Nancy; Cotton for mechanics at Grenoble; Drach for mechanics at Poitiers; Lecornu for mechanics at polytechnic college, Paris, in place of the late M. Sarrau; H. Poincaré for astronomy at polytechnic, Paris; Raffy for analytical geometry, Paris; Jules Tannery for calculus at Paris. Italy.—F. Guardacci (Florence) for geodesy at Bologna; Mich. Rajna for astronomy, and directorship of observatory, Bologna; in addition, F. Amadeo has been appointed recognised teacher for history of mathematics at Naples. America.—G. H. Hallett and C. A. Holden (extraordinary), Pennsylvania; D. N. Lehmer (extraordinary), California; James MacMahon, Cornell; Robert E. Moritz for mathematics, Washington; H. L. Rietz (extraordinary), Illinois; J. H. Tanner, Cornell; A. W. Whitney, California; besides the following instructorships in mathematics:—J. W. Bradshaw, Michigan; A. B. Coble, Baltimore; L. C. Karpinsky, Michigan; E. B. Lytle, Illinois; C. L. F. Moore, Massachusetts; A. Ranum, Wisconsin; F. C. Touton, Illinois.

THE annual dinner of the past and present students of the Queen's Faculty of Medicine in the University of Birmingham was held on November 29. In proposing the toast of "The Medical School," Sir F. Treves said:—"It is very much to be regretted that very little heed is given to science in this country. There was a time when the man of science—Galileo, for example—was cast into prison; now he is simply allowed to starve. There is no kind of encouragement offered to science. In every university throughout the country the same story is told. I think that those men who devote themselves to science in this country deserve rewards infinitely beyond any they have ever received." Mr. Chamberlain, who was present in his capacity of Chancellor of the university, in proposing the toast of "Students, Past and Present," referred to the remarks of Sir F. Treves. Mr. Chamberlain said:—"I am afraid that for all time to come probably science, and the conferring of great benefits upon one's fellow-creatures, must be, to a large extent, its own reward. But the pursuit of research is an impossibility so long as the actual means of existence are wanting, and the professional practitioner when he starts is, in very many cases at any rate, so tied by the necessity of providing an actual subsistence for himself and his family that anything like original and continuous research is in his case impossible. That can only take place when there are in this country schools established where for a year or two, perhaps in their younger time, men of ability and of interest in school subjects can be brought together under capable heads, and can carry out on the most extended scale that series of researches which already, in the hands of some of our most distinguished men of science, have led to such important results." During the course of his remarks Mr. Chamberlain also said that three classes of people are essential to the success of a modern university—students, teachers, pious benefactors. "Unfortunately," he said, "we have fewer pious benefactors in this country than they have in

the United States of America, where, by their munificent donations, counting by millions, they have covered the land with a net-work of universities which have brought higher education within the reach of almost every citizen. I hope the time is coming when men who have more than they want, more, perhaps, than is good for them, can find no better opportunity of disposing of the surplus than by benefactions which not only are of present usefulness, but, what is of more importance, are of permanent advantage to the community amongst which they live."

ON Thursday last, December 1, the prizes and certificates gained by students of the Sir John Cass Technical Institute during the session 1903–4 were distributed by Sir William White, K.C.B., F.R.S., when the chair was taken by Sir Owen Roberts, chairman of the governing body. Sir William White, in the course of his address, said that during his recent visit to America he had had the opportunity of studying the methods of technical education in vogue there, and he must certainly confess that both America and Canada can teach us a great deal so far as technical colleges in general, and the interest taken by employers of labour in the future employment of men trained in technical institutions, is concerned. The essential advantage which America and Canada, and also Germany, possess over this country is that they are all imbued with the idea that it is a wise investment on the part of a nation to provide for all kinds of education from the elementary up to the highest. It is almost impossible to make expenditure on education too lavish, provided it is well directed, if the nation is to be well educated. This country, in his opinion, will never reach a truly healthy condition until every man or woman, in whatever position the accident of birth may place them, shall, if they possess the capabilities, have also the opportunities of self-culture. Nevertheless, there is one respect, he thought, in which this country stands supreme. It is in the provision of evening classes for the working man and the working woman who, from the very nature of their circumstances, are compelled to work all day to get a living. Employers should assist these educational classes more than they do at present. The London and South-Western Railway Company are doing what may well be done by other large employers. They grant to the apprentices in their works at Nine Elms the necessary time to attend the early morning classes at the Battersea Polytechnic. The apprentices are allowed to go to these classes twice a week, and are paid for the time that they are away from the company's service, on the condition that they do a certain amount of study at home, thus completing in the evening the training which they receive during the day at the polytechnic. This is not altogether an experiment. The Admiralty has done the same thing for fifty years or more, with the result that the Admiralty, from the apprentices in its own dockyards, has trained not only many of its principal shipbuilding officers and naval architects for the Royal dockyards and the Admiralty service, but has also furnished to the private shipbuilding industry of the country some of its most famous shipbuilders. The leaders and managers in those great private establishments to-day are in no small proportion drawn from men who were trained in the Admiralty service under the system which has been in operation, and by which every apprentice who cares to improve his mind has the opportunity to do so. If employers will give the utmost encouragement to institutions like the Sir John Cass Institute, they will be rewarded by having capable men on their staff who will know the principles of their business.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, November 17.—"The Electrical Conductivity and other Properties of Sodium Hydroxide in Aqueous Solution, as Elucidating the Mechanism of Conduction." By W. R. **Bousfield**, K.C., M.P., and T. M. **Lowry**, D.Sc.

The original object of the research was to investigate the decay, as the temperature rises, in the "ionising" properties of water, which is manifest in the inflected character of the curves expressing the relation between temperature and conductivity in aqueous solutions of the alkalies.[1] The principal results of the investigation are as follows:—

(1) In the most dilute solutions, in which "ionisation" is nearly complete, and again in the most concentrated solutions, the curves expressing the relation between molecular conductivity and temperature in aqueous solutions of sodium hydroxide are not inflected between 0° C. and 100° C. In each case the form of the curve appears to be determined mainly by the rapid changes of viscosity which accompany changes of temperatures. Moderately dilute solutions give curves that are inflected between 0° C. and 100° C.; the temperature of inflection reaches a minimum, at 48° C., in the case of a normal (4 per cent.) solution, but rises to 100° C. when the concentration is raised to 30 per cent.

(2) The inflected conductivity-temperature curves can be represented by the formula

$$\kappa_t/\kappa_0 = \rho_v/\rho_0\ (1+bt)^n\ e^{-\alpha t}.$$

This formula is applicable to conductivity-temperature curves of all kinds, and gives expression, not only to the inflection now under consideration, but also to the maximum conductivity and the second inflection in the general conductivity-temperature curve.[2]

(3) The maximum conductivity of caustic soda at 18° C. is 0·3490 in a 15 per cent. solution, the value given by Kohlrausch being 0·3462. At higher temperatures the maximum conductivity is considerably greater, rising to more than 1·4 at 100° C., and occurs in solutions of greater concentration.

(4) The viscosity of a 50 per cent. solution of sodium hydroxide is approximately seventy times as great as that of water. The influence of this factor may be to some extent eliminated by dividing the molecular conductivity by the fluidity, and this ratio it is proposed to call the "intrinsic conductivity" of the solution. Whilst the molecular conductivity of sodium hydroxide solutions decreases steadily as the concentration is increased, the intrinsic conductivity falls to a minimum at about 8 per cent. NaOH, and then rises, until at 50 per cent. NaOH, the value is considerably greater than in the most dilute solutions. It is believed that this increase is due to the fact that liquid soda is an electrolyte, *per se*, and that, in concentrated solutions, the current is conveyed partly by the soda alone, as if it were in the fused state.

(5) In re-determining the densities of aqueous solutions of sodium hydroxide, quantities of sodium, amounting to about 150 grams at a time, were weighed, and converted quantitatively into concentrated solutions of sodium hydroxide by the action of steam in a platinum vessel. Eleven determinations, made with six different standard solutions, gave, as the density of a 50 per cent. solution at 18° C., the value 1·5268, with an average error of 0·0001. Solutions of known concentrations having been prepared by dilution, their densities were determined with a probable error of not more than 0·0001; the values recorded by previous observers were derived from solutions standardised by titration only, and appear to contain errors in the third or even in the second place of decimals.

(6) In the formula

$$\rho_t = \rho_0 + \alpha t + \beta t^2 + \gamma t^3,$$

which represents the influence of temperature on the density of water and aqueous solutions of soda, the coefficient of $t^3$ vanishes when a concentration of 12 per cent. NaOH is reached, whilst the coefficient of $t^2$ vanishes at 42 per cent. NaOH; at the latter concentration there is a simple linear relationship between density and temperature.

(7) The molecular volume of sodium hydroxide in dilute aqueous solution has a large negative value, a litre of water dissolving 140 grams of sodium hydroxide at 0° C., 100 grams at 18° C., or 60 grams at 50° C., without increasing in volume. The molecular volume does not increase continuously as the temperature rises, but reaches a maximum value at about 70° C. In a 50 per cent. solution the temperature has little effect on the molecular volume, the extreme variation being only about 10 per cent.

[1] Compare Roy. Soc. *Proc.*, 1902, vol. lxxi. pp. 42–54.
[2] *Loc. cit.*, p. 52.

**Entomological Society**, November 16.—Prof. E. B. Poulton, F.R.S., president, in the chair.—Mr. H. St. J. **Donisthorpe** exhibited the second recorded British specimen of *Orchestes sparsus*, Fahr., taken by him on August 28 in the New Forest.—Mr. H. W. **Andrews** exhibited specimens of *Atherix crassipes*, Mg., from the New Forest, the only previously recorded locality in Britain being near Ticehurst, Sussex.—Mr. G. O. **Sloper** exhibited aberrant forms of *Melitaea athalia* from Luan, Switzerland, and Martigny, in which the tendency of the black markings to supersede the fulvous was particularly noticeable.—The **President** exhibited cases containing Diptera, and a case containing the skins of African Sphingid larvæ, dried in botanical paper, and after seventy years still preserving their colours, from the Burchell collection in the Hope Museum, Oxford.—Mr. C. O. **Waterhouse** exhibited a gall of some lepidopterous insect found on the califate bushes in Patagonia. The gall resembled that of *Cynips kollari*, but was hollow, the walls being about ⅛ inch in thickness. The circular door prepared by the larva was about ⅛ inch in diameter. The pupa was lying free, without any silk cocoon. It was suggested that the insect was perhaps allied to Œcocecis.—Mr. G. H. **Kenrick** communicated a paper entitled "Natural Selection Applied to a Concrete Case."—Mr. J. C. **Kershaw** communicated papers on enemies of butterflies in south China, and a life-history of *Gerydus sinensis*.—Mr. Nelson **Annandale** communicated a paper on the eggs and early stages of a Coreid bug, probably *Dalader acuticosta*, with a note on its hymenopterous parasites.

**Royal Microscopical Society**, November 16.—Sir Ford North, F.R.S., in the chair.—Mr. Hugh C. **Ross** exhibited and described a new electric warm stage of his invention.—Mr. C. L. **Curties** exhibited two new designs of the Nernst lamp suitable for use with a current of 100 and 200 volts respectively, adapted for use with the microscope, and fitted with ground glass or blue glass fronts and mounted so as to be used at any height or angle required.—A paper on theories of microscopic vision, a vindication of the Abbe theory, which contained some new views on the subject, was read by Mr. **Conrady.**

**Linnean Society**, November 17.—Prof. W. A. Herdman, F.R.S., president, in the chair.—Mr. H. E. H. **Smedley** exhibited forty-one models of Palæozoic seeds and cones. The models of the seeds show the complexity of their internal structure, whilst the models of the synthetically re-constructed calamitean and other cones display the high organisation of the vascular cryptogams of Palæozoic times.—Note on the shape of the stems of plants: Lord **Avebury.** The author pointed out that while most plants had round stems, in some they were triangular, some quadrangular, &c., but that, so far as he knew, no attempt had been made to explain these differences. He thought they could, however, be accounted for on mechanical principles. In building, when the main object was to meet a strain in one direction, the well known girder was the most economical disposition of material. In a tree-stem it was necessary to resist strain coming from all directions, and the woody tissues acted as a circular series of girders. In herbs with opposite leaves the strains were mainly in two directions, and were met by two opposite girders, thus giving the quadrangular stem. Taking our native flora he showed that all herbs with quadrangular stems had opposite leaves, and as a rule herbs with opposite leaves had quadrangular stems. Sedges had triangular stems and grasses round stems, and while sedges had the leaves in threes, those of grasses were distichous. Pentagonal stems might be accounted for in a similar way, and incidentally this threw light on the petals of so many flowers. Thus plants had adopted, millions of years ago, principles of construction which have gradually been worked out by the skill and science of our architects and engineers.—Observations on some undescribed or little known species of Hemiptera Homoptera of the family Membracidæ: G. Bowdler **Buckton.** Prof. Poulton has explained the significance of the strange forms of some of the Membracidæ by their dependence on environment, and the requirements of mimicry; and the Rev. Canon Fowler has also given information respecting the economics of the species, and their maintenance during the struggle for life. The present paper may be regarded as supplementary to Canon Fowler's work on the Membracidæ in the "Biologia Centrali-Americana," and to Mr. Buckton's monograph, in which latter work an attempt has been made to classify the family so far as at present known. The specific descriptions are chiefly founded on specimens from the museums of Madrid and Brussels. Most of the new species are from Mexico and Central America, six from Africa, and one each from India, Ceylon, Sumatra, and the Philippines. Mr. Buckton then characterises twenty-four new species, five of which are made the types of new genera, and the paper concludes with general observations on the habits, economy, and transformations of the Membracidæ.

**Physical Society**, November 25.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—The measurement of small differences of phase: Dr. W. E. **Sumpner.** Hitherto, in order to measure the differences of phase between alternating-current quantities, it has been necessary to use some method involving the simultaneous reading of three deflectional instruments, such as the wattmeter method, or the three-voltmeter method either in its original or in some modified form. These methods cannot be successfully applied when the phase-differences to be determined are small. The author describes new voltmeter methods which may be used for the purpose, and gives the results of a number of measurements on alternating-current plant.—Dr. C. V. **Drysdale** exhibited and described apparatus for the direct determination of the curvatures of small lenses, such as the objectives of microscopes. Parallel light from a distant source falls upon a plane unsilvered mirror inclined at an angle of 45°. Some of the light is reflected and brought to a focus by an ordinary convex lens. The surface to be tested is placed at this point, and the reflected rays proceed as if they had come from a point on the surface. They pass through the plate glass into a telescope focused for parallel rays, and an observer sees an image of the distant source. If the surface is convex and is brought nearer to the lens, then, when it reaches such a position that its centre of curvature is at the focus of the rays emerging from the lens, the light will again retrace its former path and a distinct image of the source will be seen in the telescope. In order to obtain the two images the surface has therefore been moved through a distance equal to its radius of curvature. If the surface is concave it must be moved away from the lens. Dr. Drysdale showed how the method could be carried out by means of an auxiliary piece fitted to an ordinary microscope. He also described a method of testing the spherical and chromatic aberration of microscopic objectives. Light from a distant point is partially reflected by means of a piece of plate-glass down the axis of the microscope. In passing out of the objective it is brought to a focus upon a mirror, and retraces its path along the axis of the instrument until it reaches the plate glass. This it passes through, and by means of a telescope an observer can view the distant source. The light having passed twice through the lens to be investigated, the effects of chromatic and spherical aberration are doubled, and at the same time the effect of coma is eliminated.—Prof. S. P. **Thompson** gave an exhibition of specimens of crystals showing the phenomenon of luminous rings. He said it was well known that when a source of light was viewed through certain samples of calc-spar the field of vision contained two luminous rings each of which passed through the image of the luminous point. The subject had been investigated by Dr. Johnstone Stoney, who had attributed the phenomenon to a minute tubular structure in the crystal. There were, however, certain crystals which when cut in the ordinary way across the axis and used to view a distant source of light exhibited a single luminous ring passing through the image of the source. Looking down the axis of the crystals no ring is visible, but on tilting it a ring can be seen in the direction of the tilt which grows in diameter as the tilt is increased. So far as he knew, no explanation of these phenomena had been offered. At the meeting a piece of calc-spar showing the two rings, and pieces of beryl and tourmaline showing the single ring were exhibited.

EDINBURGH.

**Royal Society**, November 7.—Lord M'Laren in the chair.—In a paper on Prof. Seeliger's theory of temporary stars, Dr. J. **Halm** gave some important extensions bearing especially upon the characteristics of Nova Aurigæ (1892) and Nova Persei (1902). Seeliger's theory, broadly stated,

is that a temporary star results from the collision of a dark body with a nebula, the chances of such a collision being much greater than the collision of two dark bodies. A necessary consequence will be an intense superficial heating with an atmospheric expansion in all directions. In whatever direction an observer may be situated, spectroscopic observations will show, (1) a displacement violet-wards of absorption lines or bands due to the absorptive action of the expanding and cooling atmosphere advancing in the direction of the observer with the hotter interior parts of the star as background; and (2) bright bands due to the expanding atmosphere to right and left of the body of the star, there being in this case no brighter background and no spectral shift. Dr. Halm now imagines that the collision is due to the advance of the dark body into a stream of nebulous matter passing obliquely across the dark body's path. This will at once give rise to a circulation of parts of the nebula round the star, and these, of course, will also be highly heated. The portions moving transverse to the line of sight across the face of the star will produce absorption bands in their normal position in the spectrum, while the marginal portions moving on the one side towards the observer and on the other side from him will produce a shift of bright bands both towards the red and towards the violet end of the spectrum. By compounding the effects of these two conditions, namely, the simple expansion of the atmosphere equally in all directions and the swirl of incandescent matter due to oblique collision, Dr. Halm showed that the two types of spectra obtained in the cases of the recent Novæ were at once obtained.—Three papers by Dr. Thomas **Muir** were also communicated, the titles being "The Sum of the Signed Primary Minors of a Determinant," "Continuants Resolved into Linear Factors," and "The Three-line Determinants of a Six-by-Three Array."

November 21.—Lord M'Laren in the chair.—Mr. George **Romanes,** C.E., read a paper on a possible explanation of the formation of the moon. The general idea was that the moon had grown to its present form and size by the gradual agglomeration of what was originally a ring of satellites broadly similar to what we know to exist in the case of Saturn. On this hypothesis it was easily shown that the process of agglomeration of a comparatively small body like the moon could not be accompanied with an evolution of heat sufficient to produce a molten globe, and that in consequence the ordinary assumption of intense volcanic action to explain the so-called craters was difficult to accept. But it seemed possible to account for the rugged mountainous surface of the moon with the "seas," ridges, "craters," and peaks by means of the bombardment of those meteoric masses, large and small, which in virtue of the combined action of moon, earth, and sun were precipitated from time to time upon the lunar surface. In the absence of an atmosphere the masses so precipitated would impinge upon the surface with high enough velocities to render the material in the immediate vicinity liquid, the impinging mass also itself being liquefied wholly or partially according to circumstances. The author entered into a detailed examination of some of the most striking features of the moon's surface, and showed how this hypothesis accounted for them. He also exhibited a mass of lead into which small bullets had been shot at various incidences. The indentations reproduced the leading characteristics of the lunar "craters," even to the small hill in the middle of the main depression. It was also noticed that at the instant of impact the rim of lead thrown up all round was made red hot. The mysterious streaks so characteristic of Tycho in certain aspects were explained as due to great splashes of material which settled down in thin crystalline layers capable of throwing off the reflected sunlight in definite directions.—Prof. **Coker** described a laboratory apparatus for measuring the lateral strains in tension and compression members. By a well designed combination of levers and mirror attachment an apparatus capable of being fixed to the bar itself had been constructed, which was sufficiently rigid and yet sensitive enough to measure a change of 1/20,000th of an inch. Some experiments on steel, iron, and brass bars were described, in which the new apparatus was used in conjunction with Ewing's extensometer, and values of Poisson's ratio were given to three significant figures. The values varied from one-third to one-fourth.

PARIS.

**Academy of Sciences,** November 28.—M. Mascart in the chair.—On the possibility of chemical reactions: M. **de Forcrand.** The author contends that the rigid application of the thermodynamical condition of the possibility of a chemical reaction is neither practical nor necessary, and that the empirical rule that the disengagement of heat settles the course of a reaction is the only possible experimental criterion of the possibility of chemical reactions.—On the prediction of chemical reactions: M. **de Forcrand.** In general, accurate prediction of the course of a chemical reaction is impossible, but there are two rules or principles, one rigorous the other approximate. The latter, the principle of maximum work, is a simplification of the first, and ought to be considered as the only practical guide.—M. Dastre was elected a member in the section of medicine and surgery in the place of the late M. Marey.—The Leonids in 1904: Lucien **Libert.** Details of observations made at Havre on the nights of November 14, 15, and 15, 16. 111 meteors were observed and the trajectories measured.—On the singularities of uniform analytical functions: D. **Pompeiu.**—On a new class of ions: G. **Moureau.** In a previous paper it has been shown that a saline vapour becomes conducting after passing through a porcelain tube heated to about 1000° C., and remains conducting at much lower temperatures, possessing the properties of an ionised gas. In the present paper the mobilities of these new ions have been measured. It was found that in the neighbourhood of the region of ionisation the mobilities of the vapours are of the same order as the ions of the gases issuing from a flame.—On the genesis of temporary radio-activity: Ed. **Sarasin,** Th. **Tommasina,** and F. J. **Micheli.** The authors conclude from the results of their work that a very close relation appears to exist between ionisation and the production of temporary radio-activity. The two phenomena would appear to be reversible, the production of the temporary radio-activity of a body being due to the absorption, or, perhaps, adsorption of an emanation which is formed during the ionisation of a gas. On this view, the radio-activity would consist in the loss by radiation of the emanation adhering to radio-active bodies, this causing, in its turn, the ionisation of a gas.—Stereoscopy without a stereoscope: A. **Berthier.** The author points out that he has already published a description of a method similar in principle to that given by M. Ives in the *Comptes rendus* of October 24 last.—On the colloidal state of matter: G. E. **Malfitano.** The author regards colloidal matter as a system formed of an electrolyte dissociated into ions and insoluble molecules grouped round these ions.—The influence exerted by the removal of the moisture from the air supplied to the blast furnace: A. **Lodin.** The results obtained by Gailey at the Isabella blast furnaces, near Pittsburg, on he effect of drying the air forced into the furnace, have attracted much attention in Europe, not unmixed with scepticism. The author makes a comparison of the heat balances in the two cases, and shows where the economy is effected. One indirect effect of the drying process is to increase the temperature of the ingoing air, and a considerable portion of the economy effected may be attributed to this cause. In Europe, where it is usual to work with the air entering the tuyeres at a much higher temperature than at the Isabella furnaces, the relative economy which would be produced by drying the air would be too small to justify the capital expenditure required to introduce the necessary plant.—On the use of dry air in blast furnaces: Henri **Le Chatelier.** The economy claimed for the use of dry air is ascribed by the inventor of the process to the fact that the moisture of the undried air transforms a certain proportion of the coke into hydrogen and oxide of carbon. From the figures of the amount of water removed it is possible to calculate exactly this loss; it is 5 per cent., or only one-fourth of the amount claimed. It is certain, then, either that the economy claimed is incorrect, or else that the true cause is to be sought for elsewhere. The author shows that the quality of the iron produced, especially as regards its sulphur impurity, is an important factor, and that when the sulphur is to be kept down to a certain percentage the economy of fuel claimed by Gailey may be real.—On wood spirit from *Thuya articulata,* Algeria: Emilien **Grimal.** Carvacrol, thymohydroquinone, and thymoquinone were isolated from the product of the distillation

of this wood with steam.—The formation and distribution of the essential oil in an annual plant: Eug. **Charabot** and G. **Laloue.** During the formation of the flower the increase of essential oil by the flower corresponds to a loss of oil by the green parts. After the seed is formed, and there is no longer a flow of nutritive principles towards the flower, the essential oil returns to the green organs.—Floral abnormalities produced by parasites acting at a distance: Marin **Molliard.** The atrophy of the stamens, and the conversion of the sepals, petals, and carpels into green foliaceous leaves, a phenomenon frequently met with in *Trifolium repens*, is shown to be due to the burrowing of a larva (probably of *Hylastinus obscurus*) at the base of the stem of the plant.—*Xylotrechus quadrupes* and its ravages on the coffee plant of Tonkin: L. **Boutan.**—The individuality of the complex particle in a crystal: M. **Wallerant.**—On the lakes of the Grimsel and of the St. Gothard massif: André **Delebecque.**—The degree of saline concentration of the blood serum of the eel in sea water and in fresh water, after its experimental passage from the former to the latter: René **Quinton.** The percentage of salt in the blood serum of the eel varies in accordance with the degree of salinity of the water in which it is placed, and is an example of the fact that the saline concentration of fresh water fishes is that of their marine ancestors, reduced simply by the influence of the new medium in which they live.—The elimination of urea in healthy subjects: H. **Labbé** and E. **Morchoisne.**—Contribution to the study of acid dyscrasia: A. **Desgrez** and J. **Adler.**—On the bleaching of flour: E. **Fleurent.**

## DIARY OF SOCIETIES.

*THURSDAY*, DECEMBER 8.

ROYAL SOCIETY, at 4.30.—Memoir on the Theory of the Partitions of Numbers. Part III: Major P. A. MacMahon, F.R.S.—Note on a Means of Producing a High-voltage Continuous or "Pertinacious" Current: Sir Oliver Lodge, F.R.S.—The Effect of Liquid Air Temperatures on the Mechanical and other Properties of Iron and its Alloys: Sir James Dewar, F.R.S., and R. A. Hadfield.—The *Rôle* of Diffusion during Catalysis by Colloidal Metals and Similar Substances: Dr. H. J. S. Sand.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY, at 8.—Notes on Portland Cement: H. E. Bellamy.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Hydrodynamical and Electromagnetic Investigations regarding the Magnetic-Flux Distribution in Toothed-Core Armatures: Prof. H. S. Hele-Shaw, F.R.S., Dr. A. Hay, and P. H. Powell. (Conclusion of Discussion).—Studies in Magnetic Testing: G. F. C. Searle.

SOCIETY OF ARTS, at 4.30.—Burma: Sir Frederic Fryer, K.C.S.I.

MATHEMATICAL SOCIETY, at 5.30.—On Groups of Order $p^{\alpha} q^{\beta}$: Prof. W. Burnside.—On the Linear Differential Equation of the Second Order: Prof. A. C. Dixon.—On a Deficient Multinomial Expansion: Major P. A. MacMahon.—The Application of Basic Numbers to Bessel's and Legendre's Functions (second paper): Rev. F. H. Jackson.—On the Failure of Convergence of Fourier's Series: Dr. E. W. Hobson.—An Extension of Borel's Exponential Method of Summation of Divergent Series Applied to Linear Differential Equations: E. Cunningham.

*FRIDAY*, DECEMBER 9.

ROYAL ASTRONOMICAL SOCIETY, at 5.—(1) Dark Nebulosities; (2) Detached Nebula in Cygnus: W. S. Franks.—On the Relative Brightness of Binary Stars: J. E. Gore.—(1) On the Completion of the Main Problem in the New Lunar Theory; (2) The Final Values of the Coefficients in the New Lunar Theory: Prof. E. W. Brown.—On the Relative efficiency of Different Methods of Determining Longitudes on Jupiter: A. Stanley Williams.—On the Temperature of Sun-spots, and on the Spectrum of an Artificial One: W. E. Wilson.—On the Validity of Meteor Radiants deduced from Three Tracks: H. W. Chapman.—*Promised papers*:—Observations of the Leonid Meteors of 1904 November: Royal Observatory, Greenwich.—Radio-activity of Matter the Possible Cause of Heat Energy in Sun and Stars: W. E. Wilson.—Mean Areas and Heliographic Latitudes of Sun-spots in the Year 1903: Royal Observatory, Greenwich.—The Coefficients of 145 Terms in the Moon's Longitude derived from Greenwich Meridian Observations, 1750–1901: P. H. Cowell.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—Ticks and Tick-transmitted Diseases: Dr. Nuttall, F.R.S.

MALACOLOGICAL SOCIETY, at 8.—Description of a new species of Trachiopsis from British New Guinea: H. B. Preston.—A Correction in Nomenclature: E. A. Smith.—Notes on the American Cyclostomatidæ and their Opercula: W. H. Dall.—Note on the Dates of Publication of the Various Parts of Moquin-Tandon's "Hist. Moll. terr. fluv. de France": J. W. Taylor.

PHYSICAL SOCIETY, at 8.—On a Rapid Method of Approximate Harmonic Analysis: Prof. S. P. Thompson, F.R.S.—A High-Frequency Alternator: W. Duddell.—Exhibition of Experiments to show the Retardation of the Signalling Current on 3500 miles of the Pacific Cable between Vancouver and Fanning Island.—Exhibit of Ayrton-Mather Galvanometers, Universal Shunts, and Electrostatic Instruments.

*MONDAY*, DECEMBER 12.

SOCIETY OF ARTS, at 8.—Musical Wind Instruments, Reed Instruments: D. J. Blaikley.

SOCIETY OF DYERS AND COLOURISTS, at 8.—Bleaching Agents: and the Methods of Application: F. W. Walker.—The Application of Sulphide Colours in the Dyeing of Chrome Leather.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Explorations in Bolivia: Dr. H. Hoek.

*TUESDAY*, DECEMBER 13.

ZOOLOGICAL SOCIETY, at 8.30.—Some Notes on Anthropoid Apes: Hon. Walter Rothschild.—On the Cranial Osteology of the Clupeoid Fishes: Dr. W. G. Ridewood.—The Characters and Synonymy of the British Species of Leucosolenia: Prof. E. A. Minchin.

SOCIOLOGICAL SOCIETY, at 8.—The School in Some of its Relations to Social Organisation and to National Life: Prof. M. E. Sadler.

INSTITUTION OF CIVIL ENGINEERS, at 8.—On the Construction of a Concrete Railway-Viaduct: A. Wood-Hill and E. D. Pain.

*WEDNESDAY*, DECEMBER 14.

CHEMICAL SOCIETY, at 5.30.—Hydrolysis of Ammonium Salts. V. H. Veley.—The Viscosity of Liquid Mixtures. Part ii.: A. E. Dunstan.—The Diazo-reaction in the Diphenyl Series. Part ii.: Ethoxybenzidine: J. C. Cain.—The Sulphate and the Phosphate of the Dimercurammonium Series: P. C. Ray.—A Method for the Direct Production of certain Aminoazo-compounds: R. Meldola and L. Eynon.

SOCIETY OF ARTS, at 8.—The Patent Laws: C. D. Abel.

*THURSDAY*, DECEMBER 15.

ROYAL SOCIETY, at 4.30.—*Probable Papers*:—An Analysis of the Results from the Falmouth Magnetographs on "Quiet" Days during the Twelve Years 1891 to 1902: Dr. C. Chree, F.R.S.—The Halogen Hydrides as Conducting Solvents. Part iii.: B. D. Steele.—The Halogen Hydrides as Conducting Solvents. Part iv.: B. D. Steele, D. McIntosh, and E. H. Archibald.—Effects of Temperature and Pressure on the Thermal Conductivities of Solids. Part i., The Effect of Temperature on the Thermal Conductivities of some Electrical Insulators: Dr. C. H. Lees.—The Basic Gamma Function and the Elliptic Functions: Rev. F. H. Jackson.—On the Normal Series satisfying Linear Differential Equations: E. Cunningham.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Discussion on Mr. Searle's Paper, Studies in Magnetic Testing; Followed by The Combination of Dust Destructors and Electricity Works, Economically Considered: W. P. Adams.

LINNEAN SOCIETY, at 8.—The Ecology of Woodland Plants: Dr. T. W. Woodhead.—Experimental Studies on Heredity in Rabbits: C. C. Hurst.

*FRIDAY*, DECEMBER 16.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Heat Treatment Experiments with Chrome-Vanadium Steel: Capt. H. Riall Sankey and J. Kent-Smith.—Messrs. Seaton and Jude's Paper on Impact Tests on the Wrought Steels of Commerce will be further discussed.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Folkestone Harbour: Cylinder-Sinking at the Root of the Old Pier: R. H. Lee Pennell.

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