THURSDAY, FEBRUARY 9, 1899.

A HISTORY OF COAL MINING.

Annals of Coal Mining and the Coal Trade. By R. L. Galloway. Pp. xii + 533. (London: The *Colliery Guardian* Co., Ltd., 1898.)

THE scientific study of any art or industry demands, almost as a matter of necessity, that its history should not be neglected, for it is only when its mode of evolution has been clearly traced that the principles upon which it depends can be thoroughly understood. The proper scientific training of the coal miner is a subject that is at present engaging the attention of a large number of those interested in this branch of industry, and to all these Mr. R. L. Galloway's history of coal mining—for such his work really is—will come as a welcome educational weapon; nor will it prove any the less valuable because it has obviously been written without any specific intention of applying it to this purpose.

The author's object has simply been to write a history of the coal trade in Great Britain, and to trace the gradual rise and progress of coal mining from its small and almost accidental beginnings to the present gigantic industry employing directly something like three-quarters of a million of workers, and producing over two hundred millions of tons of coal annually, so that, although no record of its existence can be traced before the twelfth century, the coal trade at the end of the nineteenth may fairly be looked upon as the chief source of England's wealth and the mainstay of her greatness. Obviously enough, such a history cannot fail to be of fascinating interest from almost every point of view, and although Mr. Galloway is by no means the first who has attempted to sketch it, his work compares favourably with those of his predecessors; moreover, it is evident that it has been to him a labour of love, and that he has spared neither time nor trouble in collecting information bearing upon his subject, from all available sources.

In the earlier portion of the record, very much is guess-work, and we get little that is definite or clear before the beginning of the fourteenth century. Incidentally it may be noted that Mr. Galloway's derivation of the word "mine" from "an Eastern root signifying weight," can hardly be endorsed. Its real derivation seems to be from the Low Latin word "minare," meaning to lead or drive, derivatives of which are found in such words as "prominent" and the French "mener"; it would thus seem that etymologically the word "mine" was identical in meaning with the more modern "lode" or "lead," and was originally applied to a deposit of mineral as distinguished from the mineral itself. Numerous entries concerning the digging, and occasionally even the selling of coal, before the end of the fourteenth century, seem to have been disinterred, and it is curious to note that most of them are from ecclesiastical records; indeed the Bishops of Durham seem to have been, if not the very first, certainly among the first of the great coal-owners of the country, a circumstance that may perhaps be due to the ease with which coal was got originally at the outcrops of the numerous fine seams of the great Northern coal field. Mr. Galloway remarks on the meagreness of the records in other parts of England compared with what there is known respecting this one.

It is worth mentioning that there exists at Durham a lease a little earlier than any quoted by Mr. Galloway, bearing the date, namely, of 1325; this curious document shows that coal mining must already have reached a certain stage of development, as it draws a distinction between "pykemen" and "schafteman." During the next two centuries comparatively little is heard of the technical aspect of coal mining, but a great deal of its commercial development, which was not a little influenced by the rapidly increasing employment of this fuel for domestic purposes. As pointed out by the author, the close of the sixteenth century marks a definite epoch in coal mining, in that it corresponds approximately with the exhaustion of the greater part of the coal lying above the natural water-level, so that the mineral had now to be wrought at depths below the level of the water, and the necessity for combating this formidable enemy was now beginning to make itself severely felt. What was destined to be the most important event of the seventeenth century was, however, the commencement then made to construct railways with flanged wheels for the more ready carriage of coal from the pits to the shipping places, an idea which, seemingly of the smallest importance, was the true germ whence sprang later on the invention of railways, an invention destined to revolutionise not the coal trade alone, but the aspect of the whole civilised world. It was not, however, till the next century that the steam engine was invented; originally used for the purpose of unwatering collieries, its increasing application to all branches of industry caused the demand for coal to advance by leaps and bounds. Mr. Galloway has rightly, therefore, interwoven the history of the steam engine with that of coal mining; it would, indeed, have been difficult to have separated them, and the history of one is to a great extent the history of the other. An event of the utmost importance in the development of the coal trade was the success attained by Abraham Darby, about 1730, in smelting pig-iron with coke; Mr. Galloway certainly mentions the fact, but does not lay the stress upon it which its importance would appear to merit, nor does he even record the name of the man to whose energy and perseverance ultimate success was due after a century of failures. Nor, again, is anything like sufficient weight given here to Neilson's invention of the hot blast, a century later.

These two monumental improvements in the art of iron-making, firstly by stimulating enormously the demand for coal, and secondly by supplying the mining engineer cheaply with the constructive materal which he needed for his machinery, contributed in a degree second only to the invention of the steam engine, to the rapid expansion of the coal mining industry. As said above, the history of coal mining is to a great extent that of the steam engine; but neither chronicle is complete until it is supplemented by that of the manufacture of iron, and perhaps the only serious fault

that can be found with Mr. Galloway's book is that he has attempted to write the annals of the coal trade as apart from its twin industry of iron-making. The complexity, however, of the history of coal mining by itself may fairly be held to excuse, to some extent, this shortcoming.

The close of the eighteenth and the early years of the nineteenth century were prolific in great advances in the technique of coal mining, the invention of the safety lamp being, perhaps, one of those of most importance, although its value had not yet been fully recognised in 1835, the date at which the author closes these interesting annals. They stop short, therefore, at the dawn of the true age of steam, at the era of the railway and the steamship; it is on this ground to be regretted that the author has not extended his review yet another thirty years or so further, when he would have fittingly rounded off his picture. He has done his work so well, has brought so much industry and research, coupled evidently with a thorough knowledge of the subject, to bear upon his task, that he has succeeded in reproducing a most complete picture of the evolution of the coal-mining industry. It can only be hoped that at some future date he may continue these interesting records down to the present day. H. LOUIS.

AN ATLAS OF BACTERIOLOGY.

An Atlas of Bacteriology. Containing 111 Original Photomicrographs with Explanatory Text. By Chas. Slater, M.A., M.B., M.R.C.S. Eng., F.C.S., and Edmund J. Spitta, L.R.C.P. Lond., M.R.C.S. Eng., F.R.A.S. Pp. xiv + 120. (London: The Scientific Press, Limited, 1898.)

IT might be said that the illustrative side of the science of bacteriology, whether by photographs, drawings, or coloured pictures, is, to some extent, overdone, and that the "Hand-Atlanten" of Lehmann and Neumann and the Atlas der Bakterienkunde by Fränkel and Pfeiffer already cover the whole field. Further, that the modern text-books of bacteriology are filled with numerous and useful illustrations, and have, of course, in addition the advantage of containing a complete and elaborate description of the morphological and biological characters of all the most important bacteria, besides all other information necessary to a correct knowledge of the science of bacteriology.

Yet, on careful study of this work, it is impossible to deny that it fills a blank in the life of the student of bacteriology. In the first place, most of the photographs are excellent, and the letterpress, linking together and explaining the teaching of the illustrations, is clear, concise and accurate. In the second place, the book is compactly bound, is printed on excellent paper in good type, and is of a very handy size. Thirdly, the authors can claim to have succeeded in giving in a limited number of illustrations a very complete series, so far as the wants and requirements of the average student of bacteriology are concerned. Lastly, its price is well within the limits of even a very slender purse.

For the purpose of this notice the book may be divided as follows:—

(1) Photographic introduction (pp. 1 to 9). This introduction, although doubtless of value from the view-point of the micro-photographic expert, might reasonably be clothed in simpler language for the sake of the average reader.

(2) Bacteriological introduction (pp. 10 to 23). Although this is well written, the purpose it serves in a condensed atlas of bacteriology is not very clear. It detracts a little from the scope of the work, which presumably is to present to the student a condensed photographic record of the chief morphological and biological characters of those bacteria which he is most likely to have to investigate in the course of his bacteriological studies.

(3) Photographic records of the more important bacteria, with explanatory notes (pp. 24 to 108). Photographs are given of two micro-organisms recently discovered, and these of great importance, namely, *Bacillus pestis bubonicae* and *Micrococcus melitensis*. These same microbes are generally believed to be non-motile, and competent observers have failed to demonstrate the presence of flagella. Dr. M. H. Gordon, however, has succeeded in obtaining specimens in which the flagella, both of the bacillus of plague and the micrococcus of Malta fever, are clearly visible.

All the photographs are good and some are excellent. To the latter class belong, among others, the following:—Fig. 11.—*B. typhi murium;* Fig. 93.—Sp. *Obermeieri;* Fig. 111.—*Plasmodium malariae* (malignant Tertian); Fig. 78.—Sp. *cholera Asiatica;* Fig. 56.—*B. typhosus;* Fig. 49.—*Micrococcus gonorrhoea;* Figs. 25, 26, 27, 28.—*B. tuberculosis;* and Fig. 12.—*B. mycoides.* Much less satisfactory photographs are Figs. 50, 51, and 52.—*B. typhosus.*

A very large number of the illustrations depict cover-glass specimens. It is a pity that more photographs are not given of cultures of the bacteria. No doubt these are frequently unsatisfactory, but the general excellence of Messrs. Slater's and Spitta's present work suggests the belief that their efforts in this direction would be crowned with success. For example, gelatine plate cultures of *B. mycoides* and *B. coli communis*, and agar cultures of *Streptococcus pyogenes* and *Diplococcus pneumoniae* under a low power of the microscope.

Of photographs of bacteria that might with advantage be added the following may be mentioned:—Anærobic milk cultures of *B. enteritidis sporogenes* (Klein); impression preparation of the "swarming islands" of *Proteus vulgaris;* microscopic preparation of *B. coli communis* stained for flagella. This last is extremely important, as all students of bacteriology ought to be taught to regard the difference in the number of flagella of *B. coli* and *B. typhosus* as a valuable aid in the differential diagnosis of the two organisms. *B. typhosus* is multi-flagellated. Some varieties of *B. coli* are likewise multi-flagellated, but the true *B. coli communis* has only 1-3 flagella.

These criticisms are offered in no carping spirit, for we are struck with the general excellence of this Atlas of Bacteriology, and we can cordially recommend it not only to students but to all those who make this science their special study. A. C. HOUSTON.

OUR BOOK SHELF.

The World's Exchanges in 1898 : *a Reckoner of Foreign and Colonial Exchanges.* By John Henry Norman. Pp. 54. (London : Sampson Low, Marston, and Co.)

ONE of the main objects of this pamphlet is to show how, by the use of the Chain Rule, the principles and practice of foreign exchanges can be brought down to the understanding of pupils of secondary and continuation schools. The author's purpose is "to prove by very simple arithmetical formula (*sic*) (1) that if the world possessed but one substance as its measure of value and equivalent in exchange, the world's interchanges of things could be effected on the conditions of barter. (2) That there are in the trading world at the present time seven different monetary and currency intermediaries, five of which are of a vastly different nature. (3) That these seven different intermediaries produce forty-two different prices of intermediaries, some of which either confer a bounty or impose a tax in international or intercolonial exchanges of things, resulting in the unfair encouragement of production of things in some countries and the handicapping of industries in other districts to an extent which can be measured by heavy percentages."

Heads of English business firms have lately received some pretty strong hints in the public press that they are losing trade all over the world because their foreign representatives will not give quotations in the currencies and weights and measures which are understood in the country they are trading with. A perusal of the present pamphlet should suffice with a little practice to enable any clerk to make the necessary calculations. But if the multiplications and divisions required in using the Chain Rule are not to be made the subject of pages of long strings of meaningless figures, often ending in answers ten times too great or ten times too small, far more attention must be given to approximate methods of working with decimals than is afforded at most of our schools. In this respect our foreign competitors score, as the metric system provides for them an easy introduction to decimals, which latter they can master in far less time than is taken by our schoolboys in floundering through the British labyrinth of perches, kilderkins, nails, fathoms, and pennyweights. G. H. B.

Lecture Notes on the Theory of Electrical Measurements. By Prof. W. A. Anthony. Pp. 90. (New York : John Wiley and Sons. London : Chapman and Hall, Ltd., 1898.)

IN the few pages of open print which go to make up this little work, Prof. Anthony gives a sketch of his course of lectures on elementary measurements in electricity and magnetism, in which, while enlarging upon the theoretical part, he merely indicates the experimental and practical part by a number of disjointed notes.

This irregular treatment of subject-matter is quite intentional, the aim of the book being simply that of enabling the careful student to illuminate those passages of his lecture notes which are likely to be obscure. But the irregularity naturally makes the book unsatisfactory both for perusal and for reference. For while such a work may be beneficial to a certain type of student, and would doubtless be of value to students of Prof. Anthony's classes ; yet it may be questioned whether works of this kind can with advantage be recommended to beginners, or whether these would take kindly to a book in which all superficially interesting matter is avoided, and the uninteresting alone retained.

The book is by no means free from misprints and other slips : as "ratios" for "ratio" on p. 36 ; x for X in the equation on p. 53 ; again, the statement on p. 61 that "the potential difference between the ends of a potentiometer slide-wire may be varied by shunting a part of its current away," seems to us misleading if not inaccurate. The diagrams also, though few in number, are somewhat open to criticism ; thus we think the forces in Fig. 3 should be so drawn as to represent a state of equilibrium, while the figure on the succeeding page is almost unintelligible owing to the deflecting force not being drawn at right angles to the needle.

Apart, however, from such blemishes, and putting aside questions of general utility, it must be conceded that the matter in this little book is well arranged, and the new conceptions admirably introduced ; while the deductions of well-known formulæ are in many cases very neatly given. D. K. M.

The Micro-organism of Faulty Rum. By V. H. Veley, M.A., F.R.S., and Lilian J. Veley (*née* Gould). Pp. 64. (London : Henry Frowde, 1898.)

BACTERIAL idiosyncrasies are now so familiar and so numerous, that it is difficult for us to be taken unawares any more by the whims and peculiarities of these groups of lowly organisms. Mr. and Mrs. Veley have, however, succeeded in discovering an oddity which, even in this remarkable community, stands out in relief. Whilst studying the causes of faulty rum, these investigators have come upon an organism which, in its lust for sugar, will brave the untoward surroundings of a liquid containing over 70 per cent. of alcohol. This is an unheard-of feat amongst these low forms of life. To enable it to indulge in sugar in such environment, this organism surrounds itself with a gelatinous envelope which, whilst permitting it to obtain its favourite food-stuff, protects it from the deleterious effect of the alcohol, and these characteristics have been embodied in the name *Coleothrix methystes* selected for it by its discoverers—Κολεός, a sheath, μεθυστής, a drunkard. Unfortunately for spirit distillers, this organism elects to dwell in rum, producing, according to Mr. and Mrs. Veley, a change in the spirit which, under the title of "faulty rum," occasions losses of some thousands of pounds annually to manufacturers. The life-history of this said *Coleothrix methystes* is by no means an easy one to trace ; in fact, the various phases through which it is said to pass embracing such transformations as coccus to rod, coccus to filament, and filament to coccus forms, leave its identity still open to speculation and further inquiry ; indeed, as the authors themselves modestly remark, "a subject of legitimate controversy." Whatever may be the results of such legitimate controversy, only praise is due to the authors for the conscientious care and the great labour they have bestowed upon this most difficult piece of work ; and, doubtless, now investigators have been started in this direction, many will be stimulated to travel over the same ground, and further extend our knowledge on such an interesting and novel subject as the possibilities of life in liquids containing such a high percentage of alcohol.

G. C. FRANKLAND.

Les Recettes du Distillateur. By Ed. Fierz. Pp. 149. (Paris : Gauthier-Villars, 1899.)

THIS book contains an exposition of an art peculiarly French—the preparation of liqueurs, recipes being given for upwards of 150 essences. Stress is laid upon the necessity for using absolutely pure materials, the quality of the alcohol employed being of especial importance, and tests are given for empyreumatic oils, the presence of which would be particularly injurious. The alcohol is aromatised by distillation or digestion with suitable plants or roots, the alcohols used in the preparation of some of the liqueurs requiring the addition of upwards of twenty ingredients in this preliminary operation, and this is then mixed with sugar syrup, pure alcohol, colouring materials and essences to form the liqueur. The instructions are both detailed and precise.

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 Alleged Destruction of Swallows and Martins in Italy.

I AM naturally adverse to polemics, for I believe that what little time we have can be better employed. And yet, as an old client and reader of NATURE, and as Director of the Italian Bureau of Ornithology, I can hardly allow the several communications on the alleged decrease of swallows and martins and the destruction of small birds in general in Italy, which have appeared in recent numbers of NATURE (see p. 271), to pass without a comment.

That small birds are netted and eaten in this country is a fact which many of us deplore, and we are trying to prevent, or at least to diminish, that kind of destruction with regard to small birds, all of which I consider useful. But as to the Hirundinidæ, no such ruthless destruction as that described by Mr. J. H. Allchin takes place in Italy. To my knowledge no swallow or martin is ever netted in this country, and I confess that I should like to see such birds captured with a fish-hook! I can only ask Mr. Allchin if he candidly believes it possible to catch swallows in great numbers with artificial flies and fish-hooks? I simply do not. In Italy the Hirundinidæ are, besides, the only birds which owe protection to popular belief: in many localities they are considered "the birds of the Madonna," and it is considered unlucky to destroy them. I can assure Mr. Allchin that no decrease of the Hirundinidæ (nor indeed to a certainty of any other small Passerine bird) has been detected in Italy.

Finally, if Mr. Allchin is really desirous of acquiring trustworthy information on the condition of birds in Italy, instead of consulting the newspaper articles of Mr. Stillman, the veracity of whose assertions on such matters may be doubted, or still worse of quoting "Ouida" as an authority on a subject of which she knows nothing, he would do well to betake himself to the library of the British Museum, or to that of the London Zoological Society, and consult the four volumes which by Government commission I have published on the Avifauna of Italy[1]; the three last being the results up to 1891 of an official inquiry on the condition of each species of bird, carefully conducted by trained and experienced observers all over the country. This inquiry is yet going on, and possibly a second report will soon be issued. Mr. Allchin is also evidently misinformed as to the international aspect of the question; at least, so far as Italy is concerned. HENRY H. GIGLIOLI.

R. Zoological Museum, the University,
Florence, January 27.

The Hatching of Tuatara Eggs.

IN a memoir on the development of the Tuatara, which I am shortly about to publish, and upon my preliminary notes on which an interesting comment by Mr. G. A. Boulenger, F.R.S., has recently appeared in the pages of this journal (NATURE, vol. lviii. p. 619), I have come to the conclusion that the eggs of this reptile hatch about December of the year following that in which they are laid, and that they thus occupy about thirteen months in their development. Hitherto, so far as I am aware, no specimens have actually been hatched out in captivity, or under direct observation. On December 1, 1898, however, Mr. P. Henaghan, the keeper of the lighthouse on Stephen's Island, brought to my laboratory some eggs which had been recently laid, together with others laid during the previous season. On unpacking the eggs, one of the latter was found to be already hatched, having yielded a fine, active young Tuatara, which is still (December 21) in a state of vigorous health, though it has not been observed to eat anything. On December 8–9 a second specimen hatched out, though I am inclined to think a little prematurely, as a large part of the yolk-sac was still attached. These specimens agree closely with the dead specimens of Stage S. received by me last year, and described in my memoir, but it seems worth while to place on record the actual time of hatching, although the new observations only confirm the conclusions already arrived at. The hatching probably continues throughout the month of December, as the eggs of last season, opened during the last few days, each contain a considerable amount of yolk, together with the very advanced embryo.

A point which seems worthy of attention is the large size of the eggs containing embryos nearly ready to hatch. Two eggs opened on December 17, and containing embryos at Stage S., measured 35 × 27·5 and 32·5 × 26·5 mm. respectively, while recently-laid eggs opened on December 21, and containing embryos of about Stage N., were much smaller, the six measured ranging from 25·5 × 20 to 29 × 22 mm. These observations certainly seem to confirm the opinion of Mr. Henaghan that the eggs swell during development, which I have been at some pains to controvert in my memoir. It must be remembered, however, that the eggs of the Tuatara vary considerably in size.

The eggs nearly ready to hatch are still very tense and turgid. In hatching, the leathery egg-shell appears to be simply torn or split irregularly, probably by the shell-breaker of the young animal. In the recently-hatched animal the nostrils are still plugged up, though the plug appears to be loosening, and after a short while it completely disappears externally.

ARTHUR DENDY.

Christchurch, N.Z., December 21, 1898.

THE afore-mentioned memoir, by my friend Prof. Dendy, has been accepted by Prof. Lankester, F.R.S., for the *Quarterly Journal of Microscopical Science*, and is about to appear in the February number of that journal, to be followed immediately by another on the Pineal Eye; Prof. Lankester having arranged for publication with that generous enthusiasm he extends to all good work. As already announced in these pages, Prof. Dendy sent me last autumn some preserved material for the investigation of the development of the Tuatara's skeleton, and with it half-a-dozen eggs due for hatching about December. The latter were in moist sand packed tight in a tin canister, and were brought by Mrs. Dendy in her cabin, on a voyage to England. Upon delivery they were transferred to a hot-air bath and kept at an approximate temperature of 25° C. One embryo decomposed, and a shell, containing another, having collapsed, was opened by my pupil, Mr. H. H. Swinnerton, who is co-operating with me in the task of investigation. The other four were opened by the enclosed embryos; one prematurely on November 22, the others respectively, and at the full time, on January 14, 19, and 24 of the present year. The embryo which emerged prematurely had a pendant yolk, and was but a centim. shorter than those of Dendy's Stage S. in my possession. The three young ones which remain left the egg with the yolk absorbed, and they continue active and healthy. Although their incubation period would appear to have exceeded that of those hatched out in Prof. Dendy's laboratory, the largest egg-shell measured but 31·5 × 24 mm., the smallest 28·5 × 21 mm. The apparent swelling of the shell, alluded to by Prof. Dendy, had independently arrested the attention not only of both Mr. Swinnerton and myself, but also of our laboratory attendant, George Woodrow, who in December remarked to me that "the eggs seemed rising above the sand"; and the phenomenon would appear to be due to internal tension, no doubt resulting from the actual growth of the enclosed embryo. One of the young ones had just liberated itself as we arrived on the morning of January 24, and we were able to note that on leaving the shell it lay torpid beside it for a period less than an hour, and then with a sudden start ran briskly forward. One of the youngsters, tempted on the day of hatching with a small earth-worm, ran from it affrighted, and by all three meal-worms are still refused. "Bluebottles," however, are eagerly devoured, and upon these all are at present thriving, with every indication of success. Concerning the rupture of the egg-shell, the four shells from which the young in my possession escaped were each cut cleanly, as by a razor, along the long axis. In the case of the prematurely hatched embryo, the incision extended the whole of one side, from pole to pole, while in that of each which went the full time it started short of one pole and extended longitudinally round the other to an approximately corresponding point on the opposite side. In every case the underlying serous envelope was similarly clean cleft, and on examination of the newly-

[1] E. H. Giglioli, "Avifauna Italica," pp. vii.–626. Firenze, 1886. "Primo Resoconto dei risultati della inchiesta ornitologica in Italia." Parte I., "Avifauna Italica," pp. vii.–706. Firenze, 1889. Parte II., "Avifaune locali," pp. viii–695. Firenze, 1890. Parte III., "Notizie d'indole generale," pp. vii.–518. Firenze, 1891.

hatched embryo with its mouth closed, the egg-breaker was seen to form a sharp downwardly directed prominence, projecting freely, and in such a position as to leave little room for doubt that it is the direct agent in rupturing both membrane and shell. It may be added that in the three living specimens in my possession all traces of the egg-breaker have vanished—*i.e.* in that last hatched within seven days. G. B. HOWES.

Royal College of Science, London, January 31.

Attraction in a Spherical Hollow.

THE theorem of attraction stated by Prof. T. Alexander in NATURE of January 19, is a particular case of a more general theorem which I have not seen stated, though very likely it is not new. The well-known theorem of *couches de glissement* is also a case of it. Imagine two spheres, one of radius r and made of positive or attracting matter of density σ, the other of radius r' and made of negative or repelling matter of the same density σ, to coexist even if they overlap. In the space common to the two spheres the one kind of matter neutralises the other, so that the space may be considered as empty. The force on a unit particle of positive matter, placed at any point on the circle of intersection of the two surfaces, is parallel to the line of the centres A, B, of the two spheres and of amount $\frac{4}{3}\pi\sigma\kappa c$ where σ is the common density of the spheres, c the distance between their centres, and κ is the usual attraction constant. For the positive sphere attracts the particle towards the centre with a force $\frac{4}{3}\pi\sigma\kappa r$, and the other sphere repels the particle from its centre with a force $\frac{4}{3}\pi\sigma\kappa r'$. These forces give the resultant $\frac{4}{3}\pi\sigma\kappa c$ parallel to the line joining the centres of the spheres and from the repelling centre towards the other.

This resultant force is independent of the radii of the spheres, provided their centres remain at the same distance apart. It follows that the force at all points within the space common to the two spheres is parallel to the line joining the centres, and has the value just stated. For take any such point P and describe through it spherical surfaces about the centres A, B. The portions of the two spherical distributions which lie outside these surfaces exert no force at P. The spheres internal to P give the force $\frac{4}{3}\pi\sigma\kappa c$.

If one of the spheres is wholly within the other, we have the theorem of the force within a spherical hollow. It is only necessary in that case to suppose the hollow formed by the superposition of negative matter on the previously existing positive matter, and the result follows at once.

I may point out that a theorem similar to and including that stated above holds for two overlapping similar ellipsoids, of equal and opposite densities, and having their corresponding principal axes in the same directions, and one pair of these, say the axis of x of each, in the same line. The centres A, B lie on this line, and any point common to the two ellipsoids will have coordinates x, y, z, say, when referred to axes through A, and x', y, z when referred to parallel axes through B.

Taking, then, as axes of coordinates the principal axes of each ellipsoid, and considering any point in the overlapping portion, and describing through P about A, B as centres two ellipsoidal surfaces S, S′, each similar to the given ellipsoids, we obtain for the components of force on a unit particle due to the positive (say) matter of uniform density σ filling S, the values A_1x, A_2y, A_3z; and for the components of force at the same point due to the negative matter filling S′ the values

$$-A_1x', \quad -A_2y, \quad -A_3z$$

where A_1, A_2, A_3 are certain integrals which are here constants. The portions of the two ellipsoids external to P exert no force at P. Hence the resultant force on the particle at P is $A_1(x - x')$, that is, it is parallel to the line joining the centres, and proportional to the distance between the centres, and acts from the centre of the repelling towards that of the attracting ellipsoid.

If the coordinates of B, relatively to the axes through A, be a, b, c, so that there is not a pair of corresponding axes in line, the components of force in the overlapping space are A_1a, A_2b, A_3c. The force at every point is $\sqrt{A_1^2a^2 + A_2^2b^2 + A_3^2c^2}$, and is therefore fixed in magnitude and direction.

With reference to the magnetic experiments, it may be recalled that if within a uniformly magnetised ellipsoid there exist a similar ellipsoidal hollow, with its axes parallel to those of the magnetised ellipsoid, the magnetic force within the hollow is zero at every point. A similar result holds, of course, for a sphere. ANDREW GRAY.

Larvæ in Antelope Horns.

I HAVE read with interest the communications of your correspondents on "Larvæ in Antelope Horns" in NATURE of September 15, and also another note on the same subject in *The Entomologist* of July last; but NATURE of June 9, for some reason or other, has not reached me.

As for many years past I have been travelling and residing in Central Africa, have shot large and small game, and have made large collections of the heads of buffalos and antelopes, I have thought that it may be worth while to record my own observations in this matter.

Is it the fact, proved beyond all doubt, that the larvæ in question are those of Lepidoptera and not of Coleoptera?

My own experience is that, unless preventive measures (such as I am about to describe) have been taken in the first instance, the horns of my specimens become infested with the larvæ of what I have hitherto believed to be two small species of *Coleoptera*—the one and smaller of bright metallic-green throughout, the other and larger of dull coal-black above, and white on the underside—which larvæ eat their way up and through the horns, throw out cocoons, and continue doing so until the horns are destroyed, leaving nothing but the cores.

If the heads have been neglected, and left in the open—say either on the ground, or in a tree—the larvæ very soon develop and commence their depredations, all the sooner if the heads have been left with the skin and flesh on.

If, however, these last be removed within a few hours after the animal has been killed, and the bases of the horns and their cores be carefully lathered over with strong arsenical soap where the skin has been cut away from round the horns, and between these and their cores as far up as the hairs of the brush will reach, the larvæ do *not* develop; and heads thus treated, if properly housed, henceforth enjoy absolute immunity from them.

I have a collection of antelopes' heads treated in this way now at Machako's, and though of all ages up to ten months old, there is not a perforation or a cocoon in any one of them; whereas, on the same station, I have noticed that the horns collected by other officers, and not properly cared for, become, most of them, after a time, simply perforated and woolly with cocoons.

Should the larvæ have established themselves, they can readily be killed by pouring paraffin into the horns, and leaving these on end for a day or two so as to retain the oil.

Never once have I remarked these larvæ in the horns of a freshly-killed animal.

I have, however, occasionally found the larvæ of *Diptera* in the flesh of some antelopes—notably so lately in Masailand in the case of a fine male Grant's gazelle, whose body, otherwise in first-rate condition, after being skinned, presented the spectacle of being "flicked" white with larvæ about the size and shape of barleycorns, at intervals of two inches or so.

A propos of the destructive little Coleoptera once more:—

On landing in England from Africa in the spring of 1884, I was at Euston, and amongst my battered and travel-stained baggage on the platform was a large truck-load of buffalos' and antelopes' heads. As I was standing talking to one of my brothers who had come to meet me, an old gentleman, who had been narrowly inspecting the load of heads, suddenly stooped down, and concentrated his gaze on one particular spot: then, fumbling in the pocket of his tail-coat, he produced a pill-box, and dexterously boxed something from one of the buffalo heads. It proved to be one of the green beetles!

Then turning, and realising that I must probably be the owner of the heads, he politely raised his hat and apologised for what he had done, adding that he had taken a species of Coleoptera which—I think he said—was new to him.

I lost no time in assuring him that no apology was necessary, that the obligation lay on my side, not on his!

Mr. Lionel Crawshay, my brother (whose address is Brasenose College, Oxford), can, I think, show you specimens of the green beetle, and possibly of the other as well: if not, I shall be very pleased to send you a series of both; as also, if you wish them, specimens of horns perforated by the larvæ and with their cocoons attached. RICHARD CRAWSHAY.

Simba Camp, British East Africa, November 29, 1898.

P.S.—As an afterthought, I am enclosing you 2 specimens of the green beetle 2 specimens of the black beetle, and 2 larvæ, which I hope will survive the post. R. C.

MR. CRAWSHAY'S interesting letter does not affect the question of *Tinea vastella* and its feeding on horns. Reference to the authorities quoted in your issue of September 15 last, or to the accounts of Lord Walsingham (*Trans. Ent. Soc. Lond.*, 1881, p. 238; *id. Proc.*, 1881, p. viii., 1882, p. xx.), and Mr. R. Trimen (*Trans. S. Afr. Phil. Soc.*, iii. p. 24), shows that the moth has been bred repeatedly from horns, and in one case, from a hoof of the troop-horse killed with the Prince Imperial in Zululand, and by naturalists whose competence is beyond question. Recently M. de Joannis has described (*Bull. Soc. Ent. France*, 1897, p. 109), the emergence from buffalo and ox-horns in Algeria of a large number of examples of a new Tineid moth, *Tineola infuscatella*, together with a few specimens of *Blabophanes nigricantella*, Mill., *B. imella*, Hübn., and *Trichophaga bipartitella*, Rag., the larvæ of which moths had apparently also fed upon the horn-substance.

The horn-feeding habit cannot be impeached; but I do not regard the evidence hitherto brought forward as to the horns of a living ruminant being attacked, as absolutely conclusive. With respect to infestation of horns of newly-killed animals exposed for sale in African market-places, it has, I believe, been stated (although I am unable to give any reference thereto) that the natives are in the habit of "faking" old horns for sale by anointing their bases with fresh blood.

Mr. Crawshay's communication is of importance, however, as calling attention to the existence of other horn-attacking insects. The beetles which he has forwarded are examples of *Necrobia rufipes* (or an allied species—his "green beetle") and a *Dermestes*, which cannot be identified from the poor material sent. The larvæ are those of the *Dermestes*.

It is not news to myself, nor, I imagine, to other entomologists, that these beetles are often as common in uncleaned horns or skulls of African animals, as they are in many bone-houses in this country. When the skeleton of the African elephant, now in the Museum of Zoology and Comparative Anatomy at Cambridge, was unpacked, these two (or similar) species fell out of the bones literally in pints. I question, however, whether either of them attacks horns from which the cores and all matter other than the horn-substance have been removed. That the latter was extensively burrowed in Mr. Crawshay's examples is not by itself a proof, for that remarkable and destructive insect, *Dermestes vulpinus*, has the habit, as an adult larva, of attacking any substance that will yield to its jaws, not for food, but for the purpose of forming a suitable nidus in which to pupate. It is thus sometimes exceedingly injurious to woodwork, as in a case, by no means isolated, observed by myself in 1890, where it occurred in great abundance in the bone-sheds of a soap-works, and destroyed all the timbers so rapidly that three new roofs were required in the space of a year, even the scaffold-poles used in their erection being damaged. The fir rafters were hollowed out along the layers of the spring-wood into very thin and brittle concentric laminæ; and the damage had much resemblance to that of the most destructive species of Termites. The species, now cosmopolitan, but perhaps of Oriental origin, had been imported into the works in a cargo of Indian bones, and was never abundant or injurious so long as boiling was resorted to for extraction of grease from the bones. Their multiplication dated from the introduction of a method of fat extraction by a solvent which left behind the fragments of muscle, cartilage, &c., adhering to the bones, as well as the gelatin. It was pointed out to me, and, though incredulous, I satisfied myself of the truth of the observation, that the larvæ occasionally enlarged the "blow-holes" in the friable brickwork of the sheds in order to turn them into pupal chambers. On one occasion a workman left in the sheds a white-spotted blue handkerchief; by the next morning every white spot had been gnawed out of it.

Not only is *Dermestes vulpinus* injurious to hides, leather, furs, bones and, secondarily, to woodwork. In India it is destructive to stored silk-cocoons. I have examined examples of, I believe, this identical species unwrapped from cat-mummies, and have received it from Hong Kong, where it had damaged bunting flags in the Naval Depôt. This injury was, no doubt, due to the burrowing of larvæ which had bred in provisions or the like stored near the flags.

A still stranger instance of its habits has been lately communicated to me by Sir H. Trueman Wood, to whom a correspondent, a provision preserver in Australia, sent specimens as examples "of a grub or weevil which derived its sole sustenance from salt." Accompanying them were lumps of salt (agglomerations of fine crystals such as table-salt is apt to form), which were bored through by the insects in such a manner as to lead any non-scientific person to suppose that it had actually been done for the purpose of feeding!

Mr. Crawshay's mention of cocoons on the outside of the horns is not easily reconciled with what is known of the habits of *Necrobia* or *Dermestes*. The species of the former genus, like other Clerids, probably form a cocoon, but are unlikely to do so in an exposed situation. The pupæ of *Dermestes* are found in the above-mentioned chambers enclosed in the split larval skin.

WALTER F. H. BLANDFORD.

London, January 27.

Indian Solpugæ or Pseudo Spiders.

IN your issue of April 28 last there is an interesting article by my friend Mr. R. I. Pocock, of the British Museum, on the Solpugæ (Pseudo Spiders). In that article he does me the honour to refer to certain information I gave him, and to my having allowed numbers of them to bite me to prove to the natives of India that they were not poisonous. Mr. Pocock gives the native name as I gave it to him phonetically as "Jerry-manglum." I have since found that the correct spelling of the word is "Jalamundalum," which is used in the Tamil and Telegoo (Dravidian) languages to denote the larger spiders (Pæcilotheria), the Whip Scorpions, and generally to any animal of the kind which they dread. The derivation is from "Jala," which means heat, fever, or perspiration; and "Mundalum," a period, usually forty-seven days; the belief being that a bite of one of the spiders, Galeodes or Whip Scorpions, will give fever that may last for forty-seven days. A friend, at my request, got this information from a Brahman B.A. of the Madras University, and I think it is interesting enough to deserve a place in your columns.

H. R. P. CARTER.

20 Priory Road, Bedford Park, Chiswick, W., January 30.

Colouring of Plants.

ON reading the very interesting and suggestive article on "Experiments on the Autumn Colouring of Plants," by E. Overton, in NATURE for January 26, it occurred to me that the following observation might be of interest. While I was in Switzerland last summer, I noticed that different plants of *Sempervivum arachnoideum*, L., growing under apparently very similar conditions, differed much in colour, the leaves of some being very red, especially at the tips and on the dorsal surface; and those of others being of a whitish green, almost or quite untinged with red. Wishing to see if any correlation existed between colour and assimilation, I collected two or three specimens of each kind, planted them in boxes, and, after keeping them on a sunny window-sill for some days, so that the environment might be as far as possible exactly alike for all, I tested them for starch by Sachs' iodine method, and found that the leaves coloured by anthocyanin contained far more starch than those without the red colouring matter. From this it will be seen that my results, so far as they go, appear to differ somewhat from the conclusions drawn by Mr. Overton. Perhaps, however, I ought to add that, unfortunately, I did not examine the leaves carefully to see whether or not the red colouring matter was confined to the epidermis, or extended also to the mesophyll, though my impression is that in some cases, at any rate, it did so. My plants were gathered at the end of July or beginning of August.

MAY RATHBONE.

Backwood, Neston, Cheshire, January 30.

THE ORIGINS OF THE LINES OF α CYGNI.[1]

WHEN engaged in the classification of stars, according to their photographic spectra, in 1893[2] I came across two sets of lines of unknown origin, one in the hottest stars, the other in stars of intermediate temperature.

After the discovery of a terrestrial source of helium by Prof. Ramsay, I showed in a series of seven notes communicated to the Royal Society,[3] May–September 1895,

[1] Paper read at the Royal Society on February 2, by Sir Norman Lockyer, K.C.B., F.R.S.

[2] *Phil. Trans.*, A, vol. 184, p. 675.

[3] 1st Note, *Roy. Soc. Proc.*, vol. 58, p. 67; 2nd, *ibid.*, vol. 58, p. 113; 3rd, *ibid.*, vol. 58, p. 116; 4th, *ibid.*, vol. 58, p. 192; 5th, *ibid.*, vol. 58, p. 193; 6th, *ibid.*, vol. 59, p. 4; 7th, *ibid.*, vol. 59, p. 342.

that the cleveite gases, which I obtained by the process of distillation, accounted to a very great extent for the first set.

In 1897 in a series of three communications to the Royal Society,[1] I pointed out that some of the other set of unknown lines in the stars of intermediate temperature, taking *a* Cygni as an example, were due to the enhanced spark lines of iron and other metals, the arc lines being almost entirely absent.

During the last year, this research has been continued; and latterly, by the kindness of Mr. Hugh Spottiswoode, the photographs of the enhanced lines have been obtained by the use of the large induction coil, formerly belonging to Dr. Spottiswoode, P.R.S. I am anxious to express here my deep obligation to Mr. Hugh Spottiswoode for the loan of such a magnificent addition to our instrumental aids.

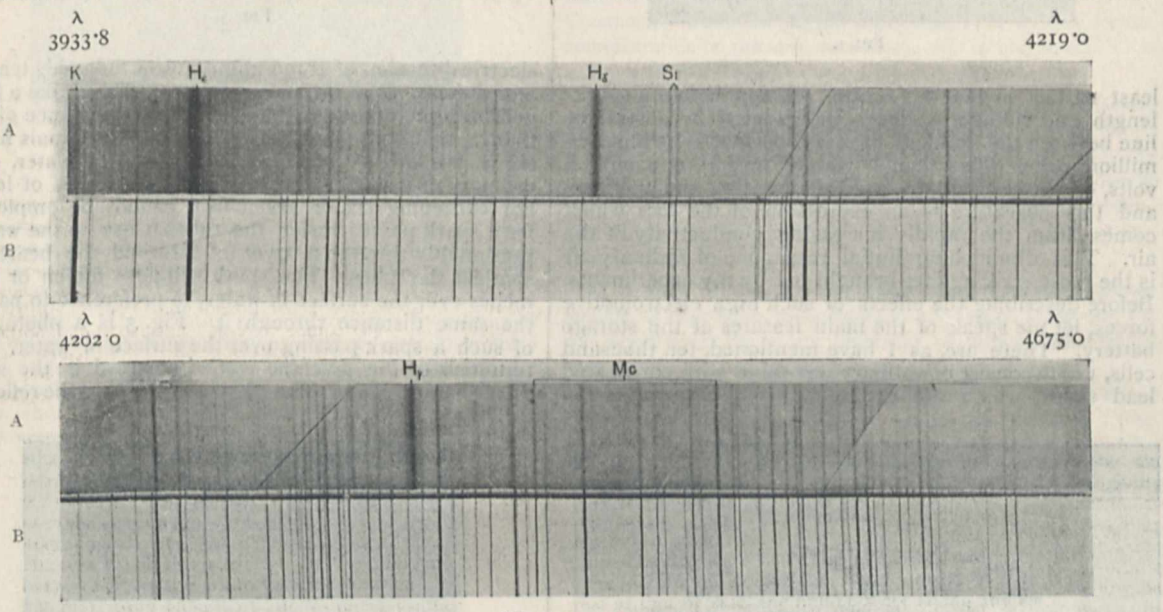
The spark obtained by means of the Spottiswoode coil is so luminous that higher dispersions than those formerly employed can be effectively used, and in consequence of this, the detection of the enhanced lines becomes more easy; their number therefore has been considerably increased.

I shall deal in a subsequent communication, when the inquiry has reached a further stage, with the details for each element.

The lines of the stars of intermediate temperature, like *a* Cygni, have long been recognised by the Harvard observers as well as by myself as presenting great difficulties.

In 1893 I wrote as follows[1]: "With the exception of the K line, the lines of hydrogen and the high temperature line of magnesium at λ4481, all the lines may be said to be at present of unknown origin. Some of the lines fall near lines of iron, but the absence of the strongest lines indicates that the close coincidences are probably accidental." In the Harvard "Spectra of Bright Stars," 1897, p. 5, the following words occur, relating to the same stars: "This system of lines should perhaps be regarded as forming a separate class, as in the case of the Orion lines, and should not be described as 'metallic,' as has just been done in the absence of any more distinctive name."

From the fact that these unknown lines have now been traced to a "proto-metallic" origin, as effectively as the unknown lines of the hottest stars have been traced to



Comparison of α Cygni and the enhanced lines of certain metals (chiefly of the iron group).
A = spectrum of α Cygni between wave-lengths stated. B = spectrum of enhanced lines.

The observations have already been mapped for the following substances:—

Iron, manganese, nickel, cobalt, magnesium, chromium, calcium, strontium, copper, vanadium, titanium, silicon.

In the accompanying photograph, a comparison is shown between the lines of *a* Cygni and the enhanced lines of the above substances thrown together. The extraordinary number of coincidences is seen at a glance. The facts are as follows:—

The number of lines measured in the spectrum of α Cygni at Kensington between λ3798·1 and λ4861·6 is	307
Of these the number which approximately coincides with the enhanced metallic lines so far observed is	120
The number of lines (excluding the hydrogen series) in α Cygni of intensity over 4 (the maximum being represented by 10) is	40
Of this number, the coincidences with enhanced metallic lines with the dispersion employed amount to	38

[1] *Roy. Soc. Proc.*, vol. 60, p. 475; *ibid.*, vol. 61, p. 148; *ibid.*, vol. 61, p. 441.

helium and asterium, we may expect that the consequences of this determination in relation to stellar classification and other connected matters, will be very far-reaching. At present I am using this new spectrum consisting of enhanced lines as an explorer, in relation to some further details of stellar classification having special reference to stars of Groups III. and IV. in which bright as well as dark lines occur.

HIGH ELECTROMOTIVE FORCE.[2]

IN the course of my investigation of electrical oscillations I have been enabled, by a simple transformation of my apparatus, to study electrical discharges of greater intensity and length than have hitherto been obtained in atmospheric air. These discharges are produced by means of a storage battery of ten thousand

[1] *Phil. Trans.*, A, vol. 184, p. 694.

[2] Extract from a lecture delivered by Prof. John Trowbridge before the American Academy of Arts and Sciences, at a meeting held in the Jefferson Physical Laboratory, Harvard University, Cambridge, U.S., December 14, 1898.

cells, giving approximately twenty thousand volts. This battery charges Leyden jars or Franklin plates, in multiple, and a simple mechanical contrivance enables me to discharge them in series. Thus I have followed the path indicated by Planté; but my experiments have covered a far greater range.

The discharges in ordinary air produced by my apparatus, with a voltage of three millions, are from 6½ feet to 7 feet in length. Prof. Elihu Thomson has obtained discharges of 60 inches by means of transformers. The discharges produced by my apparatus should be at

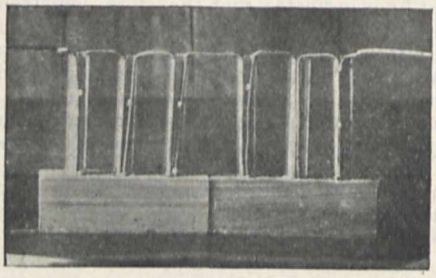


FIG. 1.

least 10 feet in length: for the relation between spark-length and voltage is closely represented by a straight line between the limits of twenty thousand volts and one million volts. This line, however, beyond one million volts, curves towards the axis representing the voltage; and this curvature is an expression of the loss which comes from the rapidly increasing conductivity of the air. This diminishing initial resistance of ordinary air is the most striking fact brought out by my experiments. Before describing the effects of such high electromotive forces, let me speak of the main features of the storage battery. There are, as I have mentioned, ten thousand cells, which consist of ordinary test-tubes with corrugated lead strips, which are separated from each other by

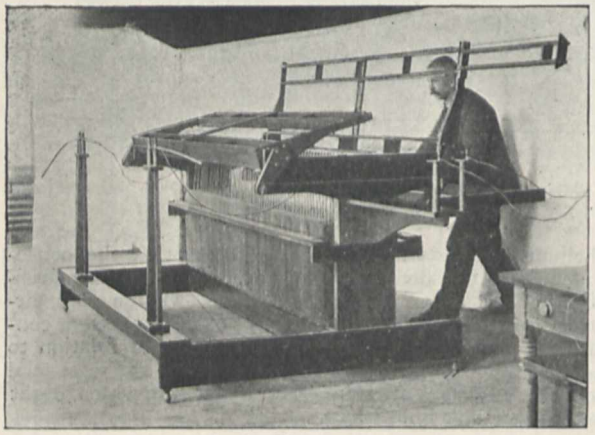


FIG. 2.

rubber bands. These strips are immersed in dilute sulphuric acid; and thus constitute Planté cells. The test-tubes are held upright in wooden blocks which have been boiled in paraffin. Lead wires are employed to connect the cells with each other and with the switch-boards. The cells are charged in multiple—forty cells being in each branch circuit—and a system of switches is employed to throw the cells into series. Fig. 1 shows the type of cells.

The construction of the apparatus for charging the Leyden jars in multiple and discharging in series, when high electromotive forces are generated, required a complete departure from the method employed by Planté; and consists, in the main, of a system of levers which obviate short circuiting. Fig. 2 exhibits this apparatus, which, in a certain sense, can be termed a step-up condenser. The figure of the operator shows the size of the apparatus, which produces in ordinary air a spark 50 inches in length. A larger apparatus, constructed on a similar plan, enables me to experiment with discharges 6½ to 7 feet in length.

I wish, especially, to call attention to the results obtained with this latter more powerful apparatus, which gives an

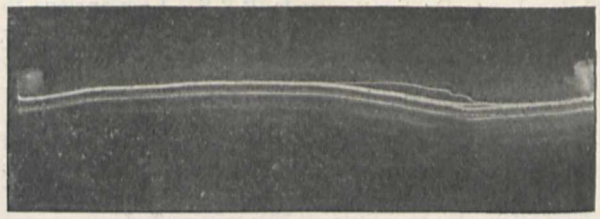


FIG. 3.

electrical tension of three million volts. At this tension, atmospheric air at ordinary pressure behaves like a fairly good conductor, and exhibits an initial resistance of less than a thousand ohms between pointed terminals five or six inches apart. Resistances of distilled water, or of ordinary city water, contained in glass tubes, of length not exceeding six or seven feet, cannot be employed; for a spark passes inside the tubes close to the walls—presumably through a layer of air—and the heated air shatters the tubes. The spark will pass fifteen or more inches over the surface of water, in preference to passing the same distance through it. Fig. 3 is a photograph of such a spark passing over the surface of water. The terminals of the machine were immersed in the water, fifteen inches apart. The photograph shows the reflection

FIG. 4.

of the spark from the surface of the water, and thus gives two views, so to speak, of different sides of the spark. No ribbon effect is observable, and an absence of a zigzag path is noticeable.

A peculiar stratified appearance is seen in photographs of the brush discharge from the positive pole. Fig. 4 shows this stratification. The pole consisted of a metallic sphere one foot in diameter. Fig. 5 exhibits the brush discharge from the negative pole. In both cases these are photographs of single discharges, which are thus seen to consist both of forked white discharges,

like lightning discharges, and numerous brush discharges, which fill the air between the terminals.

It seemed an interesting question to ascertain whether the spectrum of atmospheric air obtained by means of the great electromotive force of three million volts would show more lines than are produced by lower voltages. Photographs were therefore taken between brass terminals of the spectrum produced by the spark; and comparison spectra between zinc and copper terminals were obtained by means of the spark of a transformer giving about one hundred thousand volts, with large

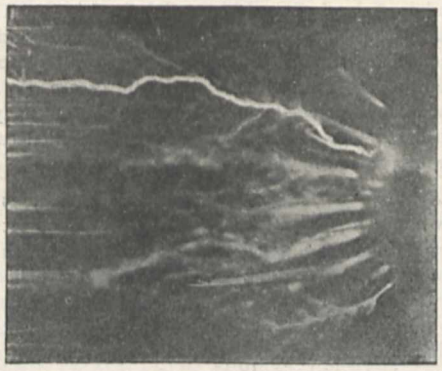


FIG. 5.

quantity of electricity. The characteristic atmospheric lines can be seen common to the three spectra. The photograph, however, of the spark produced by three million volts (A, Fig. 6) shows an absence of metallic lines, and must closely resemble, I believe, the spectrum of lightning. The photographs were taken by means of a Browning direct vision spectroscope, on orthochromatic plates, which were sensitive from the D line to the neighbourhood of the H lines. It is interesting to discover that no new lines apparently come out by the employment of very high electromotive force.

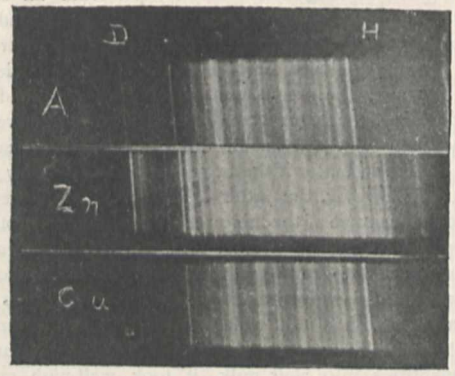


FIG. 6.

The condensers of the apparatus, which develops three million volts, were at first raised only six inches above the floor. When the room was darkened, luminous discharges were observed, which passed from the edges of the condensers to the floor. The condensers were then lifted to a height of three feet: these brush discharges were much lessened, and the length of the electrical discharges between the terminals was increased. There was still considerable loss; for sparks could be drawn from the neighbouring gas-pipes, and even from the brick walls. In order to obtain discharges in ordinary air of greater length than seven feet, by the employment of three million volts, the entire apparatus should be lifted to a considerable height above the earth, and should be remote from neighbouring objects.

The inductive effect of such high tension extends to a remarkable distance. Photographic plates contained in ordinary holders, held six to ten feet from the terminals of the apparatus, show on development arborescent figures, evidently caused by inductive electrical discharges. X-ray photographs of the skeleton of the hand can be taken by a single discharge passing through a Crookes' tube. The tube, however, is spoiled in the operation. The discharge will penetrate a space so highly rarefied that an eight-inch spark from a powerful Ruhmkorf coil cannot pass through it. If a Crookes' tube could be constructed which would resist the destructive effect of the discharge, great penetrating effect could undoubtedly be obtained.

NOTES.

THE new Session of Parliament was opened on Tuesday with the customary formalities. The legislative plans of the Government include, as stated in the Speech from the Throne to the Commons, "a measure for the establishment of a Board for the administration of primary, secondary, and technical education in England and Wales."

AT the last meeting of the Institution of Electrical Engineers, Lord Kelvin was elected an honorary member of the Institution. Lord Kelvin is the oldest surviving past president of the Institution, having held the office of president in 1874, when it was the Society of Telegraph Engineers, and again in 1889, which was the first year after the society had received the designation that it now bears.

IT is reported that the Russian Government contemplates sending an expedition to Samarkand and Merv, to investigate and report upon the recent outbreaks of malarial fever which have greatly alarmed the inhabitants of those districts.

WE learn from *Science* that the sculptor Herr Ernst Herter has completed the statue of von Helmholtz, which is to be erected in the court of the University of Berlin, between the statues of the two Humboldts. The monument will be unveiled in the spring.

M. ROUX has been elected a member of the Section of Rural Economy of the Paris Academy of Sciences, in succession to the late M. Aimé Girard.

M. E. A. MARTEL, general secretary of the Paris Société de spéléologie, has been awarded the grand medal of honour of the Société de topographie.

PROF. PERCY FRANKLAND, F.R.S., has been elected president of the Physics, Chemistry, and Biology Section of the Sanitary Institute, for the congress to be held in Southampton in August next.

THE Earl of Rosse will give an address upon the heat of the moon, at the Camera Club this evening.

THE annual general meeting of the Royal Horticultural Society will be held on Tuesday next, February 14. The annual meeting of the Royal Photographic Society will also be held on the same day.

THE annual general meeting of the Malacological Society will be held to-morrow (Friday), and a presidential address will be delivered by Lieut.-Colonel H. H. Godwin-Austen, F.R.S.

THE death is announced of Major J. Hotchkiss, who in 1895 was president of the Section of Geology of the American Association for the Advancement of Science, and was the author of a number of papers on economic geology and engineering.

THE annual meeting of the Institution of Naval Architects will take place on Wednesday, March 22, and the two following days, at the Society of Arts. The Right Hon. the Earl of Hopetoun, G.C.M.G., president, will occupy the chair.

COLONEL EDMOND BAINBRIDGE, C.B., Royal Artillery, Superintendent of the Royal Laboratory, Woolwich, has been appointed to succeed the late Sir William Anderson, K.C.B., as head of the Ordnance Factories.

Malpighia records the death of two distinguished Italian botanists, Prof. T. Caruel, director of the Museum of the Botanical Garden at Florence, a copious writer on many branches of botany; and Dr. G. Gibelli, Professor of Botany at Turin.

MR. ASA VAN WORMER (says the *American Naturalist*), a wealthy merchant of Cincinnati, has presented the sum of 56,000 dollars to the University of Cincinnati, for the erection of a fire-proof library.

Cosmos for January 28 contains an article by M. Larbalétrier, giving an account of the cultivation of the truffle in France, with a table showing the importations and exportations for the years 1895–1897. During the year 1897 France exported 193,376 kil. of truffles, valued at 1,740,380 francs; of these, 86,000 kil. came to this country. A map shows the areas both of the natural production and of the cultivation of the esculent. With the exception of the culture in the neighbourhood of Paris, these are entirely in the southern and, especially, in the south-eastern departments.

IT is announced, by the *Geographical Journal*, that considerable progress has been made with the preparation, for publication, of the extensive scientific material collected during the voyage of the *Fram*, and that there is a likelihood that the first volume of memoirs will be issued during the coming summer or autumn. The collection will be in quarto form, and the separate memoirs will be the work of a number of specialists in the subjects treated of, each being paged separately. The total number will probably be about twenty, forming from three to five volumes. The memoirs will be published at the expense of the Nansen Fund for the advancement of science.

AN effort is being made to introduce into this country the Nodon-Bretonneau method for seasoning wood by means of electricity. Upon this system the timber to be seasoned is placed in a large tank and immersed, all but an inch or two, in a solution containing 10 per cent. of borax, 5 of resin, and 0·75 of carbonate of soda. The lead plate upon which it rests is connected to the positive pole of a dynamo, and the negative pole being attached to a similar plate arranged on its upper surface so as to give good electrical contact, the circuit is completed through the wood. Under the influence of the current the sap appears to rise to the surface of the bath, while the aseptic borax and resin solution takes its place in the pores of the wood. This part of the process requires from five to eight hours for its completion, and then the wood is removed and dried either by artificial or natural means. In the latter case a fortnight's exposure in summer weather is said to render it as well-seasoned as storage in the usual way for five years.

THE *British Medical Journal* publishes the following statement:—A somewhat mysterious communication was made last week to the Académie de Médecine. It was to the effect that M. Jaubert, who is a chemist formerly attached to the École Polytechnique, had succeeded in finding a substance which, when used in proper proportion, was capable of removing from the air of a closed chamber the carbonic acid, watery vapour, and other irrespirable products produced by a living animal enclosed in the chamber, while at the same time giving out "automatically in exchange the mathematically exact quantity of oxygen required." Two experiments were made by Dr. Laborde, the one on a guinea-pig under a bell jar, the other on M. Jaubert's brother, who wore a tightly-fitted respiratory mask. The nature of the substance is not mentioned, the only indication being that it is the lightest "reservoir" of oxygen in existence. The note is published only to obtain priority for the discoverer; but we are told that the research has been in progress since May last, with the approval and assistance of the French Ministry of the Marine, which was interested in M. Jaubert's scheme because it promised to be useful in submarine boats and in diving-bells. It is stated that three or four kilograms of this substance is enough to keep a healthy adult alive for twenty-four hours in a space hermetically closed. M. Laborde thinks that the substance will be of use also in medicine, since a few grams—an amount which can be easily carried in a waistcoat pocket—would at once yield several decalitres of very pure oxygen gas.

THE *British Food Journal and Analytical Review* is the title of a new monthly publication, which has for its object the discussion of all matters of general interest connected with adulteration and fraudulent trading. Arrangements have been made whereby the British Analytical Control will have this journal as its press organ. For the enlightenment of those who do not know what is meant by the "British Analytical Control," we are informed that it is a system of permanent control and guarantee in relation to food products and to other articles of public necessity and utility, which has been established in Great Britain and the Colonies and Dependencies of the Crown. There can be no doubt that such an association, established as it is with the approval and co-operation of a number of leading public analysts and other scientific men, is capable of doing most useful work in bringing public opinion to bear upon this important subject.

A RECENT number of the *Centralblatt für Bakteriologie* contains a paper on the vitality of the typhoid bacillus in milk and butter, by Messrs. Bolley and Field, of the Government Experiment Station for North Dakota, U.S.A. The butter used in these investigations was derived from an ordinary creamery, and contained one ounce of salt per pound. Ten days appears to be the longest period of time over which typhoid bacilli introduced direct into butter could be detected. When, however, the cream was infected with typhoid germs before churning, the latter were discovered in butter even after three months. Typhoid bacilli do not apparently make any marked growth in butter if the butter-milk is thoroughly worked out of it; if, however, the latter is left in to any extent, the bacilli take advantage of the mixture and multiply. In sterilised milk typhoid bacteria can exist for upwards of four months, and, inoculated into ordinary milk freshly drawn, they have been demonstrated as long as three months. No types of bacteria were met with in milk which proved capable of overcoming the typhoid bacillus; even when inoculated in comparatively small quantities into sour milk, it took well-nigh complete possession of the liquid becoming almost a pure culture. These experiments furnish yet another warning, to those concerned with the conduct of our dairy supplies, of the supreme importance of vigilance in all matters connected with the manufacture and distribution of such easily-infected articles of food as milk and butter.

THE *Journal* of Grahamstown (Cape of Good Hope) refers to an interesting return published by the Department for Agriculture, showing the ravages of rinderpest in the Cape Colony, and the results of the highly creditable battle waged against it by our officials. From it we learn that the proportion of cattle infected (including those inoculated) was 98 per cent. of the

whole; the number that perished were 35 per cent., and those saved were 65 per cent. Various systems of inoculation were used, as that of Dr. Koch, the improved method elaborated by Dr. Edington, and the process of Drs. Turner and Kolle. In some districts all three were in operation. In twenty-three districts, as shown by the printed returns, 393,777 head of cattle were inoculated under Dr. Edington's system, the resultant mortality being 32,464, or only 8¼ per cent. Thus more than 360,000 cattle were saved, or over *two millions sterling* in value, by the application of the glycerinated bile process.

WE are glad to notice, from a short report by Mr. Alex. Meek, that the Northumberland Sea Fisheries Committee has established some connection with the Durham College of Science, and that a certain amount of scientific work is now being carried on in the marine laboratory at Cullercoats. The report is chiefly occupied with the results of the trawling expeditions carried on in the summer of 1898 by Mr. John Dent in the steamer *Livingstone*. The hauls seem to have been comparatively few in number—probably too few as yet in each year to justify any conclusions drawn from the curves given. The report ends with an interesting account of the mussel cultivation carried on by Major Browne at Budle Bay, on the Northumberland coast. As the fishing boats of the neighbourhood require about 1500 tons annually for bait, and as all of this, with the exception of 200 tons supplied by the Budle Bay farm, has to be imported from a distance, it seems as if mussel culture on the Northumberland coast ought to be an industry with a future before it.

INVESTIGATIONS carried on by the New York State Museum and the U.S. Fish Commission, lead Mr. T. H. Bean to conclude that marine fishes now certainly known in the New York fauna represent 200 species. The fresh waters contain 116 species, and there are, besides, thirteen anadromous forms. The list might be further increased by the addition of nineteen, including forms doubtfully assigned to the fauna, which would bring the total up to 348 species. Mr. Bean remarks that no systematic account of the fishes has been published since 1842, and many large regions of the State are almost, or altogether, unknown to the ichthyologist.

COMMENTING upon photographs of ribbon lightning obtained by the Rev. J. Stewart-Smith, in the U.S. *Monthly Weather Review*, Prof. Cleveland Abbe remarks that they are not taken by moving the camera during exposure. He points out that a discharge of lightning is too fleeting to be influenced by the motion of the camera. With artificial oscillatory discharges one may so control the time of the discharges and the motion of the sensitive film as to produce the appearance of a ribbon; but no motion of the camera seems likely to explain the many details in these ribbon photographs of natural lightning. On the contrary, Prof. Abbe thinks there is one flash on Mr. Stewart-Smith's plate that has every indication of being certainly an oscillatory discharge, showing lines of flow identical with those photographed by Prof. Trowbridge at Cambridge, Massachusetts, and fully maintaining his conclusion, which was also that of Prof. Joseph Henry and J. Ogden Rood, that the lightning flash is an oscillatory discharge, repeated frequently to and fro within the crack in the air that is opened by the first discharge. The whole process requires but a few millionths of a second, and the motion of the camera within that short time is insignificant.

WE have received from the Government Astronomer of New South Wales a copy of the "Results of Rain, River and Evaporation Observations" made in that Colony during 1897, containing monthly and annual totals of rainfall at 1518 stations, and the annual rainfall at all stations with three and up to fourteen years' records, with much other useful information, and accompanied by maps showing the tabular results very clearly at a glance. This system, under the careful superintendence of Mr. Russell, has become one of the most perfect that exists, and it is satisfactory to find that the author is able to state that the importance of the work is being recognised every year by a wider circle; no less than 1450 of the observers being volunteers. The average rainfall for the whole Colony during 1897 was 18·89 inches, being 25 per cent. less than the average for the previous twenty-four years. In the catchment of the river Darling the average was 19·75 inches, and in that of the Murray 17·77 inches. In parts of the Colony, there has been an abundance of rain; in others, the intensity of drought.

DR. PAUL BERGHOLZ has sent us a translation into the German language of the late Father B. Viñes' paper entitled "Investigation of the cyclonic circulation and the translatory movement of West Indian hurricanes." The original work was in Spanish, and was translated into English by Dr. C. Finley, of Havana, for presentation to the Meteorological Congress held at Chicago in August 1893. It was recently published by the U.S. Weather Bureau, and briefly noticed in our columns. The investigation is held in such high esteem, as probably the most satisfactory statement of the laws and phenomena of these storms which has yet been made, that Dr. Bergholz has rendered good service to the science of meteorology in preparing an independent translation for the use of German readers. He has also carefully revised it, and rendered it more useful by the publication of several charts showing the zones of the tracks of the storms in the various months. The translation appears in the *Marine-Rundschau*, 1898.

THE Italian Central Meteorological Office is apparently reducing the extent of its publications—not that the number of observing stations is decreasing, for in the last published *Annali*, for 1896, Part ii., they reach 392; but that only ten-day, monthly and annual means are given for temperature and rainfall, together with summaries of the general state of the weather. These results are arranged according to provinces, and in the alphabetical order of the stations. A separate volume of the *Annali* (Part i.) contains, in the same way as in the French Service, some valuable discussions of the detailed observations, including earthquake phenomena. The last published part of this series (for 1895) contains a discussion of the observations of the meteorological observatory on Mount Etna, situated at 2942 metres above sea-level.

THE Geological Survey of Western Australia has issued a *Bulletin* (No. 2) containing two reports by Mr. R. Neil Smith. The first relates to the state of mining in the Kimberley district, and in it the author points out that very little work has been done, except in a few mines, since 1891. The gold-field ls evidently not suitable for large companies, but simply for the gaining of a precarious living by working miners. Patches of alluvial gold, and small veins of uncertain continuance, are found at rare intervals, and these may pay well for a few months. The second report deals with the question of obtaining artesian water between the Pilbarra gold-fields and the Great Desert, and the author concludes that the comparatively small superficial extent of the impervious ranges, and the thinness and probable want of continuity of the water-bearing strata, are unfavourable to any system of artesian wells.

QUARTZ mining in Victoria, Australia, is now being carried on in a very economical manner. The methods of mining the stone underground and bringing it to the surface have been reduced to a science, and it is probably nowhere more economically done than in Victoria. There is much room for improvement, though, in the method of milling the ore. The half-yearly statements of several of the public companies,

recently issued, give interesting details, and show what can be done by systematic and careful management. It is said that anything over 3 dwts. to the ton would be regarded as comparatively rich. One company crushed for the half-year 6900 tons for 911 ozs. 1 dwt. of gold, an average of 2 dwts. 15 grs. per ton. This gave a profit on actual working expenses of 1030*l.* 17*s.* 1*d.* The cost of treating the stone had been only 6*s.* 9*d.* per ton, against 7*s.* 0¾*d.* the previous half-year.

FROM the Geological Survey of Queensland we have received a copy of *Bulletin* No. 10, comprising "Six Reports on the Geological Features of part of the district to be traversed by the proposed Transcontinental Railway," by Mr. Robert L. Jack, Government Geologist. These Reports were issued in a Parliamentary paper in 1885, and with an appendix consisting of a list of fossils named by Dr. H. Woodward and Mr. R. Etheridge, jun.; but, having for some time been out of print, the Reports have now been reprinted with notes and additions. They deal chiefly with the gold-mining and copper-mining of the Western Downs, and the Cloncurry and Leichhardt districts. We have received also *Bulletin* No. 8, a "Report on the Gold Mines at the Fanning and Mount Success, 1898," by Mr. W. H. Rands, Assistant Government Geologist. The Far Fanning has been worked for many years past in a desultory fashion, but last year some increased activity took place. Mr. Rands, however, reports that there is a great lack of really *bonâ fide* work; the deposits are worked irregularly, and the smallness of the crushings, compared with the large faces of so-called crushing material, shows that a system of working which consists in picking out the best stone has been largely carried on.

SOME interesting observations on the hibernation of ants are described by Miss Theodora Smith in the *Halifax Naturalist*—the organ of the Halifax Scientific Society. Miss Smith had a nest of *Myrmica scabrinodis*, and she placed it in a cold room (in an empty house), where the temperature was about equal to that of the outside air. Under the nest she placed two artificial nests, one of soil and moss, and the other of pure yellow clay—the latter being at the bottom. The combination of nests thus resembled the natural order of things. Observations of the behaviour of the ants under different conditions of temperature showed that the ants went into the clay soil nest for warmth—that is, when the weather was cold—but usually preferred to remain in the mossy black soil when warm enough for them to do so. Miss Smith points out that though in the summer and spring months the young are separated according to size; *i.e.* the eggs are placed in one chamber, the small larvæ in another, those a little larger in another, while the nymph larvæ are separated entirely from the rest, in the winter this division of the relative sizes is not found, all the larvæ, of whatever size, being placed together in an inner chamber. It is suggested that this may be for warmth, and it may be that the young do not require the special attention given to them during more active times of growth.

UNDER the auspices of the British Fire Prevention Committee a detailed report has been brought out by Messrs. Gustave Kaufman, Emil Swensson, and F. L. Garlinghouse, on the Horne Building Fire, of Pittsburgh, U.S.A., which, in approximately two hours from the time of discovery, destroyed three large buildings on opposite sides of Penn Avenue, while damaging half a dozen smaller adjacent structures. An examination of the damage done has led the Board to draw the following conclusions: (1) In buildings of about this height (roughly 115 feet), the distortion of the steel framework, due to the heat of the fire, cannot be sufficient to work any serious damage, nor is it probable that at any time would connection rivets be sheared off. This conclusion is arrived at for the reason that there is no probability that any future fire will be fiercer than the one at issue. (2) The method of fastening fire-proofing to the underside of beams with sheet-iron strips should be discarded. (3) It cannot be too often reiterated that open front buildings like this should be protected from external fires by metal shutters, and also that all shafts should be provided with metal doors which can be readily closed at all floors. (4) The most important lesson taught by this fire was the lack of strength developed by the fire-clay proofing. The building was permitted to move in any direction without any material restrictions by the fire-proofing. The floor arches showed by the scaling off of the lower webs that they were unable to offer any sufficient force to counteract the tendency to lateral motion. (5) The column protection, although composed of the very best obtainable kind of fire-clay tile, was not of sufficient strength. The authors strongly advocate the use of first-class concrete as a fire-resisting material for encasing the columns, girders, and other steel constructions.

REGARDING "soul" as the highest intellectual faculties, Dr. D. G. Brinton refers in *Science* to Dr. C. Clapham's arguments as to its position in the body. Savages believe that the "soul" is in the liver or the heart; cynics suggest that it is in the stomach; phrenologists regard the front part of the brain as the seat of intellect; but the most advanced physiologists are now inclined to teach that the posterior cerebral lobes have the highest intellectual value. In connection with this view, Dr. Clapham has pointed out that man has the most highly developed posterior lobes, and this is conspicuous in men of marked ability and in the highest races. In idiots the lobes are imperfectly developed, and in chronic dementia these portions of the brain reveal frequent lesions.

MESSRS. R. FRIEDLÄNDER AND SON, Berlin, have just issued a classified catalogue of physical books, papers, and periodicals which they have for sale.

MESSRS. H. T. SOPPITT and C. Crossland give, in the *Yorkshire Naturalist* for January, a list of seven new British Fungi found in West Yorkshire, including one new to science, *Saccolabus granulospermus*.

AN address on "Medicine in the Nineteenth Century," delivered by Prof. Clifford Allbutt before the Johns Hopkins University, Baltimore, in October last, is printed in the *Bulletin* of the Johns Hopkins Hospital.

THE twenty-ninth annual report of the Wellington College Natural Science Society has been received. It comprises abstracts of addresses delivered before the Society, meteorological records, and brief references to the work of the members of the various sections.

AN illustrated article on the Natural History Museum at South Kensington is contributed to *Naturen*—an illustrated monthly magazine of popular natural history—by the editor, Dr. J. Brunchorst. The article is one of a series on museums. *Naturen* is published at Bergen, by John Grieg.

A VALUABLE paper upon the origin and history of white and so-called wild cattle is contributed to the *Transactions* of the Natural History Society of Glasgow (vol. v. new series, 1897–98), by Mr. R. Hedger Wallace. Among other papers is one by Mr. G. F. Scott-Elliot, on limits to the range of plant species.

MR. H. LING ROTH contributes some interesting notes on Benin customs to the *Internationales Archiv für Ethnographie* (vol. xi. 1898). The notes are based upon information given by officials of the lately-deposed King of Benin, and a comparison is made between the statements of the court officials and the records of early chroniclers. Another paper by Mr. Ling Roth, on primitive art from Benin, appeared in *The Studio* in December 1898.

THE Trustees of the British Museum have published the first volume of the monograph of the *Lepidoptera Phalaenae* which they have in preparation. The volume is a "Catalogue of the *Syntomidae* in the British Museum," by Sir George F. Hampson, Bart. In addition to the numerous species of *Syntomidae* in the British Museum Collection, other rich collections have been lent for examination. Coloured illustrations of new or hitherto inadequately figured species are published separately, in order not to add to the cost of the catalogue.

Bulletin vol. iii. No. 5 (October 1898) of the College of Agriculture of the Imperial University of Tokyo, now published entirely in English, is mainly devoted to the discussion of various questions connected with the cultivation of rice. It contains, besides, papers on the formation of proteids and the assimilation of nitrates by phanerogams in the absence of light, by Prof. Suzuki; and on the properties of cocoons of the various silkworm races of Japan, by Prof. Kawara.

THE Hull Scientific and Field Naturalists' Club has just issued the first number of a series of annual *Transactions*, containing papers brought before the members at the fortnightly meetings. It is intended to publish original papers and notes upon local natural history; and if every local society of naturalists did the same, and placed their observations on record, much valuable scientific material would be accumulated.

A READY means of obtaining a number of copies of an illustration is so often required in the scientific world that many men of science will be glad to have their attention called to an appliance called the Photo-Autocopyist, which enables this to be done. The apparatus and method are very simple, but a little experience is necessary to produce good effects. The negative of which copies are wanted is printed in the usual way upon a stout paper having a gelatine surface, which has been previously sensitised by immersion for a few minutes in a 3 per cent. solution of bichromate of potash, and then dried. The gelatinised sheet is taken from the frame when sufficiently printed and washed. It then constitutes the printing surface, which is stretched upon a frame, and inked with an ink roller, the ink only adhering to the indented parts which have been acted upon through the negative. Ordinary paper is then placed upon the inked surface, pressed in a copying press, and taken out at once. A finished, permanent, print is thus obtained in a minute or two, and to procure others it is only necessary to ink the surface again and put it under the press with another sheet of paper. The process is a simple modification of the Collotype method of reproduction, and as a means of quickly obtaining permanent prints from photographic negatives it should prove extremely useful.

SEVERAL new editions of well-known works have reached us during the past few days. The second edition of Prof. W. C. Unwin's "Testing of Materials of Construction" (a text-book for the engineering laboratory, and a collection of the results of experiment) has come from Messrs. Longmans, Green, and Co.—Pages 273 to 672 of the English version (third edition) of Carl Busley's "Marine Steam Engine," translated by Mr. H. A. B. Cole, have been published by Messrs. Lipsius and Tischer, Kiel and Leipzig (London: H. Grevel and Co.), with an atlas containing plates 9-45. It is expected that the third (and concluding) part, consisting of only a few sheets and plates, will be published in the course of the present year. The completed work will be a manual and book of reference for all who are concerned with steam navigation.—Under the title "An Intermediate Text-book of Geology," Messrs. W. Blackwood and Sons have published a text book by Prof. C. Lapworth, founded upon Page's "Introductory Text-book of Geology." With the latter title, the work passed through twelve editions, several of which were prepared by Prof. Lapworth, and in its new form it should be even more successful. The text has been rewritten, with the exception of a few parts, and nearly a hundred pages have been added. Special attention has been paid to the subject of the geographical distribution of the geological formations at home and abroad. Systematic students of geology will find the new volume very serviceable.—A third edition of "Gordon in Central Africa, 1874-1879," edited by Dr. G. Birkbeck Hill, has been published by Messrs. Macmillan and Co., Ltd.

A SERIES of tables, showing the differences between Greenwich mean time and the civil times used in various parts of the world, compiled by Prof. John Milne, F.R.S., is published in the February number of the *Geographical Journal*. The names of places in the tables are arranged in alphabetical order, and the amount by which the time used at each is fast or slow of Greenwich mean time is indicated. Some of the descriptive notes are interesting. It is pointed out that the Chinese at most places use an approximate apparent solar time, obtained from sun-dials. At Tientsin the civil time is determined by the municipal chronometer, which, however, has sometimes been known to have an error of three minutes. The Persians keep sun time, watches being set at sunset. In Teheran there is a midday gun fired by the time shown on a sun-dial. But a few minutes makes no difference in Persia; the railway trains start when full or when required, and Persian telegraphists do not give time of issue or receipt of telegrams.

THE constancy of composition of natural gas is a question of some practical importance to manufacturers in the Pittsburgh region, and as the opinion has been frequently expressed that natural gas fluctuates in its heating power, it seemed worth while to see if these changes in composition really occur. The results of an investigation by Mr. F. C. Phillips on this subject are given in the *Proceedings* of the American Academy of Arts and Sciences for November 1898. Since the nitrogen in the gas appeared to be the most readily determined constituent, attention was first directed to this element, and an apparatus devised by which comparatively large quantities of the gas could be completely burnt by red-hot copper oxide, and the residual nitrogen collected and measured. The results of duplicate determinations on the same sample of gas were closely concordant, the variations not exceeding in any case 0·03 per cent.; but since samples of gas from the same well, collected at different times, showed variations of nearly 2 per cent., it would appear that fluctuations in the composition of natural gas do really occur.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. Emily Price; a Bonnet Monkey (*Macacus sinicus*, ♂) from India, presented by Miss May Wieland; a Sooty Mangabey (*Cercocebus fuliginosus*, ♂) from West Africa, presented by Mr. B. Stewart; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Captain Chas. T. Swain; a Vulpine Phalanger (*Trichosurus vulpecula*, ♀) from Australia, presented by Mr. W. J. Matthews; a Golden-backed Weaver Bird (*Pyromelana aurea*, ♂) from West Africa, presented by Mr. A. F. Wiener; three Common Marmosets (*Hapale jacchus*) from South-east Brazil, a Great Kangaroo (*Macropus giganteus*, ♀), a Great Wallaroo (*Macropus robustus*) from Australia, a West Indian Agouti (*Dasyprocta cristata*) from the West Indies, deposited; two Indian Chevrotains (*Tragulus meminna*) from India, five Sacred Kingfishers (*Halcyon sancta*), four Lace Monitors (*Varanus varius*) from Australia, a Black-throated Diver (*Colymbus arcticus*) from Holland, purchased; a Red Kangaroo (*Macropus rufus*, ♂), five Puff Adders (*Bitis arietans*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1898 VII. (CODDINGTON-PAULY).—Mr. C. J. Merfield, of Sydney Observatory, gives an ephemeris of this comet, in *Astronomische Nachrichten* (Bd. 148, No. 3542), as he considers it likely that it will be possible to observe the comet from northern observatories.

1899.		α (app.) h. m. s.		δ (app.) ° ′ ″
Feb. 10	...	2 18 2	...	−35 36 44
14	...	23 11	...	33 36 25
18	...	28 16	...	31 40 50
22	...	33 17	...	29 50 0
26	...	38 15	...	28 3 48
Mar. 2	...	43 10	...	26 22 9
6	...	48 3	...	24 44 57
10	...	52 52	...	23 12 4
14	..	2 57 40	...	−21 43 25

The comet is rapidly moving northwards, passing from near φ Fornacis into Eridanus. It should be looked for soon after sunset, almost due south from Mira Ceti. It is said to be easily visible with an instrument of six inches aperture.

EROS (433).—In *Harvard College Observatory Circular*, No. 37, Prof. E. C. Pickering describes the finding of trails of the planet on thirteen more plates, in addition to those mentioned in the last *Circular*. These plates were exposed during the period 1893–6, and the estimated photographic magnitude varied from 8·2 to 12·5. He lays great stress on the fact that all the photographs which have been found showing the planet have been taken with *doublet* objectives, giving a large field and large relative aperture. The difficulty is enhanced by the variation in the brightness of the planet, as during the last eleven years it has only been brighter than the ninth magnitude for two months.

In *Popular Astronomy*, January 1899, Mr. W. W. Payne brings together the information given in various disconnected articles by several authors. This will prove convenient for many interested in the planet, and unable to find access to the individual papers.

THE SUN'S HEAT.—In the *Astronomische Nachrichten* (Bd. 148, No 3540), Dr. T. J. J. See introduces a new law bearing on the thermodynamics of a contracting gas, and discusses its bearing on the question of the heat of the sun, and also its application to estimating the relative ages of the stars and nebulæ.

The modern theory of the sun's heat is primarily due to Helmholtz, and its conclusions are based on the supposition that the sun's mass is of *homogeneous* density. This Prof. See doubts, and the result of a series of computations for the heat given out by the contraction of a *heterogeneous* mass was the law of temperature he now brings forward. The effect of this unequal density is to lengthen considerably the period heretofore advanced for the duration of the sun as a light- and heat-giving source. Helmholtz's theory indicates that the output of heat for a given change in radius of the contracting mass increases very rapidly as the radius itself becomes small. From this it appears that the greatest amount of heat is produced when the mass has reached its least dimensions and contraction is about to cease.

Discussing the resulting temperature of a mass contracting under its own gravity, the law deduced is: "The absolute temperature of a gaseous star or nebula condensing under its own gravitation varies inversely as the radius of the contracting mass." The curve representing this condition will be recognised as a rectangular hyperbola referred to its asymptotes.

With this idea it would follow that at first when the nebula is infinitely expanded, its temperature is the absolute zero of space, and that this gradually rises to a maximum when the mass has contracted to the smallest radius consistent with the laws of gases. After liquefaction has set in, free contraction is obstructed and finally ceases; the temperature falls, and the body becomes finally invisible.

This is in accord with the idea of the nebulæ being low temperature bodies. As it contracts the production of heat exceeds the radiation, and the temperature rises inversely as the radius decreases.

In this connection Prof. See mentions the curves of Lane for the laws of internal temperature and density of gaseous masses. (*Am. Jour. Sci.*, July 1870.) He illustrates these by the case of the sun, and infers that it is *increasing* in temperature still. The presence of hydrogen in the white stars he reasons in the same manner. While the nebula is yet considerably extended, gravity is small, and all the elements float in the atmosphere without regard to relative atomic weight, and such produce spectra with many substances, as we see in such solar stars as Capella, Arcturus, &c. When the mass is further condensed, the heavier elements are kept relatively lower by the increased gravitation, and hydrogen, the lightest of the elements, is present as the exterior envelope, and hence the simplified spectrum of the Sirian stars.

The phenomenon of variable stars with dark companions is accounted for on this assumption, the two being of the same age but of greatly different masses. In the case of coloured double stars the companion is generally blue or purple, and the large star yellow or red, which again is in accord with this theory.

Taking the present temperature of the sun to be 8000° C., he calculates that the temperature of the central nebula at the time of formation of the earth was less than 40° C.; the earth beginning at this, contracted until it rose to about 2000° C., which is high enough to account for all known geological phenomena. Jupiter and Saturn are considered, on similar grounds, to be still gaseous and increasing in temperature, and though not now self-luminous, may eventually become so. In conclusion, Prof. See suggests that as the nebulæ are at low temperatures many of them may be invisible, although existent. Many nebulæ have been photographed by the ultra-violet light they emit, which are quite invisible in the most powerful telescopes. If this be true, the numerical predominance of stars over nebulæ, visually, is explained, as according to the nebular hypothesis, the two classes of bodies should exist in approximately equal numbers.

THE CONSTITUTION OF THE ELECTRIC SPARK.[1]

WHEN an electric spark passes between metallic electrodes, the spectrum of the metal appears, not only in immediate contact with the electrodes, but stretches often across, from pole to pole. It follows that during the short time of the duration of the spark, the metal vapours must be able to diffuse through measurable distances.

The following investigation was undertaken primarily to measure this velocity of diffusion with the special view of comparing different metals, and different lines of the same metal.

Feddersen published, in the year 1862, an interesting research, in which photographs of sparks passing between different metal poles are taken after reflection from a rotating mirror. He could from his experiments draw some conclusions which have a bearing on the subject, but it was necessary for our purpose that the light should also be sent through a spectroscope, so as to distinguish between the luminous particles of air and those of the metal poles.

The method of the rotating mirror tried during the course of several years in various forms by one of us, did not prove successful. On the other hand, good results were obtained at once on trying the method used by Prof. Dixon, in his researches on explosive waves. This method consists in fixing a photographic film round the rim of a rotating wheel. All that is necessary for its success is to have sparks so powerful that each single one gives a good impression of its spectrum on the film. Were the sparks absolutely instantaneous, the images taken on the rotating wheel would be identical with those developed on a stationary plate, but on trial this is found not to be the case. The metal lines are found to be inclined and curved when the wheel rotates, and their inclination serves to measure the rate of diffusion of the metallic particles. The air lines, on the other hand, remain straight, though slightly widened.

To avoid the tendency of the film to fly off the wheel when fixed round its rim, as in the original form of the apparatus, a spinning disc was constructed for us by the Cambridge Scientific Instrument Company. The film is placed flat against the disc, and is kept in place by a second smaller disc, which can be screwed lightly to the first. The diameters of the two discs are 33 and 22·2 cm., the photographs being taken in the annular space of 10·8 cm., left uncovered by the smaller disc. An electric motor drives the disc, and we have obtained velocities of 170 turns per second, though in our experiments the number of revolutions was generally about 120, giving a linear velocity

[1] By Prof. Arthur Schuster, F.R.S., and G. Hemsalech. Read before the Royal Society February 2.

of about 100 metres/second for that part of the film on which the photograph was taken.

The electric discharges were obtained from a battery of six Leyden jars, having a total capacity of 0·033 microfarad, and being charged from an induction machine constructed for us by Mr. H. C. Wimshurst. This machine has twelve plates of 62 cm. diameter, and gives sparks which are 13 inches long. The electrodes were, as a rule, placed 1 cm. apart, and an image of the spark was projected on the slit of the spectroscope, the distance of the slit from the electrodes being equal to four times the focal length of the projecting lens, so that the image was equal in size to the spark. The prism used was made by Steinheil, and had a refracting angle of 60°.

We may now pass to the description of the results obtained when the spectrum of a single spark is taken on a moving film. A preliminary trial with various metallic electrodes had shown us that the sharpest results were obtained with zinc, and we therefore chose that metal for our first investigation. The principal lines of zinc as they appear on our photographs are the double line, the least refrangible of the two having a wave-length 4924·8, and the blue triplet, the wave-length of the leading line being 4810·7. All the lines are curved on the photographs taken with the spinning disc, but the displacements, especially near the poles, are subject to considerable variations. This is probably due to the fact that the path of the metallic particles is not always straight, and, if straight, its image does not necessarily coincide with the slit. A very slight error in measurement will also affect the results considerably when the total displacement measured is small. Our results do not for this reason allow us at present to give any opinion as to the maximum velocity of the particles near the pole; but if these are considerable, they drop down very quickly to speeds which, in the case of zinc, are not far off 500 metres/second.

We have adopted two methods of comparison between different photographs. We have in the first place measured the displacements at a number of nearly equidistant points, and from these measurements we have deduced the time taken for a metallic molecule to pass from the pole to a point 2 mm. away from it. If this method could be applied in every case, it would form a rational and consistent basis of comparison. But the curved lines which are to be measured are often very diffuse near the pole, this, and the continuous spectrum, may render it impossible to obtain satisfactory measurements at that point. In order not to have to reject unnecessarily a large number of measurements because the spectrum near the pole was indistinct, we have adopted another method, which, though less rational than the first, is found to give consistent results. From all our measurements we may deduce certain figures for the molecular velocities at different and generally equidistant points on the photographs, and may take the average of all these figures as the mean velocity of the particle. In the following tables, V_1 will always refer to the mean velocity between the pole, and a point 2 mm. away from it, while V_2 refers to the average velocity taken for different distances, as just explained. The influence of change of capacity and change in the length of the spark was investigated in the case of zinc, and the following tables exhibit the results. As the zinc lines are sharp near the pole, the first of the above methods of measurement could be applied.

TABLE I.—*Average Velocity* (V_1) *in metres/second of Zinc Molecules.*

Sparking distance.	Wave-length.	Number of jars.		
		2.	4.	6.
cm.				
0·51	4925	814	556	416
	4811	1014	668	529
1·03	4925	400	499	415
	4811	501	548	545
1·54	4925	723	1061	435?
	4811	1210	1526	492?

The first striking result to be deduced from the table is the uniformly higher velocity deduced from the double line 4925, as compared with that found when one of the lines of the triplet is measured; for we have ascertained that the two first lines of the triplet are always displaced by the same amount, and the third is so much mixed up with the air lines in its neighbourhood that it cannot be measured. It was one of the objects of the investigation to detect, if possible, differences of this kind, which might be accounted for by the fact that the molecules producing different lines of the same spectrum have not necessarily the same mass. We nevertheless hesitate to ascribe the smaller apparent velocity derived from $\lambda = 4925$ to this reason. This line, as has been mentioned, is one component of a double line, and the doublet is not resolved on the photographs taken with the moving film. Near the pole where the light is strong, the edge of the least refrangible component of the doublet would be considered to be the least refrangible edge of the doublet; but near the centre of the spark the light is weaker, and the lines, owing to the motion of the wheel, are drawn out towards the violet. The most intense portion of the image will here be that part where the two lines are superposed, and, in wishing to set the cross wire on the edge of the line, we should be tempted to set it on the edge of the *most* refrangible component. There is reason to believe that this is the cause of the greater deflection of the double line, and the photographs show some signs that if this source of error is eliminated, the molecule giving out the double line moves more quickly than that giving rise to the triplet. We reserve the decision of this point until we have been able to apply greater dispersion.

Comparing the spark obtained with different capacities, it is found that when the spark gap is small, there seems a very curious *diminution* of velocity as the capacity increases; this is not what should have been expected at first sight, as with the large number of jars we should expect higher temperatures, and therefore greater velocity of diffusion. When the spark gap is 1 cm., the experiments do not reveal any marked change due to capacity. When the gap is increased still further the sparks become very irregular and unsteady, and no certain conclusions can be drawn from our measurements; the numbers marked with a query are specially doubtful. When six jars are used practically identical numbers are obtained for all sparking distances, but with small capacity the centimetre spark seems to give a lower result than in the two other cases. While we should not like at present to consider this as an established result, the table serves to show that the centimetre spark and the highest capacity used gives the most consistent numbers, and our experiments with other metals were all made under these conditions, except in the case of bismuth, where clearer spectra were obtained with only two jars.

Comparing different metals with each other, we find in the first place that those having comparatively low atomic weights, viz. aluminium and magnesium, have higher molecular velocities. With magnesium the metal vapour is scattered about to such an extent that no measurements could be made, but the average velocity of the aluminium molecule was found to be over three times as great as that of zinc, the numbers not laying any claim to accuracy. Comparing zinc and cadmium with each other, we obtain almost identical numbers, both for the corresponding doublet and triplets.

Bismuth gave remarkable results. In spite of its high atomic weight some of the lines are but little displaced, indicating an average molecular velocity of 1420 metres/second. For other lines the velocity falls down to that of zinc and cadmium, while one line ($\lambda = 3793$) has a still smaller velocity.

We have not obtained satisfactory results with mercury; the best were those in which poles used were of zinc or cadmium, which were covered with amalgam. Differences in molecular velocities were obtained for different lines, but the result here is not so certain as with bismuth. There is obviously no simple law connecting these velocities with the atomic weight.

Dr. Feddersen was led through his researches to the conclusion that the metallic particles after being once torn off from the electrodes by the discharge took no further part in it, were thrown irregularly into the space surrounding the electrodes quite independently of the electric current. Although in some cases, and especially with magnesium poles, there is some evidence that this is partly true, we are led to take the following modified view of the matter.

The initial discharge of the jar takes place through the air; it must do so because there is at first no metallic vapour present. The intense heat generated by the electric current volatilises the metal, which then begins to diffuse away from the poles; the

subsequent oscillations of the discharge take place through the metallic vapours, and not through the air. We find confirmation of this view in a striking experiment which is easily repeated. If a coil of wire be inserted in the spark circuit of a Leyden jar, which may be charged either by a Wimshurst machine or an induction coil, the air lines disappear almost completely, the metallic lines alone remaining. According to our view we should explain the experiment by saying that the coil which adds self-induction lengthens the duration of the discharge, and allows time for the metallit molecules to diffuse properly into the spark gap. A great part of the energy of the current may then do useful work by heating up the metallic molecules instead of those of air. Mr. Hemsalech is at present engaged in investigating the changes in the metallic spectra which accompany the insertion of self-induction.

The first spark passing through the air will give rise to a sound wave which, during the complete time of the discharge, will only travel a few millimetres. We may therefore consider that the mass of metallic vapours suddenly set free is driven by its own pressure into the partial vacuum formed by the heated air. It would seem more correct to liken the process to that of a gas under pressure flowing into a vacuum than to that of a pure thermal diffusion. There is not much difference between these views, and we may take it that in our experiment we have approximately measured the velocity of sound in the metallic vapours. This gives a relation between their temperature and density. If we neglect the differences in the ratio of specific heat, we find approximately

$$V = 80 \sqrt{T/\rho},$$

where T is the absolute temperature and ρ the vapour density referred to hydrogen. Thus for cadmium the average molecular velocity found was 560, and substituting $\rho = 56$ we obtain $T = 2700$, which seems a possible value. Hence we conclude that the molecule of cadmium in the spark cannot have a mass which is much smaller than that directly determined near the boiling point of the metal.

In conclusion we have also taken some photographs in which the slit was directly focussed on the sensitive film without the interposition of the film. The photographs show a straight image of the slit followed by a number of curved bands extending from both poles into the spark gap.

The straight image we consider to be the initial discharge through air creating sufficient heat to fill the space with vapour through which the oscillating discharges may then pass. Our experiments point to the fact that the periodic time was rather too small in our experiments to give the best results. The metallic molecule before it has had time to reach through a sufficient distance was possibly affected in its motion by the subsequent oscillation. We hope to remedy this defect by introducing still higher capacities than those used. Our experiments allow us to give the following approximate numerical data. The air rendered luminous by the first discharge remains luminous for a time of about 5×10^{-7} seconds, the metallic vapours then begin to diffuse and reach the centre of the spark (the gap being 1 cm. long) in a time which in the case of cadmium was about 6×10^{-6} seconds. The periodic time of the oscillations with our six jars and a circuit possessing as little self-induction as possible was about 2×10^{-6} seconds. The metallic vapours remain luminous in the centre of the spark for a longer period than near the poles, the duration of the time during which some luminosity can be traced with a discharge from six Leyden jars is about $1{\cdot}5 \times 10^{-5}$ seconds.

MR. BALFOUR AND PROF. JEBB ON TECHNICAL AND SECONDARY EDUCATION.

TWO important speeches on technical and secondary education were made during last week—one by Mr. Balfour in opening a new hall which has been erected in connection with the Battersea Polytechnic, and the other by Prof. Jebb at Cambridge. The *Times* reports of the remarks made on these two occasions are abridged below.

MR. BALFOUR ON TECHNICAL EDUCATION.

Everybody interested in the least in the progress of education must watch with the profoundest interest the great experiment now being carried on in this metropolis, and not the least in the building where I am now addressing you, in connection with technical education. If I understand the matter rightly, the experiment differs from any other efforts in the same direction which have been made, either in this country, in other great centres of population, or on the continent of Europe—in Germany or in Switzerland, or in any other countries which have been pioneers in this matter of scientific and technical education.

Every scheme of education has to be considered from two distinct points of view. We have to consider its effect in qualifying the individual who receives the education for the particular work in life which he has to do. That is the first aspect of it; but there is another aspect not less important, which certainly ought never to be lost sight of, and which is not lost sight of in this institution—namely, the general educational results at which any sound system of education ought to aim. There is the technical side and there is the general side. There is the skill infused in the pupil for following that profession in life which he has selected, or which circumstances have forced upon him; and there is that other and that broader aspect in which all education of every kind is intended to co-operate—namely, the development of the general faculties of mind, eye, and body, and also to make a man or a woman a complete citizen, with all their faculties developed to the highest possible point.

Technical Instruction.

Taking these two aspects in turn, and dealing, in the first instance, with the industrial and technical aspect, I do not feel myself qualified to speak with any authority upon that part of the work of this institution which has to do with handicrafts. I understand that the aim of the institution in this connection is to supply those who are engaged in these handicrafts with more theoretical and general instruction in connection with their special pursuit which is required to enable the people to reach the highest results in that pursuit. I cannot imagine a better object. I am not aware that in other places the same object is pursued systematically and successfully in the same way in which it is pursued in the London polytechnics. After all, it has to be recognised that work is mainly to be learnt in the workshops, and I am convinced that no wise teacher would for a moment attempt to substitute either the lecture-room or experiment-room for that which can be learnt only in the workshop. But unquestionably there are branches of knowledge connected with trades and handicrafts which have a theoretical side which cannot with equal facility be learnt except in a place devoted to that side, and I believe that the work done in this institution in that connection is one of the greatest value, not merely to the pupils, but to the trades and industries which they have elected to follow.

Scientific Education.

But there is another side, and, from a national point of view, perhaps a decidedly more important side than that, and the side I mean is the complete scientific equipment of a student for those professions in which a thorough grounding in science, theoretical and practical, is absolutely necessary if he is to make the most of himself and the most of the profession in which he is engaged. I have always been deeply interested in this aspect of the question, which is the one specially considered in Germany and elsewhere, and the value of which we have perhaps in this country until recent years unduly ignored and neglected. It is an interesting question to ask ourselves how it comes about, and why it comes about, that it is only in the latter half of the nineteenth century that the absolute necessity of this thorough scientific grounding has been recognised in connection with great industrial enterprises. And the real reason I take to be this—that it is only after science has developed to a certain point, and after industry has developed to a certain point, that you can, as it were, successfully and usefully combine the two, and that there is forced upon you the necessity of recognising that almost every advance in theoretical science is reflected in a corresponding advance of industrial enterprise, and in like manner industrial enterprise and the practical application of science is itself from day to day giving birth to new scientific conceptions and new improvements either in the machinery of discovery or in the results of discovery. If anybody wishes to have a concrete illustration of this abstract truth I would ask him to make the following comparison. Take for a moment the career of the greatest man of science that this world has ever seen—I mean Sir Isaac Newson. As far as I know—I speak under correction—neither by Sir Isaac Newton himself, nor by

any one during his lifetime, were any of his epoch-making discoveries turned to any practical industrial account. So far as I know neither the unparalleled advances he made in the methods of mathematical investigation nor his discoveries in physics, in the laws of energy and the laws of motion, nor his discoveries in the region of light had any important practical bearing upon the industries either of his own country or any other country during his long life. Those discoveries were, for the most part, made while he was comparatively a young man—made, let me tell the younger members of my audience, at that happy time of life between twenty and thirty when the inventive energies are freshest, and when I hope many of them will be able to add to the store of our knowledge; but though those discoveries were made at this early period, and though Newton lived to a very advanced age, the fact broadly, I believe, is that his inventions had no important effect upon the industrial world. Now, compare with the career of Newton the careers of two of the greatest men of science that we have seen in our time—Pasteur and Lord Kelvin—two of the greatest names, I was going to say, in the science of all time, but certainly in the science of the last half of the nineteenth century. Almost every discovery of those two great men found its immediate echo in some practical advantage to the industrial world. It would be a mere impertinence before an audience in which there are many persons incomparably more qualified than I am to speak on those subjects, to dwell upon the details, but the fact is familiar to almost everybody, and the extraordinary additions which both these great men have made in very different spheres to our theoretic knowledge have had an application of incalculable value, either in the department of commercial production, of navigation, or of medicine and therapeutics.

A Plea for Thoroughness.

Can you have a more instructive contrast than I have endeavoured to lay before you between the immediate results of the scientific career of Newton and the scientific career of two of Newton's great successors, and on what does it depend? It depends upon this, that theoretical science and practical production have each on their sides now so advanced, come so close together, are so intertwined, that nothing can happen in one branch which has not its copy in another branch. Theory and practice are now almost different sides of the same shield, and he who advances theory knows probably in his own experience that it will be met in practice, and he who advances practice may rest assured that some of the fruits of his labour will be found valuable to theory. In order to obtain the highest results which we hope may really follow from such training as students obtain in the higher and more difficult branches of science in institutions like this it is absolutely necessary that the training should be thorough. It is absolutely necessary if we in this country are to compete on equal terms with the scientifically trained pupils of foreign polytechnics that the scientific training here must be offered and must be taken—and I believe it to be taken by the pupils here—in the same spirit in which it is taken in Germany or in Switzerland. Whatever else may be said of the system of education there—and do not suppose that I for one hold it up as being superior in every respect to what we have in this country—at all events, the sternest critics must admit that it is thorough in the branches with which it deals; and the man who has got the best out of one highly equipped foreign place of technical instruction does really know not merely the theoretical groundwork, but the whole special detail of the science most nearly concerned with his work in life. That thoroughness is aimed at, and I believe is attained in this institution; and it is for that reason I look forward with such great confidence to the results of the system of education here instituted in its higher branches. For it is the higher branches, mark you, that ought to be on a universal level. Part of the work of a polytechnic is more properly described as secondary education. Part of it must be more than secondary education; and if we fall short of the highest ideal of all we fall short of something which is, I believe, absolutely necessary both from an educational and from a technical point of view.

The General Aspect of Education.

It remains for me to say a word upon the second and more general aspect of education.

I feel that even those students of this institution who come here merely to gain some addition to their knowledge of a special handicraft may carry away something which is of far more importance to them than the mere acquisition of technical skill. They may carry away that broadened knowledge of the laws of nature and the progress of science which, to my mind, is not less liberalising and of not less value in the highest sense of education than the most accurate knowledge of the grammar of a dead language or the works of an ancient civilisation. I make no attack, I need hardly say, on literary education, but I cannot admit that scientific education—even if it be humble in its amount, if it be stopped comparatively early in the career of the learner—is not capable of producing as beneficial educational effects on the taught as any system of education which the ingenuity of the world as has yet succeeded in devising. Let me conclude by saying that I value the great privilege of being asked to take a leading part in this interesting ceremony. I believe that the polytechnic is doing a great work, not merely for the economic, but for the educational future of the country. I believe that in that work this splendid building, which we owe entirely to the liberality of private donors and of liberal companies, is destined in future to play no small part in the lives of those who come to this institution for educational advantages which until twenty years ago were not within the reach of any citizen of this great city.

PROF. JEBB ON SECONDARY EDUCATION.

A meeting of members of the University of Cambridge was held at Trinity College Lodge on Saturday afternoon to consider prospective legislation with regard to secondary education.

Prof. Jebb, M.P., moved the following resolutions: (1) "That this meeting welcomes the Board of Education Bill introduced by the Duke of Devonshire in the House of Lords last August as an important step towards the organisation of secondary education in England." (2) "That, in the opinion of this meeting, the consultative committee proposed in Clause 3 of the Bill should be made permanent, and should contain representatives of the Universities and of the teaching profession." (3) "That, in the opinion of this meeting, it is desirable that a system of inspection and examination conducted by a University, and approved for the purpose by the Board of Education, should be accepted as adequate under Clause 2, section (4) of the Bill." (4) "That copies of resolutions 1, 2 and 3 be forwarded to the Marquis of Salisbury, the Duke of Devonshire, Mr. Balfour, and Sir John Gorst." Speaking to the first proposition Prof. Jebb, in the course of his remarks, said:—

Scope of the Board of Education Bill.

The first duty of a recognised central department will be to take something in the nature of a census or a general survey of our existing educational resources. Such a survey was necessary, because at present, owing to the number of separate and independent agencies at work, there was no means of ascertaining precisely where gaps and deficiencies existed, and where, on the other hand, power was being wasted—though the existence of such evils was sufficiently manifest. The central authority, overlooking the whole field, would be able to determine what parts of the ground were vacant and in what parts of it there was overlapping, and therefore loss of power. The scope of the Bill, confined as it was to setting up a central authority, was limited. He believed this limitation to be a wise one, not merely on Parliamentary grounds, because such a Bill was easier to get through both Houses, but on larger grounds of educational policy. The establishment of a strong central authority, commanding public confidence, would in itself facilitate the creation of local authorities of a satisfactory kind; it would tend towards harmony among the various agencies and interests which claimed representation in the local management of secondary education. Further, the preliminary stock-taking by the central authority of our educational resources—that general survey or census to which he had just referred—was an operation which might with great advantage be performed, or at least begun, before the new local authorities came into active operation, since it would in some respects facilitate their task, and give them the advantage of information which no one of them separately could collect with equal efficiency or comprehensiveness. But there should be no mistake about the fact that the Government, speaking by the mouth of the Lord President on August 1, had clearly recognised the necessity of creating new statutory local authorities for secondary education, and regarded that as the next step to be

taken. Dr. Jebb next touched upon the uneasiness caused in some quarters by Clause 7 in the revised Directory of the Science and Art Department, issued in 1897, and said a needless fear had arisen lest the clause was designed to forestall the establishment of local authorities by Parliament and to set up voluntary organisations in their place. It was a "temporary and partial expedient." After what the Lord President had said he might say that they had the most explicit and the most completely satisfactory assurances that the Government contemplated following up their creation of a central authority by the creation of local authorities, and that it would be altogether unjustifiable to refuse a welcome to the Board of Education Bill on the ground that its own immediate scope was limited. With regard to the second proposition, Dr. Jebb addressed himself to the desirability of the Consultative Committee of the Board of Education being of a permanent character. They desired that, if not a statutory body, it should, at all events, be a recognised institution, not a merely occasional resource, which might or might not be called into existence by the Minister of the time. In asking for some express recognition of the Universities and the teachers on the Consultative Committee they were merely asking that the Government should not leave to chance a result which would probably occur in any case, and that the committee should always include certain elements which, as would be generally allowed, would be indispensable to its efficiency for the purposes which the Bill contemplated.

Need for a Central Authority.

There existed in England a very large supply of institutions which gave secondary education in some form or other. There were public schools, grammar schools, large and small, of various types, proprietary and private schools, technical colleges and institutes, polytechnics, science and art classes in connection with South Kensington; and at the top of the elementary school system there were the higher grade Board schools, some of which were also schools of science, receiving Government aid; there were also higher grade schools not subject to School Boards, but under voluntary management. These various resources for secondary teaching were controlled by various agencies which had no connection with each other. The central control was divided up between the Charity Commission, the Department of Science and Art, and the Education Department; the Board of Agriculture, too, had certain functions in this respect. The local authorities were no less manifold and disparate. Within the same town or district the local power over secondary education might be shared between a county or borough council, a School Board, various governing bodies, committees under the Science and Art Department, and managers of voluntary schools. The inevitable result was overlapping and waste of power, greater or less in different places, but prevalent in some degree everywhere. Such waste of power meant increased cost to the taxpayer or ratepayer. Economy alone dictated organisation. But organisation was also demanded by regard to the efficiency of our secondary system as a whole, which vitally concerned not only our industrial and commercial interests, but also the general welfare of the nation and the empire.

Organisation of Education Board.

The Board of Education Bill introduced in the House of Lords by the Duke of Devonshire last August was to be again introduced this Session. Its object was to establish a Board of Education for England and Wales, which should take the place of the existing Education Department (including the Department of Science and Art at South Kensington), and should also exercise certain powers now pertaining to the Charity Commission. This Board would have the superintendence of all matters relating to education, both secondary and elementary. It might probably be organised in three departments—one for secondary education proper, one for the more technical branches of science and art teaching and for the control of science and art museums, and a third for elementary education. The object was to establish a single strong central authority which could survey the whole field. At the same time, nothing was more remote from the intention of the Bill than to impose a rigid or bureaucratic system of secondary education on the country. There was no idea of a cast-iron uniformity. The local authorities, which in due course would be created, would have free discretion to deal in their own way with the varying needs and circumstances of their respective localities. The central authority would merely exercise a general supervision, affording guidance and assistance as they might be needed. The Duke of Devonshire indicated, in his speech at Birmingham on January 23, what the first task of the new central authority would be. He said that the literary side of education should not be unduly neglected in comparison with the scientific and the technical. It would be a guarantee for the maintenance of the distinctly liberal studies and of that liberal spirit in education generally which was the very breath of life to secondary schools. Already a very large number of schools, of various sizes and types, had had experience of examination by the Universities, and had been thoroughly satisfied with it. About one hundred secondary schools were represented in the Cambridge local examinations, and about the same or a slightly larger number were examined by the Oxford and Cambridge Joint Board. The cost was very moderate, making the aid of the Universities available for many schools of which the resources were comparatively limited. He could not, of course, speak with any authority as to the manner in which the Government might be disposed to regard the suggestion made in this resolution; but it appeared reasonable to hope and believe that the assistance of the Universities in work for which they had already proved their competence, and which had been done to the satisfaction of the schools, would be accepted by the Education Board of the future. Such assistance would so far diminish the number of new inspectors that would have to be appointed. In conclusion, he would only say that the Board of Education Bill appeared to him, on the whole, to receive a cordial welcome from all who were interested in the welfare of secondary education in this country. The Government had shown itself fully alive to the importance of the question. It had chosen the method of procedure which was recommended by practical considerations, and which was most likely to conduce to effective legislation on sound lines and without unavoidable delay. Dr. Jebb concluded by moving the resolutions *en bloc*, and after short addresses by the Master of Trinity, Mr. Swallow, and Mr. Bryce, M.P., the resolutions were put to the meeting and carried.

EXPERIMENTAL CONTRIBUTIONS TO THE THEORY OF HEREDITY.[1]

IN this, the first part of a paper on reversion, the two following questions are dealt with, viz.: (1) Is there invariably evidence of reversion? (2) May reversion, when it does occur, result in the complete, or all but complete restoration of either comparatively recent or of comparatively remote ancestors? The first question is answered in the negative, but to the second an affirmative answer is given. In support of the view that reversion does not invariably occur, it is pointed out (1) that clear evidence of reversion is rare in the pure-bred offspring of highly prepotent animals, such as Galloway, Aberdeen, Angus, and Shorthorn cattle. And (2) that there is sometimes no evidence of reversion in cross-bred animals. While it is deemed unnecessary to submit evidence of the fact, long recognised by breeders, that the offspring of highly prepotent animals are, as a rule, the image of their parents, it is thought desirable to submit evidence in support of the contention that in cross-bred animals indications of reversion may be wholly wanting. The following experiments bear on this point: (*a*) When a prepotent Galloway bull (which is black and hornless) is crossed with a Highland heifer, the result may be an animal which experts are unable to distinguish from a pure-bred Galloway—there may be neither a trace of the long-horned Highland parent, nor yet any indication of reversion. (*b*) A peculiarly marked skewbald (bay and white) Iceland pony mare, when mated with a whole-coloured bay Shetland pony, produced a foal which in colour, form, and gait is almost identical with the skewbald dam—on no single point does it suggest the bay Shetland sire. (*c*) A nearly black Shetland mare, when mated with a bay Welsh pony, produced a bay foal which in its make, colour, &c., is the image of the sire. (*d*) A pure white fantail pigeon, crossed with a blue pouter hen, yielded a nearly white bird having the form and habits of a pouter, but no suggestion of *Columba livia*, the supposed ancestor of the numerous varieties of pigeons. (*e*) A white Shorthorn crossed with Aberdeen, Angus, or Galloway cattle results in "blue-greys," which,

[1] By Prof. J. C. Ewart, F.R.S. (Communicated to the Royal Society of Edinburgh, December 5, 1898.)

though more or less intermediate in their characters, rarely afford any evidence of reversion. It thus appears that, notwithstanding the "swamping effects of intercrossing," the offspring of quite distinct varieties sometimes afford no evidence of reversion, and, further, that Galton's law of heredity (which teaches that the intermediate and remote ancestors together contribute one-half of the total heritage of the average offspring) does not appear to hold in the case of highly prepotent animals. In dealing with the second question, experiments are first described in support of the view that there may be complete, or all but complete, reversion to comparatively recent ancestors. (*a*) A blue and white fantail (a cross between a white fantail and a dark blue cross-bred fantail), when mated with a blue fantail, invariably produces pure white fantails, identical, as far as external characters go, with their grandsire. (*b*) A smooth-coated white rabbit (a cross between an Angora and a smooth-coated white buck), mated with a smooth-coated and almost white doe (the granddaughter of a Himalaya rabbit), produced a litter of three, one of which is the image of the mother, one is an Angora like the grandmother, while the third is a Himalaya (with the characteristic black ears and muzzle and dark grey feet and tail) like the great grandmother.

The following experiment supports the view that there may be reversion to intermediate ancestors:—A Dalmatian dog crossed with a well-bred sable collie produced three pups, which closely resemble young pointers—these pups, with their white ground colour and four or five yellowish-brown patches, in all probability reproduce fairly accurately the intermediate ancestors of the Dalmatian sire. This experiment also suggests that if prepotent ancestors occur along the route which any given variety has travelled, reversion may be at any point abruptly arrested. The remaining experiments detailed afford evidence of more or less complete reversion to comparatively remote ancestors: (*a*) An Indian game Dorking cock, crossed with a dark bantam hen, produced, amongst other birds, a cockerel almost identical with a jungle fowl. It not only resembles *Gallus bankiva* in form and colour, but also in being extremely shy and (unlike the Dorking-like members of the same brood) in its habit of flying away for a considerable distance when suddenly disturbed. (*b*) The zebra-horse hybrids hitherto bred are in their markings very unlike their zebra parent. When the sire or dam is a Burchell zebra, the hybrids in the arrangement of their stripes are not unlike the Somali zebra (*Equus grevyi*), which is, in all probability, in its decoration, the most primitive of all the living zebras. The zebra ♂-horse ♀ hybrids (*Zebrules*), bred by the author at Penycuik, and the horse ♂-zebra ♀ hybrids (*Zebrinnies*), bred at Theobald's Park, Herts, by Lady Meux, differ from the Burchell zebra parents, and agree with the Somali zebra in having (1) rounded instead of pointed arches on the forehead; (2) more than twelve cervical stripes; (3) numerous stripes across the loins and croup—instead of five or six broad oblique stripes—and (4) in having the mane extending some distance beyond the withers.

In one of the Penycuik hybrids there are two sets of stripes over the hind quarters. In this hybrid the more pronounced stripes seem to have been inherited through the zebra parent, while the less distinct, which run in a different direction, have in all probability been inherited through the horse parent. This view is supported by the markings usually found in zebra-ass hybrids, in which the dorsal and shoulder stripes and the bars across the legs are, without doubt, inherited from or through the donkey parent, while the majority of the other markings are probably transmitted by the zebra. (*c*) Mules and hinnies are often more richly striped than their parents; *e.g.* a hinny recently obtained at Penycuik by crossing a light grey she-ass with a bay Welsh pony has, in addition to dorsal and shoulder stripes, distinct bars across the legs—there are no leg bars in either of the parents. Moreover, this hinny is of a yellowish brown colour, and in many ways seems more primitive than either of its parents. (*d*) The nearest approach to complete reversion has hitherto been obtained by crossing pigeons. Darwin, by crossing a barb-fantail with a barb-spot, produced a bird "which was hardly distinguishable from the wild Shetland species." [1]

Referring to this experiment, Weismann says that Darwin devoted his attention to the coloration of the species, and failed to state whether there was complete reversion, *i.e.* a complete agreement in form as well as in colour of the barb-fantail-spot with the wild rock pigeon. By way of settling whether in the case of pigeons complete, or all but complete reversion occurs, the author first crossed an "owl" with an "archangel" pigeon, and then mated the cross-bred bird with a pure white fantail. The owl-archangel cross had neither the frill, short beak, or short round head of the owl, nor yet the crest or bronzed black colour of the archangel. The owl-archangel-fantail cross is almost identical in colour, size, and form with the Indian wild rock pigeon. The only essential difference is in the tail, for though there are twelve feathers (in the fantail parent there are thirty), the tail is slightly arched; this is the only suggestion of the white fantail sire.

The author believes that the experiments recorded afford substantial support to the reversion hypothesis.

[1] "Animals and Plants," vol. i. p. 210.

MASSIVE LAVA FLOWS ON THE SIERRA NEVADA.

AN account of "Some Lava Flows of the Western Slope of the Sierra Nevada, California," is given by Mr. F. Leslie Ransome, in *Bulletin* No. 89 of the United States Geological Survey, 1898. The area is described as having been worn down to a rough peneplain during the interval between the close of the Jura-trias and the beginning of the Miocene period. The rocks upon which this somewhat uneven peneplain has been carved are those of the so-called "Bed-rock series" of the Gold Belt, and are of Jura-trias and earlier age. They consist on the lower slopes (or foothill region) of clay-slates, schists, limestones, quartzites and various igneous rocks; and on the higher slopes mainly of gneissic and granitic rocks.

Volcanic eruptions began during the Miocene period, and, accompanied by elevation and tilting of the peneplain, lasted to the end of the Pliocene. The first eruptions were rhyolitic, followed by the laying down of a great cloak of andesitic breccias and tuffs. The deposition of auriferous gravels both preceded and accompanied the piling up of volcanic materials. Thus the earlier accumulation of andesitic breccias and tuffs was interrupted by at least one period of considerable erosion during which a large stream, the predecessor of the present Stanislaus river, cut through the volcanic cover into the Bed-rock series along the greater part of its course. During subsequent eruptions massive flows of lava extended over limited areas, displacing the stream before mentioned, and following generally the course of the Stanislaus river, while andesitic breccias and tuffs were spread for hundreds of square miles over the western slope of the Sierra. Other more restricted flows of lava followed, and the volcanic period was brought to an end by fresh andesitic eruptions, as shown by breccias which rest on the massive flows of lava. To these lavas the author applies the name of *Latite*, derived from the Italian province of Latium, where there occur in abundance rocks closely related to those he describes. Mineralogically the Sierra Nevada latites are nearly allied to ordinary andesites, but chemically they stand between the andesites and trachytes. They correspond to the plutonic monzonites of Brögger, and represent the effusive forms of the magma. The author would use the term latite in a broad sense, and to include such varieties as toscanite, vulsinite, and ciminite, which have been described by Washington in his studies in the Italian volcanic regions.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—At the 196th meeting of the Junior Scientific Club, on February 3, Mr. F. N. A. Fleischmann exhibited a heart-shaped twin of calcite, and Mr. H. B. Hartley gave an exhibit of Japanese sword blades, explaining at the same time the mode of manufacture that has been used since the fourteenth century in Japan. Mr. M. Burr read a paper on "grasshoppers."—The officers for this term are—President, Mr. F. Soddy (Merton); Chemical Secretary, Mr. H. B. Hartley (Balliol); Biological Secretary, Mr. A. G. Gibson (Ch. Ch.); Treasurer, Mr. W. E. Blackall (Non-Collegiate); Editor, Mr. H. E. Stapleton (St. John's); Committee, Mr. F. N. A. Fleischmann (Magdalen), Mr. E. Gurney (New College), and Hon. F. R. Henley (Balliol). At the next meeting of the Club (Wednesday, February 15), Prof. Odling, F.R.S., will read a paper on "Chemical

Theories under discussion about the year 1850—some personal reminiscences."

CAMBRIDGE.—The General Board of Studies has received offers from Sir Walter Gilbey, the Board of Agriculture, certain County Councils, and the Drapers' Company of sums amounting to over 2000*l.* a year for the next ten years for the support of a department of Agricultural Science in connection with the University. The Board proposes that a Professorship of Agriculture should be founded, together with a Board of Agricultural Studies to whom the administration of the department will be entrusted; and recommend that the offers be gratefully accepted by the University. Detailed proposals for the organisation of the department will be hereafter submitted, provided the general scheme is approved by the Senate. It is estimated that, during the ten years for which in the first instance the department will be established, its operations can be carried on without entailing any financial responsibility on the University Chest.

Mr. B. L. Cohen, M.P., has promised 3000*l.* to the University Benefaction Fund, and a number of smaller donations have been received as a result of the formation of the Cambridge University Association.

CAPTAIN PARTINGTON has given 2000*l.* towards the cost of building the new physical laboratory of Owens College, Manchester.

PROF. CLEVELAND ABBE is reported by *Science* to have given to the Johns Hopkins University his valuable collection of books, journals and pamphlets relating to meteorology.

THE views of several American naturalists on advances in methods of teaching were discussed at the recent meeting of American Naturalists and Affiliated Societies, and are printed in *Science* of January 20. The subjects dealt with are: zoology, by Prof. E. G. Conklin; anatomy, Prof. G. S. Huntington; physiology, Prof. W. T. Porter; psychology, Prof. H. Münsterberg; anthropology, Dr. Franz Boas; botany, Prof. W. F. Ganong.

A COPY of the Tōkyō Imperial University Calendar for the year 1897–98 has been received. At the end of the Calendar is a long list of papers published since 1887 in the Journals of the Medical and Science Colleges, the Memoirs of the Literature College, and the Bulletins of the Agriculture College. Since the Calendar went to press, the president of the University, Prof. Masakazu Toyama, has been appointed Minister of State for Education, and has been succeeded by Prof. Dairoku Kikuchi, M.A. (Cantab.).

THE patronage of the chair of Pathology now vacant in the University of Glasgow is in the hands of a Board of Curators, four of whom are appointed by the University Court, and three by the Managers of the Western Infirmary. The Curators met on Thursday, February 2; there were present:—The Principal (in the chair), Dr. Hector Cameron Dr. McVail, Mr. J. H. Dickson, Mr. James Boyd and Mr. William Ker. Instructions were given to advertise the vacancy—applications to be sent in by March 24. The new professor will be required to begin his duties on April 25.

A GRADUATES' magazine, *The Technology Review*, has just been issued by the recently organised Association of Class Secretaries of the Massachusetts Institute of Technology. It is an octavo volume of 140 pages, attractive in appearance, and well produced. The first number contains the introduction; a photograph with biographical sketch of President Crafts; articles on "The Function of the Laboratory," by Prof. Silas W. Holman; and on the "Pierce Building," by Prof. Eleazer B. Homer, the architect; reprints in fac-simile of early institute documents and letters—all in the first and more general half. The latter half, seventy pages, is given to news of the Institute, of the undergraduate and graduate classes. Plans are shown of the several floors of the new Pierce Building, of the first floor of the Rogers Building as now altered, and of the dynamo house. A good review of Prof. Holman's recent book on "Matter, Energy, Force and Work," is given by Dr. Goodwin.

THE seventh annual report of the Technical Instruction Committee of the City of Liverpool shows that the work of the Committee during the past year has been for the most part concerned with the consolidation and improvement of work previously in existence. There is reason to hope that, even before legislation takes place, means will be devised for the establishment of a satisfactory working scheme of co-ordination of all the public educational agencies of the City. The establishment of a School of Commerce—at present on a comparatively small scale it is true—by co-operation with the Liverpool Chamber of Commerce and the authorities of University College, constitutes an important development of higher commercial instruction, which, in another form, was comprised in the original scheme of the Committee. The school was started at the beginning of the winter session with very good promise of success.

THE proportion of children who should be receiving a secondary education has been variously estimated by different authorities. The Schools Inquiry Commissioners in 1868 estimated the proportion at 12·8 per thousand for boys, but made no estimate for girls. Committees working under the Welsh Intermediate Act have taken 20 per thousand (viz. 12 boys and 8 girls) as their estimate of the proportion of the population for whom provision should be made. The recent annual report of the Liverpool Technical Instruction Committee mentions that the number of Liverpool pupils attending secondary schools is approximately 7·5 per thousand of the population. The Committee point to this figure as an eloquent testimony to the deficiency which exists in Liverpool in the present provision for secondary education, and the urgent necessity for the matter to be dealt with, in the interests both of the City and of the nation, by some responsible public authority.

THE *Record of Technical and Secondary Education* refers to the constitution of the new University of London as "an event which will greatly affect the higher technical teaching of the metropolis. The Technical Education Board are giving considerable attention to the subject, and have formed a special sub-committee to report upon the matter and to frame a memorial to the Commissioners. It seems probable that the new University will give a stimulus to the development of economic and commercial teaching, and measures are likely to be taken for strengthening those subjects in the various schools and institutions of London. Commercial education hus, during the past year, been under the consideration of a special committee of the London Chamber of Commerce, and also a special sub-committee of the Technical Education Board. The last-named committee have collected a considerable amount of evidence, hnd are likely to issue their report in the course of a few weeks."

MR. S. PROUT NEWCOMBE has offered the London County Council his educational collection of natural history specimens and literature. This collection, which consists of about 21,000 objects, with a considerable number of works on natural history subjects, all classified to correspond with the examples, is at present accommodated in the Free Library of St. George's, Hanover Square. The Library Commissioners accepted the collection in May 1894, subject to the provision that they might return it at the end of four years if they were no longer able to afford it accommodation. The requirements of the library now demand additional space, and it has been found that to make the collection as useful as possible a lecture-class-room should be associated with it. The Commissioners have, therefore, availed themselves of the provision in the deed of gift, and have asked Mr. Prout Newcombe to remove the collection. The General Purposes Committee of the London County Council, who have had the offer under consideration, now recommend the Council to accept the gift.

THE will of the late Mr. Edward Austin, of Boston, Massachusetts, provides for public bequests of more than one million dollars, four hundred thousand dollars going to the Massachusetts Institute of Technology. *The Technology Review* gives the following extracts from the will referring to gifts to educational institutions. I give to Harvard College, Cambridge, 500,000 dollars, the interest upon which they will pay to needy meritorious students and teachers, to assist them in payment of their studies. To the Massachusetts Institute of Technology, I give four hundred thousand dollars, the interest to be applied as that of my bequest to Harvard College. To Radcliffe College (women's college) I give thirty thousand dollars, the interest to be in the same as that to Harvard College. To Roanoke College (Julius D. Dreher, president) I give thirty thousand dollars, on same terms as that to Harvard

College. To Tuskegee Normal and Industrial School (Booker T. Washington), I give thirty thousand dollars, on same terms as that to Harvard College. I give to bacteriological laboratory (Harvard Medical School) ten thousand dollars. Mr. Austin was one of the class of East India merchants so prosperous in the first half of this century. He was born in Portsmouth in 1803, but his childhood was spent in Boston, where also his permanent home and interests were centred.

SCIENTIFIC SERIALS.

American Journal of Mathematics, vol. xxi. No. 1, January.—Systems of revolution and their relation to conical systems in the theory of Lamé's products, by F. H. Safford. In problems requiring the solution of Laplace's equation, it is often possible (the author remarks) to obtain a solution by transferring to curvilinear coordinates, λ, μ, ν, and assuming that V is a product of three factors, *i.e.* V = L.M.N, where L, M, N are functions of λ, μ, ν respectively. Such an expression for V is called a Lamé's product. The problem treated is an application of a theorem due to Lord Kelvin, by means of which, from a known solution, V, of Laplace's equation in terms of coordinates corresponding to a system of mutually orthogonal surfaces, a solution may be readily deduced for a new system of surfaces obtained from the first by inversion. The theorem is used in an extended sense, so that real surfaces have been obtained from imaginary surfaces by inversions with regard to imaginary points as centres. A. Wangerin, in his "Reduction der Potential-Gleichung" (Leipzig, 1875), has discussed many of the topics considered here with the aid of elliptic functions. The use of these functions is avoided in the present paper. Wangerin states that the most general surfaces of revolution for which Lamé's products, with an extraneous factor, exist, are those whose meridian curves are obtained from the curves (got by equating the real and imaginary parts of the equation $x + ri = f(t + mi)$, where f is either *sn* or *cn*) by an inversion with respect to a point on the axis of revolution. The same topics are treated by Haentzschel in his "Reduction der Potential-Gleichung" (Berlin, 1863), but he obtains surfaces of revolution of the thirty-second degree.—A. L. Baker contributes a short elementary proof of Cauchy's theorem, $W = \int dW = \int w dz$, taken around a closed curve enclosing no point where $w = \infty$ is zero.—The number is closed with a long essay (pp. 25–84), by C. L. Bouton, entitled "Invariants of the general linear differential equation and their relation to the theory of continuous groups." The titles of the chapters will indicate the line of work. Cap 1. Cockle's work ("Criticoids") and differential covariants. Cap 2. Cockle's results by Lie's methods. Cap 3. Invariants of the general linear differential equation in two variables for transformation of both variables. Cap 4. Consideration of a subgroup. Cap 5. Differential equation in canonical form (complete solution in explicit form of the problem of finding all the covariants and invariants of the equation in its canonical form (Forsyth's "Identical Covariants," &c.). The bibliographical references and the consideration of Sir J. Cockle's scattered results (the first dating from 1862) are a very useful feature of the memoir.—The pictorial accompaniment of the initial number of the new volume is a photograph, from a painting, of Prof. Simon Newcomb.

Wiedemann's Annalen der Physik und Chemie (Supplementary Number, 1898).—Mobilities of electric ions, by F. Kohlrausch. The conductivities of very dilute solutions may be theoretically determined from their concentrations by adding up the separate mobilities of the ions constituting the molecule. The author gives tables of mobilities from which the conductivities of monovalent salt solutions can be calculated down to concentrations of decinormal strength.—Kinetic theory of liquids, by C. Dieterici. It is shown that by applying the methods and data of the kinetic theory of gases, the properties of liquids may be to a large extent mathematically deduced. The size of the molecules exerts of course a great effect, and it will have to be more definitely known before the liquid theory is complete.—Magnetisation by alternating currents, by Max Wien. Toroids of soft iron wire, exposed to alternations of 128, 256, or 512 per second, provided by an alternate current siren, are not capable of following those frequencies by corresponding magnetic inductions. Eddy currents of higher periods are developed, and the soft iron becomes magnetically harder.—Reaction pressure of kathode rays, by E. Riecke. An ordinary radiometer is used to determine the reaction pressure, the vanes acting as kathodes. The pressure is proportional to the current intensity, with a current of 3×10^{-6} absolute units the pressure is 0·04 dynes per square cm.—Induction coils, by W. Hess. The discharge of an induction coil is studied by introducing a liquid condenser in parallel with the spark gap. The liquid condenser contains CS_2, and produces a Kerr effect between two crossed nicols. A strained glass plate is put between the nicols, and converts the dark field into a field of fringes. These are displaced by any fluctuation of potential, and when the displacements of a section of the fringes are photographed, a record is obtained of the whole course of the discharge. Some excellent photographs are reproduced.—Effect of Röntgen rays upon spark discharges, by H. Starke. Like ultra-violet light, Röntgen rays are capable of reducing the discharge potential between terminals upon which they impinge. But, unlike ultra-violet rays, they are indifferent as to the sign of the terminal impinged upon.—A new method of demonstrating Hertz's experiments, by J. Precht. The sections of a Hertzian resonator provided with a parabolic mirror are connected with a spark gap having a blunt kathode and a pointed anode. A steady discharge from an influence machine traverses the spark gap, and the gap is so adjusted that only a glow discharge passes. Any electromagnetic waves received by the mirror convert the glow into a shower of sparks, and at the same time the discharge potential is diminished.—Use of the coherer, by O. Behrendsen. For showing the reflection of electromagnetic waves, it is necessary to use a coherer which is not very sensitive, and to avoid single wires. The author uses a coherer made of powdered arc carbon.—Pyro-electricity and piezo-electricity, by W. Voigt. The question is raised whether the whole of the pyro-electric charge of a crystal can be described as piezo-electric, and as due to the change of volume which accompanies every change of temperature. The author shows that in tourmaline and other crystals with a singular axis, about 20 per cent. of the charge is purely pyro-electric. In the other crystals it is altogether piezo-electric.—Gliding discharge along pure glass surfaces, by M. Toepler. The length of sparks in air may be considerably extended by making them pass along glass surfaces backed by tinfoil, which is in metallic connection with one of the terminals.—Magnetisation of crystals in different directions as depending upon temperature, by Ascan Lutteroth. Faraday found that the orientation of a crystal in a magnetic field is less pronounced at higher than at lower temperatures. The author shows by experiments on various sulphates that this may or may not be true according to the choice of the axis of suspension, and explains his observations on the basis of molecular magnets.—Conduction of electricity by thin sheets of dielectrics, by W. Leick. Gutta-percha, paraffin, and sulphur show greater conductivity in thin layers than in thick layers. The conductivity depends upon the current strength, the resistance decreasing as the current increases. Gutta-percha and paraffin do not show any polarisation, but sulphur does.—Absorption of uranyl salts, by Ernst Deussen. Kundt's law of dispersion does not apply to the more easily soluble uranyl salts such as the nitrate and the chloride. But it holds for the nitrate in glycerin, and for the chloride in alcohol. In the case of the less soluble salts, such as the sulphate, acetate, and oxalate, the bands are displaced towards the red.—Effect of gases and metals upon the photographic plate, by B. von Lengyel. Hydrogen is capable of modifying silver bromide so as to give images on development. Metals which, like zinc, are capable of disengaging hydrogen from moist air, also exert an effect upon the sensitive plate. The Becquerel rays of uranium and thorium are, however, a pure radiation.—Visibility of Röntgen rays, by E. Dorn. The X-rays are not only visible to the ordinary eye, but to totally colour-blind eyes, sometimes appearing exceedingly bright, but always diffused owing to the absence of refraction. The rods of the retina are more affected by them than the cones.—A new electromagnetic string interrupter, by L. Arons. This interrupter dispenses with electromagnets, the vibrating string being attracted by a permanent magnet, which breaks the circuit by withdrawing a platinum wire attached to the string from a mercury surface. The attraction is electrodynamic. Since the self-induction of the circuit can be thus made very small, very high frequencies can be attained.

SOCIETIES AND ACADEMIES

LONDON.

Royal Society, January 19.—"On the Vibrations in the Field round a Theoretical Hertzian Oscillator." By Karl Pearson, F.R.S., and Alice Lee, B.A.

The object of this paper is to investigate the types of wave motion in the neighbourhood of a *theoretical* Hertzian oscillator. By a theoretical Hertzian oscillator the writers understand a Maxwellian "double point" of initial maximum moment $\pm El$. But as the actual oscillator has been shown by Bjerknes and others to give a damped wave train, they take the maximum moment to run down with the time, and to oscillate between the limits $\pm Ee^{-p_1 t}$. This gives a wave train corresponding to that observed by Bjerknes and represented at a given distance by

$$Ce^{-p_1 t}\sin(p_2 t + \gamma).$$

The investigation for a "double point" with a *steady* wave train was originally made by Hertz himself, and has found its way into most of the current text-books of electro-magnetism. The theory there given, is insufficient for two reasons, both of which were recognised by Hertz himself, namely, because (i.) the actual oscillator has sensible extension, and (ii,) the wave train it gives forth is not steady.

The present paper only attempts to remove the latter objection to Hertz's original theory; like that theory it becomes less accurate as we approach nearer to an actual oscillator. The chief divergences between the present and Hertz's original theory actually fall in that portion of the field wherein his chief interference experiments were made.

The writers investigate the general theory of a double point with damped intensity, and replace the well-known Hertzian diagrams of the field by a more complete series of 56, representing the field for seven complete oscillations, and showing how the field for some twelve metres round the oscillator chosen, gradually falls to nearly $\frac{1}{20}$ of its maximum initial strength. These diagrams are entirely due to Miss Alice Lee, and involved a large expenditure of labour and time, which would, perhaps, not have been justified were any other graphic representation of a damped wave motion available.

The writers next deal with the type of waves propagated, their velocities and their phases. The following general conclusions are reached:—

(i.) Three waves of electro-magnetic force may be considered as sent out from the oscillator. These are:—

(*a*) A wave of purely transverse electric force.

(*b*) A wave of electric force parallel to the axis, briefly termed the wave of axial electric force.

(*c*) A wave of magnetic force.

The waves of axial electric and of magnetic force move outwards with the same velocity, which is, however, a function of the distance from the centre of the oscillator. The intensity of both forces for points on the same sphere varies as the cosine of the latitude, the polar axis being the axis of the oscillator.

The wave of transverse electric force is propagated with the same velocity at all equal distances from the centre of the oscillator, but this velocity differs from that of the two previous waves; further, the amplitude is independent of the latitude, being constant over any sphere. The velocity after the wave has reached a certain distance from the double point is always greater than that of the waves of magnetic and of axial electric force. Its excess over the velocity of light tends to become three times the excess of the velocity of the magnetic wave over the velocity of light; both the excesses decreasing asymptotically.

(ii.) The velocities of these waves undergo remarkable changes in the neighbourhood of the oscillator, but these changes extend to distances which are greater than those within which a great proportion of Hertz's interference experiments were made.

(iii.) The point of zero phase for both transverse and axial electric waves does not coincide with the centre of the oscillator, so that these waves appear to start from spheres of small but finite radius round the oscillator. A fourth wave dealt with by Hertz, namely, the wave of magnetic induction, does not, as he supposes, start with zero phase from the origin, but with a finite phase. The wave in the equatorial plane, largely relied upon by Hertz for his interference experiments "of the first kind," is a compound of the waves of transverse and axial electric force, and has a much more complex series of velocity changes than Hertz appears to have realised.

(iv.) The existence of the two electric force waves and the singular changes of the wave motion in the neighbourhood of the oscillator very possibly throw light on the difficulties which arise in Hertz's experiments. It would seem that such experiments should be made at distances greater than 6 to 7 ($\lambda/2\pi$) from the centre of the oscillator, or, roughly, about a wave-length from the oscillator. In Hertz's case this amounts to about 10 metres—a distance at which Hertz rather terminated than started his interference experiments.

February 2.—"Sets of Operations in Relation to Groups of Finite Order." By A. N. Whitehead, M.A. Communicated by Prof. A. R. Forsyth, F.R.S.

The present paper is concerned with the Theory of Groups of Finite Orders. The more general object of the paper is to place this theory in relation to a special algebra of the type considered in the general theory of Universal Algebra. This special algebra, which may be called the Algebra of Groups of Finite Order, has many affinities to the Algebra of Symbolic Logic; and a comparison of it with this algebra is given in the last section of this paper.

The N symbols, or operations, are considered to be capable of addition according to the law

$$S+S=S.$$

This is the well-known law of addition in Symbolic Logic, and the introduction of numerical symbols as factors is thereby avoided.

The sum of a selection of the N fundamental operations, such as $S_p+S_q+S_r+S_t$, is called a set. If a set obeys certain special conditions it is called a group. The sum of the whole number (N) of fundamental operations, namely, $S_0+S_1+\ldots\ldots+S_{N-1}$, obeys these conditions. This sum is called the complete group, and all other groups are its sub-groups.

The first six sections of this paper are devoted to the detailed establishment of this purely algebraic view of the subject. At times the modification in treatment from that adopted in the standard treatises on the subject, such as Burnside's "Theory of Groups of Finite Orders," is slight.

The more special object of this paper follows directly from the changed point of view from which the Theory of Groups is here regarded. The idea of the group is no longer so absorbing; the set takes its place as the fundamental general entity which has to be investigated. Accordingly in this paper some of the general properties of sets are investigated. A set of operations has numerous groups associated with it, and these groups have many relations with each other. The fundamental idea of this part of the paper (*cf.* § 7) is the formation from a set H of an unending series of other sets, here called the successive powers of H, and in the notation of the algebra written H^2, H^3,..... This series is called the power sequence of H. Any group which contains H also contains its power sequence. The power sequence is proved to have a periodic property (*cf.* § 9) which introduces a curious analogy to recurring decimals. This periodicity is the foundation of the rest of the paper. It governs the relations to each other of the various allied groups and sets. The periodicity is expressed by an equation of the form

$$H^{n+sm+q}=H^{n+q},$$

where m is called the period of H, and n the characteristic, and s and q are any integers including zero. The number of theorems relating to m is very large.

Linnean Society, January 19.—William Carruthers, F.R.S., Vice-President, in the chair.—Mr. H. W. Monckton exhibited specimens of *Mya arenaria*, Linn., from Norway. He and Mr. R. S. Herries (Sec. Geol. Soc.) had found a colony of these molluscs living on a sand-flat at the head of the Fjærland Fjord, about eighty miles from the open sea and where the water at the surface is fairly fresh. The great snowfield, the Sostedal, approaches close to the north-west side of the fjord, and at a level of only 3500 feet to 4000 feet above it, where glaciers descend into the valleys at the head of the fjord to within four miles of the mud-flat in question. The shells were for the most part small and thin, and this might be due to the freshness or to the coldness of the water, or both.—Dr. W. G. Ridewood read a paper, entitled "Some Observations on the Caudal Diplospondyly of Sharks," from which he concluded that the occurrence of twice as many vertebræ as muscle-segments is a secondary feature, but one of ancient date; and,

further, that it is purely adaptive, being calculated to maintain a due proportion between the length of the centrum and the width of the body, without diminishing the length of the muscle-segments.—Mr. George Murray, F.R.S., and Miss F. G. Whitting (Newnham Coll., Camb.) communicated a paper on new Peridiniaceæ from the Atlantic, of which (in the absence of Mr. Murray through indisposition) an abstract was given by the Secretary.—Mr. A. J. Maslen read a paper on *Lepidostrobus* After remarking that the late Prof. Williamson's collection of fossil plants in the Natural History Museum contained a number. of slides which he had associated with *Lepidostrobus*, but which could not be referred with certainty to the particular vegetative organs to which they belonged, while it was difficult also to refer isolated sections of the same type of *Strobilus* to one another, he explained that the present paper gave the result of a re-examination of Williamson's slides of *Lepidostrobus*, undertaken at the suggestion of Dr. D. H. Scott. His object and endeavour had been to make out, if possible, at least some distinct forms; but he had found great difficulty in determining whether the observed structural differences in isolated sections were really of specific value or not. He considered it safer to adopt Williamson's *Lepidostrobus Oldhami* for a common type of structure, and by comparison to describe three marked variations (α, β, and γ). A clearly distinct form he described as a new species under the name *Lepidostrobus foliaceus*.

Entomological Society, January 18.—Annual Meeting.—Mr. Roland Trimen, F.R.S., President, in the chair.—It was announced that the following gentlemen were elected as officers and Council for 1899:—President, Mr. G. H. Verrall; Treasurer, Mr. R. McLachlan, F.R.S.; Secretaries, Mr. J. J. Walker and Mr. C. J. Gahan; Librarian, Mr. G. C. Champion; and as other members of Council, Mr. W. F. H. Blandford, Dr. T. A. Chapman, Mr. H. St. J. K. Donisthorpe, the Rev. Canon W. W. Fowler, Mr. A. H. Jones, Mr. F. Merrifield, Mr. E. Saunders, Mr. R. Trimen, F.R.S., Mr. J. W. Tutt and Mr. C. O. Waterhouse.—The address of the retiring President was then read by the Secretary. In this, after a review of the present position of the Society, an account was given of the various experimental researches and observations made on the subject of seasonal dimorphism in lepidoptera from those of Weismann down to the evidence recently brought forward by Dr. Dixey on the existence of this phenomenon in Neotropical Pierinæ.

MANCHESTER.

Literary and Philosophical Society, January 24.—Mr. J. Cosmo Melvill, President, in the chair.—The President announced that the Council had awarded the Wilde Medal of the Society for 1899 to Sir Edward Frankland, K.C.B., F.R.S., and the Wilde Premium of fifteen guineas to Dr. Charles H. Lees. The presentation of the medal and premium had been fixed for February 28, when the Wilde Lecture would also be delivered by Prof. William Ramsay, F.R.S.—Dr. F. H. Bowman stated that he had recently seen a specimen of wheat grown in South Africa, consisting of about 420 stalks which were apparently produced from a single seed; each stalk had an ear containing on the average forty grains. The President and Mr. Charles Bailey agreed that the plant was most probably *Triticum compositum*, and Mr. Tristram stated that plants bearing 190 stalks had been grown in Lancashire.—The President exhibited specimens of *Eichhornia speciosa*, Kunth (the water hyacinth), and *Blitum virgatum*, L. (the strawberry blite), and also a series of leaves of the common holly (*Ilex aquifolium*, L.) showing every kind of variation.—Mr. Charles Bailey explained the structure of the peculiar permanent sheath which encloses the extremity of each root and rootlet of the *Pontederia* (*Eichhornia*) *crassipes*. The specimens exhibited to the members under the microscope showed that these sheaths were like the long finger of a glove in shape, and varied in size according to the age of the organ. The organic connection between the root and its sheath is found at the extremity of the root at the bottom of the sheath. The sheaths are of fair consistency, and are doubtless designed for the protection of the plant, which, by means of its inflated leaf-stalk, passes its life floating upon the surface of the water; the growing and tender extremities of the root are in this way guarded against the attacks of the smaller aquatic animals. The species of the cryptogamic genus *Azolla*, which also pass their existence in a floating condition, have a very similar root-sheath, but in their case the organ is only temporary, being discarded before the root reaches maturity.

PARIS.

Academy of Sciences, January 30.—M. van Tieghem in the chair.—Remarks by M. Faye on vol. i. of the *Annales de l'observatoire de Nice*.—Observation of the B-group in the solar spectrum, made at the summit of Mont Blanc, by M. A. de la Baume-Pluvinel. Photographs of the solar spectrum at Paris, Chamonix, and the summit of Mont Blanc, show that the group of B lines still remains at the highest elevation, but with an intensity much less than in the lower layers of the atmosphere.—Remarks on the preceding communication, by M. Janssen.—On the generalisation of the first method of Jacobi, by M. N. Saltykow.—On groups of the class $N - u$ and of degree N, transitive not less than $u - 1$ times, by M. Edmond Maillet.—On the problem of iteration, by M. Léméray.—On the prolongation of analytical functions, by M. Émile Borel.—On orthogonal systems, by M. A. Pellet.—Doubly cylindrial surfaces and isothermal surfaces, by M. L. Raffy.—On surfaces of total constant curvature, by M. Tzitzéica.—On the lines of curvature of certain surfaces, by M. Blutel.—On curves of traction, by M. H. Bouasse.—Permanent torsion and the point of recalescence in steel, by M. G. Moreau. It is shown that for wires of different diameters with a sufficiently large initial torsion, the relation between the residual torsion T_r, the torsion T, and the diameter d, is given by $T_r = T - k/d$. Measurements of k for a well tempered steel wire raised to different temperatures by means of an electric current, showed that k remained constant up to about 300°, and then slowly diminished up to the point of recalescence, 715°, after which it remained constant.—Double refraction produced by the magnetic field related to the Zeeman phenomenon, by M. A. Cotton. In a previous paper it has been shown that the production of a magnetic field affects the optical properties of sodium vapour and nitrogen peroxide. An analysis of the light which reappears under the action of the field now shows that the explanation originally suggested is correct; for each of the new rays created by the field, the flame absorbs from the ray of white light only those vibrations identical with those it emits itself.—On the transparency of opaque bodies for luminous radiations of great wave-length, by M. Gustave de Bon. With a lamp wrapped in black paper, objects placed in an opaque box in contact with a phosphorescent zinc sulphide screen could be photographed.—On the differences existing between X-rays proceeding from one body, by M. G. Sagnac. The bundle of secondary rays emitted by a heavy metal exposed to X-rays, consists of rays of very different penetrative power, in every case less than that of the original rays.—The explosive power of acetylene at very low temperatures, by M. Georges Claude. The solubility of acetylene in acetone increases very rapidly as the temperature diminishes, acetone at −80° dissolving more than 2000 volumes of the gas. A platinum wire may be kept at a red heat in this solution without any explosion taking place. Liquid acetylene at −80° behaves similarly.—On the alloys of iron and nickel, by M. F. Osmond. A series of iron-nickel alloys was prepared, containing only small amounts of manganese and carbon, and in which the nickel varied in amount from 0·27 to 98·5 per cent. These alloys were heated, and the temperature at which their magnetic properties vanished noted: the curve showing the results has three branches, showing maximum transformation temperatures at 0, and 70 per cent. of nickel.—On the decomposition of carbon monoxide in presence of metallic oxides, by M. G. Boudouard. Carbon monoxide was passed over the oxides of nickel, cobalt, and iron, at 445°, and the rate of reduction measured. If the time of heating is sufficiently prolonged the decomposition is total with the oxides of nickel and cobalt.—On a new method of estimating carbon monoxide, by MM. Schlagdenhauffen and Pagel. Carbon monoxide completely reduces silver oxide at 60°, cuprous oxide at 215°–300°, and hence these oxides may be used to estimate the gas.—On some aromatic iodo-ketones, by M. A. Collet. A description of the preparation and properties of iodo-acetophenone, $C_6H_5.CO.CH_2I$, and the corresponding $CH_3.C_6H_4.CO.CH_2I$, and $CH_3.C_6H_4.CO.CHI.CH_3$.—Remarks on the preparation of the oxyethylamines, by M. F. Chancel. By the action of ammonia upon glycol chlorhydrin, the chlorhydrate of trioxyethylamine is readily obtained in a pure state.—Extraction and synthesis of the perfume of the jasmine flower, by M. Albert Verley. Preliminary attempts to isolate the essence by distillation with steam having failed, the perfume was taken up by fat in the usual way. This extracted with heavy petroleum oil and acetone gave only 40 gr., 90 per cent. of which

was submitted to distillation under reduced pressure. A liquid was isolated of the composition $C_9H_{10}O_2$, which proved to be the methyl acetal of phenyl-glycol. It was synthesised by heating phenyl-glycol and formaldehyde with dilute sulphuric acid on the water bath.—Action of the benzidine diazochlorides of ortho-toluidine and orthodianisidine upon acetylacetone, by M. G. Favrel.—On the reducing power of the tissues, by M. Henri Hélier. The reducing power of a tissue is defined as the quantity of oxygen that it is capable of removing from potassium permanganate to reduce the latter to Mn_2O_3. The present paper gives data for the liver and pancreas.—The clinical exploration of the renal functions and of phloridzic glycosuria, by M. Ch. Achard.—Action of the Turkish bath upon the internal organs, by MM. Bianchi and Félix Regnault. —On a hailstorm observed at Bizerte, by M. Voiellaud.—Barometric movements on the orthogonal of the meridian of the moon, by M. A. Poincaré.

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 9.

ROYAL SOCIETY, at 4.30.—On the Reflection of Cathode Rays: A. A. C. Swinton.—On the Recovery of Iron from Overstrain: James Muir.—A Soil Bacillus of the Type of De Bary's *B. megatherium*: Dr. W. C. Sturgis.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

MATHEMATICAL SOCIETY, at 8.—On a certain Minimal Surface and on a Solution of $\nabla^2 V = 0$: T. J. Bromwich.—The Group of Linear Homogeneous Substitutions on mq Variables which is defined by a certain Invariant: Dr. L. E. Dickson.—On the Complete System of Differential Covariants of a Single Pfaffian Expression, and of a Set of Pfaffian Expressions: J. Brill.—Groups of Order p^3q: E. A. Western.—The Irreducible Concomitants of any Number of Binary Quartics: A. Young.—The Scattering of Electric Waves by an Insulating Sphere; A. E. H. Love, F.R.S.—The Figure of Jacobi with respect to a Linear System of Hyperquadrics: Prof. Schoute.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Rules for the Regulation of the Wiring of Premises for Connection to Public Supply Mains: J. Pigg.—The Regulation of Wiring Rules: C. H. Wordingham.—The Institution Wiring Rules: R. E. Crompton.—(Continuation of Discussion, if time permits): Electric Traction by Surface Contacts: Miles Walker.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—Fifth Report to the Alloys Research Committee: Steel: Sir William C. Roberts-Austen, K.C.B., F.R.S.—Machinery for Book and General Printing: William Powrie.—Evaporative Condensers: Harry G. V. Oldham.

CAMERA CLUB, at 8.15.—The Heat of the Moon: The Earl of Rosse, F.R.S.

FRIDAY, FEBRUARY 10.

ROYAL INSTITUTION, at 9.—Motion of a Perfect Fluid: Prof. H. S. Hele-Shaw.

ROYAL ASTRONOMICAL SOCIETY, at 3.—Anniversary Meeting.

PHYSICAL SOCIETY, at 5.—Annual General Meeting.—Address by the President.—An Ampere-Meter and a Volt-Meter with a Long Scale: Benjamin Davies. (This will probably be read by Dr. Lodge.)

MALACOLOGICAL SOCIETY, at 8.—Annual General Meeting.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Electrical Driving of Engineering Workshops: William Middleton.

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30

SATURDAY, FEBRUARY 11.

ROYAL INSTITUTION, at 3.—Mechanical Properties of Bodies: Lord Rayleigh.

MONDAY, FEBRUARY 13.

IMPERIAL INSTITUTE, at 8.30.—Cuba: Richard Davey.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—Exploration in the Canadian Rockies: a Search for Mount Hooker and Mount Brown: Prof. Norman Collie, F.R.S.

TUESDAY, FEBRUARY 14.

ROYAL INSTITUTION, at 3.—Morphology of the Mollusca: Prof. E. Ray Lankester, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.— The Lake Superior Iron Ore Mines, and their Influence upon the Production of Iron and Steel: Jeremiah Head and Archibald P. Head.

ANTHROPOLOGICAL INSTITUTE, at 8.—The Arabs of the Indian Frontier: Sir T. H. Holdich, R.E., K.C.I.E., C.B. (With Lantern Illustrations.) —Exhibition of Photographs by J. Guthrie Watson.

ROYAL HORTICULTURAL SOCIETY.—Annual Meeting.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Annual General Meeting.

WEDNESDAY, FEBRUARY 15.

SOCIETY OF ARTS, at 8.—The Balloon as an Instrument of Scientific Research: Rev. John M. Bacon.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Report on the Phenological Observations for 1898: Edward Mawley.—The Circulation of the Atmosphere: Prof. W. M. Davis.

ROYAL MICROSCOPICAL SOCIETY, at 8.—Preceded at 7.30 by an Exhibition of Objects shown by Multiple-Colour Illumination: Julius Rheinberg.

ENTOMOLOGICAL SOCIETY, at 8.

OXFORD UNIVERSITY SCIENTIFIC CLUB, at 8.—Chemical Theories under Discussion about the Year 1850—some Personal Reminiscences.

THURSDAY, FEBRUARY 16.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* On the Reflex Electrical Effects in Mixed Nerve and in the Anterior and Posterior Roots: Miss Sowton.—The Characteristic of Nerve: Dr. A. D. Waller, F.R.S.—Observations on the Cerebro-spinal Fluid in the Human Subject: Dr. St. Clair Thomson, Dr. L. Hill, and Prof. Halliburton, F.R.S.—The Thermal Deformation of the Crystallised-Normal Sulphates of Potassium, Rubidium, and Cæsium: A. E. Tutton.

ROYAL INSTITUTION, at 3.—Toxins and Antitoxins: Dr. Allan Macfadyen.

LINNEAN SOCIETY, at 8.—On the Genus *Lemnalia*, Gray, with an Account of the Branching Systems of the Order Alcyonacea: Gilbert C. Bourne.—On some African *Labiatae*, with Alternate Leaves: J. H. Burkill and C. H. Wright.—Report on the Marine Mollusca obtained during the First Expedition of Prof. A. C. Haddon to the Torres Straits: James Cosmo Melvill and Robert Standen.

CHEMICAL SOCIETY, at 8.—On the Absorption Spectrum and Constitution attributed to Cyanuric Acid: W. N. Hartley, F.R.S.—Ballot for the Election of Fellows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Recherches sur les Instruments les Méthodes et le Dessin Topographiques; Colonel A. Laussedat (Paris, Gauthier-Villars).—Elementary Hydrostatics: C. Morgan (Rivingtons).—Die Welt als That: Dr. I. Reinke (Berlin, Paetel).—West African Studies: M. H. Kingsley (Macmillan).—Vaccination; its Natural History and Pathology; Dr. S. M. Copeman (Macmillan).—Society for the Promotion of Engineering Education. Proceedings of the Sixth Annual Meeting (Columbia, Mo.).—Elementary Physiology: B. Moore (Longmans).—An Introduction to the Differential and Integral Calculus and Differential Equations: F. G. Taylor (Longmans).—Instinct and Reason: H. R. Marshall (Macmillan).—The Human Body: Prof. H. N. Martin, 5th edition (New York, Holt).—A Junior Course of Practical Zoology: A. M. Marshall and C. H. Hurst, 5th edition (Smith, Elder).

PAMPHLETS.—Licht-, Elektrizitäts- und X-Strahlen: R. Mewes, Zweite Ausgabe (Berlin, Krayn).—Sprachregeln für die Bildung und Betonung Zoologischer und Botanischer Namen: P. Kretschmer (Berlin, Friedländer).—Dietary Studies in Chicago (Washington).

SERIALS.—Contemporary Review, February (Isbister).—Photogram, February (Dawbarn).—Physical Society of London, Proceedings, January (Taylor).—Transactions of the Natural History Society of Glasgow, Vol. v., n. s., Part 2 (Glasgow).—Natural Science, February (Pentland).—Humanitarian, February (Duckworth).—Scribner's Magazine, February (Low).—National Review, February (Arnold).—Knowledge, February (Witherby).—Fortnightly Review, February (Chapman).—Journal of Botany, February (West).—L'Anthropologie, tome ix. No. 6.—Observatory, February (Taylor).—Geographical Journal, February (Stanford).—Record of Technical and Secondary Education, January (Macmillan).—Zeitschrift für Physikalische Chemie, xxviii. Band, 1 Heft (Leipzig).—Bulletin of the American Mathematical Society January (New York).—Monthly Weather Review, October (Washington).

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