THURSDAY, JANUARY 28, 1904.

PROF. ARMSTRONG'S EDUCATIONAL CAMPAIGN.

The Teaching of Scientific Method and other Papers on Education. By Henry E. Armstrong, LL.D., Ph.D., F.R.S. Pp. x+476. (London: Macmillan and Co., Ltd., 1903.) Price 6s.

THIS book reproduces the chief contributions which Prof. Armstrong has made to the literature of education from 1884 to the present time, with the addition of a parody by another hand of that most parodied of music hall lyrics, "The Absent Minded Beggar." I have been so constantly in touch with Prof. Armstrong, and occasionally so closely associated with him, that the book comes to me in no degree as a new work, and I have perforce read it from the point of view of one who regards the mode of presentation of the case rather than the merits of the case itself. Though the work is entitled "The Teaching of Scientific Method," its scope is much wider, for it is an indictment of our educational system from top to bottom, and an indication of how education is to be set right in its relation to all the arts of peace and war.

It appears to me that the weakness of Prof. Armstrong's book lies in the want of system and coordination. The arrangement is probably as good as it could be, provided that nothing were feasible but the mere reprinting of twenty-three occasional addresses, but it is impossible not to suppose that the constant reiteration of doctrine, and the continual reappearance of almost the same words, will deter a reader who sits down to read the book solidly through. It would have been a considerable labour, but it would have given unity and plan to the book, if Prof. Armstrong had mixed the twenty-three outpourings, and had subjected the mixed liquid to a process of fractional distillation.

Coming to the matter of the book, it is unnecessary in the pages of NATURE to say a single word in justification of Prof. Armstrong's assertion of the importance of science as an element in national education, and of the importance of teaching science well. I shall confine myself, therefore, to the question as to whether the method of teaching science which Prof. Armstrong advocates is really a way of teaching it well. On this question there is an apparent diversity of opinion among those who may be supposed to be entitled to express an opinion. I will assume no editorial plural in writing on the subject. I, as one teacher, after twenty years' constant study and observation of science teaching in schools am of opinion that Prof. Armstrong is advocating what is essentially a good method, and though I know that this same method has been spoken of by distinguished people in terms of condemnation and ridicule, I am ready to justify my opinion.

The objects of science teaching in schools have been stated again and again in all degrees of fulness and eloquence. They appear different to different people. Science gained a footing in the schools of this country, I think, in the hope that it would prove a bread-and-butter study, and would provide a body of useful information as clearly available for practical purposes as arithmetic. It was an important ingredient of that "modern side" education which was the outcome of a rebellion against the classical basis on which all education had previously rested. It was accepted reluctantly by schoolmasters, who, too ignorant of science to understand its higher possibilities, regarded the intrusion as essentially Philistine in origin and in aim.

In France science was introduced into the school curriculum with a totally different object. The aim there was to add an element of natural philosophy, to open the mind of the young to an appreciation of the grandeur of natural laws, to use science as an element of culture.

My own independent critical knowledge of science teaching in schools does not go back more than twenty years, but I am prepared to maintain that twenty years ago the science teaching that prevailed in this country was in the main execrable. Good teachers there were, no doubt, for good teachers there always will be, independently of all systems. But whether looked at as giving useful information, culture, or mental training, the teaching of science in my school days and after was in the main worthy of the contempt with which it was regarded by all those who had a humane interest in education.

This state of things has now been altered to a degree which makes the change one of the most remarkable and gratifying educational revolutions with which I am acquainted. The change has been wrought by the efforts of a number of men who were sufficiently interested in science and sufficiently imbued with the spirit of the teacher to set to work and show that science could be made an invaluable mind-training study, and among these men I reckon Prof. Armstrong as a potent leader.

Prof. Armstrong renounces the claim, often imputed to him, of having discovered a new method of teaching. What he has done has been to formulate a scheme of teaching in accordance with principles which are almost as old as civilisation. The aim of this scheme has been to free science teaching from the dogmatic didactic methods by which it has been dominated, and to substitute a system which should yield the benefits of the experimental method. Two things, and two things only, I think, are essential to Prof. Armstrong's plan, first, that the pupils should perform experiments with their own hands, and second, that these experiments should not be the mere confirmation of something previously learned on authority, but the means of eliciting something previously unknown or of elucidating something previously uncertain. In this way only, it is maintained, can pupils gain the knowledge and use of scientific method. Incidentally, it is urged that the experimental studies should be made quantitative, and that a small number of problems should be studied thoroughly.

I cannot imagine that this view of the way in which science should be taught can be seriously disputed, and I think it is a pity that so many of Prof. Armstrong's critics should have fastened on quite subsidiary matters and left his main contention unacknowledged.

I feel bound to admit that in some respects Prof. Armstrong has overstated his case. His advocacy has suggested that he desires the pupil to discover everything for himself and by himself, and so is incurred the criticism that it is ridiculous to expect a child to achieve in two or three years that which it has taken grown philosophers centuries of labour to achieve. A beginner cannot discover much for himself by himself, but a judicious teacher may lead him to discover much. I think that Prof. Armstrong has exaggerated the importance of quantitative work, great though that importance be. One has only to think of the achievements of Scheele in order to realise what a splendid thing qualitative work may be when faithfully performed. Again, the element of useful information must not be underestimated; we want to get the pupil along, and there is surely much that may be told, if it is properly presented and punctuated with experiments. In doing this there is no need to throw the pupil into a state of passive acceptance, still less of passive resistance; a good teacher knows how to avoid either.

Another point on which Prof. Armstrong's critics have fastened is his nomenclature. This is really a trifling matter, but such as it is I am on the side of the critics. "Chalk gas" seems unnecessary, even as a temporary name for carbon dioxide. Why not fixed air, which is both descriptive and historical? However, as I have said, such things are mere trifles.

In conclusion, I will express the opinion that it is not the matter of Prof. Armstrong's proposals that has created opposition, but the manner. There is probably no decent member of society more repugnant to the average Englishman than the aggressive educational reformer. If a man quietly records in books the outcome of his mature reflections and experience—well, you can avoid him by not reading his book, but if he appears at all your meetings with his new doctrines, if he invents new terms that dart promiscuously about the atmosphere of the educational world, and if eventually he gets known to the newspapers as a man likely to furnish occasion for the headline "animated debate," it is quite otherwise. If a man is a stylist like Matthew Arnold, deft with epigram, breathing a cultivated irony, he is forgiven everything for his literary excellence. But Prof. Armstrong has not chosen the persuasive method of Matthew Arnold. He is vigorous almost to violence, red-hot, scathing, scornful, uncompromising and incessant. He is no respecter of persons or institutions, however eminent, however ancient. He is absolutely impartial in his iconoclasm.

These peculiarities may have hindered the acceptance of improved methods. In any case, improvement could only have come in slowly, for it is laborious, and taxes the ingenuity as well as the diligence of the teacher. The eagerness of public administrators for speedy results, the false economy which gives the teacher no time to think, and the crowding of elementary classes, not only in the case of science, but all through the school course, are great obstacles to thoroughness. How idle it is to preach improved methods to an overworked teacher who has seventy, eighty or a hundred children to teach at once!

When all reasonable concessions have been made to his critics, it will, I believe, appear that Prof. Armstrong has rendered an inestimable service to the cause of true education. ARTHUR SMITHELLS.

PRACTICAL ZOOLOGY.

First Report on Economic Zoology. By Fred. V. Theobald, M.A. Pp. xxxiv+192; 18 figures. (London: Printed by Order of the Trustees of the British Museum, 1903.) Price 6s.

THIS volume of reports on problems of economic zoology is very welcome. It represents a type of publication familiar in America, which has never been more than very rare in Britain; it is packed with valuable practical advice which must surely justify zoology in the eyes of any unconverted utilitarian; and it illustrates the nature and amount of scientific information on matters of economic importance which the staff of the zoological department of the British Museum "is almost daily called upon, and is prepared to furnish to the public service or to individuals." As is well known, this side of the Museum's work has been brought into particular prominence since Prof. Ray Lankester became director.

The contents are necessarily very heterogeneous, and afford a fine illustration of the multitudinous ways in which man's practical interests come into contact with animal life. We find discussions on cereal pests, root-crop pests, fruit pests, garden pests, forest pests, on poison for moles, on tapeworm in sheep, on the origin and varieties of domesticated geese, on dipterous larvæ in human excreta, on *Anobium tesselatum* in St. Albans Cathedral, on green matter in Lewes Public Baths, on the cigar beetle and the Teredo, on the tsetse fly and the Ceylon pearl fisheries, on the screw worm in St. Lucia, locusts in the Sudan, mosquitoes at Blackheath, and so on through a variety of subjects that is positively astounding. Mr. Theobald deserves warm congratulation on the impressiveness of his "First Report."

The variety of subjects which have had to be discussed in response to inquiries from the Board of Agriculture, the Foreign Office, the Colonial Office, and from private individuals makes the volume very multifarious, and gives a special appositeness to Prof. Ray Lankester's introductory scheme or outline of economic zoology. He gives a classified survey of the various subdivisions which it is found convenient to recognise in the treatment of this subject. This classification of animals in their economic relation to man, which recalls a little book by Dr. Edwin Lankester, proceeds from the simpler relations of primitive man and the animals around him to the more complex relations of civilised man with his endless arts and industries and circumscribed conditions. We give the classification in outline:—

Group A.—Animals *captured* or *slaughtered* by man for food, or for the use by him in other ways, of their skin, bone, fat, or other products. *Examples:*—

animals of the chase; food-fishes; whales; pearl-mussels.

Group B.—Animals *bred* or *cultivated* by man for food or for the use of their products in industry or for their services as living things. *Examples*:—flocks and herds; horses; dogs; poultry; gold-fish; bees; silkworms and leeches.

Group C.—Animals which directly promote man's operations as a civilised being without being killed, captured or trained by him. *Examples*:—scavengers such as vultures; carrion-feeding insects; earthworms and flower-fertilising insects.

Group D.—Animals which concern man as causing bodily injury, sometimes death, to him, and in other cases disease, often of a deadly character. *Examples*:—lions; wolves; snakes; stinging and parasitic insects; disease-germ carriers, as flies and mosquitoes; parasitic worms; parasitic Protozoa.

Group E.—Animals which concern man as causing bodily injury or disease (both possibly of a deadly character) to (*a*) his stock of domesticated animals; or (*b*) to his vegetable plantations; or (*c*) to wild animals in the preservation of which he is interested; or (*d*) to wild plants in the preservation of which he is interested. *Examples*:—Similar to those of Group D, but also insects and worms which destroy crops, fruit and forest trees, and pests such as frugivorous birds, rabbits and voles.

Group F.—Animals which concern man as being destructive to his worked up products of art and industry, such as (*a*) his various works, buildings, larger constructions and habitations; (*b*) furniture, books, drapery and clothing; (*c*) his food and his stores. *Examples*:—White ants; wood-eating larvæ; clothes' moths, weevils, acari and marine borers.

Group G.—Animals which are known as "beneficials" on account of their being destructive to or checking the increase of the injurious animals classed under Groups D, E, and F. *Examples*:—Certain carnivorous and insectivorous birds, reptiles and Amphibia; parasitic and predaceous insects, acari, myriapods, &c.

We have, then, in this "First Report on Economic Zoology" a large number of expert discussions of particular points—all of practical importance and some of theoretical interest as well; and we have also a luminous orientation of the whole subject. No one can help being impressed by the fact that zoology does not lose either in interest or in thoroughness as it becomes more social.

J. A. T.

IRRIGATION WORKS.

Irrigation Engineering. By Herbert M. Wilson, C.E. Fourth edition. Pp. xxiii+573. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 17*s*. net.

AN annual grant of about 500,000*l*. having been recently allotted by the Congress of the United States for the construction of irrigation works in arid regions, under the supervision of the director of the Geological Survey, various projects have been prepared with a view to their execution in the near future, which have already given employment to a number of engineers. This development has enhanced the importance of a sound knowledge of the principles of irrigation engineering, and has, accordingly, led the author to revise thoroughly and enlarge his book on the subject.

The area of land irrigated in the United States, reaching more than $7\frac{1}{2}$ million acres, is second only to India with 33 million acres, being larger than the irrigated area in Egypt of 6 million acres, in Italy of $4\frac{7}{10}$ million acres, and in Spain of $2\frac{4}{5}$ million acres. The States in which irrigation has been most resorted to are Colorado, California, Montana, Utah, and Idaho, with irrigated lands ranging from $1\frac{1}{3}$ million to half a million acres. After a very short introductory chapter on irrigation, the book is divided into three parts, dealing with hydrography, irrigation canals and canal works, and storage reservoirs respectively, in nineteen chapters altogether.

The subjects treated of in the first and third parts are, for the most part, similar to those contained in books on water-supply, the chief exceptions being chapter iv., on alkali, drainage, and sedimentation; chapter v., on the quantity of water required; and the end portion of the last chapter in part i., relating to sewage irrigation, which belongs strictly to sewage disposal. When the drainage of irrigated lands is not efficiently provided for, and an excess of water is carelessly distributed, any alkali in solution in the water accumulates by the evaporation which occurs as soon as the water rises to the surface, sodium carbonate being the most injurious to the soil; and the land also becomes water-logged and swampy, which, besides being bad for agriculture, is liable to occasion malarial fevers. Silt, which is brought down in large quantities in flood-time by many rivers, the waters of which are used for irrigation, is very valuable as a manure if it can be spread over the land, but it is very liable to deposit in the storage reservoirs and canals provided for irrigation, before the water reaches its destination; and the aim of the engineer is to convey the lighter and more fertile silt on to the land with the water, and to arrest the heavier silt before it reaches the reservoir, or to scour it out through sluices in the dam; and in the case of a diversion canal from a river, to arrange its entrance so as to keep out most of the heavier silt, and to make the remainder deposit in a part of the canal from whence it can be readily removed. The amount of water required to irrigate a given area depends upon the conditions of the locality and the crops raised, and forms the basis of all irrigation schemes.

The second part deals with works relating exclusively to irrigation in seven chapters, in which inundation and perennial canals, their alignment, slope, and cross section, headworks and diversion weirs, scouring sluices, regulators and escapes, falls and drainage works, distributaries and the application of water and pipe irrigation, are successively considered; and this constitutes the most important part of the book as regards irrigation. The book, however, as a whole, deals with the principles and practice of irrigation in a very complete manner, and is profusely illustrated by forty-one full-page views and plans, and one hundred and forty-two figures in the text; it is written in a simple style and printed in large type; and within a moderate compass the volume furnishes a large amount of information, combined with the results of experience, especially in the United States, which should prove of considerable value to engineers engaged in irrigating arid regions.

OUR BOOK SHELF.

Graphic Statics, with Applications to Trusses, Beams, and Arches. By Jerome Sondericker, B.S., C.E. Pp. viii+137. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1903.) Price 8*s*. 6*d*. net.

THIS is a very practical treatise on the determination of the forces in braced structures, beams, masonry arches, and abutments. It is based on a course of instruction given at the Massachusetts Institute of Technology. The author presupposes a knowledge of the strengths of materials, of the principles of statics, and of ordinary beam formula for stresses and deflections, and is thus able to present his methods in a very concise form without any lengthy preliminary explanation, and he pays special attention to the precautions which should be taken in drawing the diagrams in order to secure the best results.

The graphical processes are accompanied by analytical calculations, and the student is wisely encouraged to make himself familiar with both methods of computation, and not to follow either slavishly. Building construction is mainly drawn upon in providing examples, which include such cases as steel framed buildings under the action of gravitation loads and wind pressures. The author does not employ the strain energy method or its equivalent for structures with redundant elements, but proceeds by arbitrary assumption as to what seems probable in each particular case. This is often the only feasible plan, but too much reliance should not be placed on the results obtained. For instance, there is probably considerable error on p. 79 in the tacit assumption that the reactions in the trussed beam are the same as if the middle support did not yield. Considerable attention is given to frames where the members are subject to binding stresses as well as to direct stresses.

The three-hinged arch is dealt with, and some of the methods which have been proposed for determining the line of resistance in a masonry arch are briefly discussed; the author works out one example in full detail, showing how to find the linear arch which lies within a specified region (such as the middle third), and has the least horizontal thrust.

Memories of the Months. Third series. By Sir Herbert Maxwell, Bart. Pp. xi+290; illustrated. (London: Edward Arnold, 1903.) Price 7*s*. 6*d*.

THE author has no occasion to offer apologies for converting the "Memories" into a trilogy, and it is with sincere pleasure that we welcome this latest addition to a charming series, of which we hope we have not yet seen the end. Whether his subject be forestry, the habits and activity of squirrels, local place-names, salmon-disease, or "vole-plagues," Sir Herbert writes with a charm peculiarly his own, and, while imparting information, does so in a style which many of our best novelists might envy. Perhaps the highest praise we can bestow is to say that whenever one of the author's books comes into our hands for review, we invariably read it from beginning to end—and that with pleasure and satisfaction.

As Sir Herbert is not, we believe, a professed naturalist, a few slight errors, mainly due to lack of acquaintance with current zoological literature, could scarcely fail to occur in a work of this nature.

For instance, his arguments and conclusions drawn from the remarkable distribution of the fresh-water fishes of the genus Galaxias (p. 50) are rendered practically nugatory by the recent discovery of a marine representative of that group. Again, he does not appear to be aware that the Thessalian vole (p. 39) has been assigned to a new species by Captain Barrett-Hamilton, under the name of *Microtus hartingi*. We may also direct attention to the practical repetition, on pp. 46 and 47, of the account of the damage inflicted on Scottish pine forests by crossbills given on pp. 1 and 2, the repetition extending even to the fading of the crimson of the head and neck of the bird to dull greenish-olive after death. Another repetition will be found by comparing pp. 73 and 115, in connection with the origin of the name Winchester; with the discrepancy that "Gwent" is stated to mean "white" in the latter, and "downs" in the former passage. Finally, the misprint *Odicnemus* on p. 102 is scarcely consonant with the author's predilection for etymology.

Where all is interesting, it is difficult to select passages for special notice. Attention may, however, be directed to the calculation of the muscular activity of the goldcrest as contrasted with that of man (p. 40). It may also be noted that the author defends his contention as to the limited height to which holly is prickly by the remark that when this has been called in question it is owing to artificial strains, and not the natural wild stock, having been the subject of observations.

With this we must take leave of a volume as charming and full of interest as its predecessors. R. L.

Educational Woodwork. By A. C. Horth. Pp. 159. (London: Percival Marshall and Co., n.d.) Price 3*s*. 6*d*. net.

THE author has attempted to provide, within the restricted limits of a hundred and sixty pages, a three years' course of woodwork, drawing, and object lessons; chapters on discipline, organisation and method; particulars as to the fittings and furniture required for the exercises, as well as hints on the instruction of deaf, blind, and special children. At the same time he has found space for nearly two hundred illustrations. The consequence is that the instructions are meagre, and in many cases quite inadequate. The illustrations in the earlier pages are good, but some of the drawings intended to help the object lessons outlined in chapter viii. will fail to convey much meaning to pupils. The courses of woodwork are also published separately in pamphlet form at fourpence net for each year.

Die Proportion des goldnen Schnitts. By J. Kübler. Pp. 36. (Leipzig: B. G. Teubner, 1903.)

THIS is an attempt to discuss the properties of quantities in continued proportion, and in particular the series of proportionals derived from the problem of medial section, in connection with a large number of mathematical, physical, and even physiological problems.

If books of this kind are written and read as a recreation by people who enjoy thinking about semi-mathematical and semi-philosophical considerations, and who merely take the conclusions arrived at for what they are worth, without attaching special scientific value to them, then the present volume completely fulfils its object.

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 Royal Society.

AT the special meeting of the Royal Society held on January 21, when the constitution and functions of the sectional committees were under consideration, the opinion was expressed by more than one speaker that the usefulness of the society in encouraging and advancing scientific work is not what it might be; but no very definite suggestions were made with a view to its improvement.

It seemed to me that the functions of these sectional committees had a good deal to do with the lack of scientific enterprise which we observe in the Royal Society, and that they might with advantage be done away with.

As many of the fellows had left the meeting before I spoke, and as everything that affects the efficiency of the Royal Society concerns the public, I crave the hospitality of the columns of NATURE to develop as shortly as possible my views on this matter.

The main function of the sectional committees is to *refer* papers received by the society from fellows, to some other fellow or fellows of the society to be certified that they are or are not fit to be accepted and published by the society.

It is well known that the fellows of the society are *de facto* chosen by the council after rigid scrutiny and the most careful inquiry, and the only object of this scrutiny and inquiry is to satisfy the council that the candidate whom it recommends is a man of eminence in his own science, and that the work which he is likely to do will be a credit to the society. So convinced is the society of the thoroughness and impartiality with which the council discharges this duty that the confirmation of its selection by election has come to be a pure formality. This being so, it cannot fail to surprise the newly elected fellow, when he proceeds to justify his election by doing work and communicating the results of it to the society, to find that he is now in no better position than he was before he was elected. His work is *referred* in the same way as that of any outsider. His recent selection by the council is ignored by that body or is regarded as having no weight, and it treats him, scientifically, as a perfect stranger.

Furthermore, this *reference*, which amounts to neither more nor less than a secret revision of the title of the fellow to the privileges of the society, is repeated on every occasion when he comes under the notice of the society by offering it work. So long as he is content to be a passive fellow, or at least an inactive one, he is spared this injustice and indignity. It is no wonder then that the fellowship of the Royal Society has come to be looked on as an invitation to repose rather than as an incentive to work.

How different is the state of things which we observe in the parallel society in France, the Academy of Sciences. Its constitution is thoroughly democratic, and all its proceedings are inspired by enlightened self-respect. But we need only contemplate the work which it puts through in the year and compare it with what is turned out by the Royal Society to see that there is something for us to learn by its study.

First and foremost the academy meets fifty-two times in the year, namely, on every Monday, with the exception of Easter Monday and Whit Monday, and then it meets on the following Tuesdays. By the time-table of the current year the Royal Society is to meet twenty times.

Papers by members, or communicated by members of the academy, are not obliged to be sent in before the meeting. The *agenda* of the meeting is compiled at the meeting, each member who has a paper to communicate giving notice of it to the secretary on his arrival in the room, and the papers are taken strictly in the order of their intimation. If the paper communicated by the member is to be published in the *Comptes rendus* of the sitting, it has to be handed in to the secretary at the sitting; the corrected proof has to be returned to the printer on the Wednesday evening, and it is then published without fail on the Sunday. The communication, reading, and publication of a paper presented to the academy is therefore an affair of the inside of a week, and it is a certainty. This promptitude in the putting through of work is due to the fundamental fact that when a man is elected a member of the academy he enters at once into the full enjoyment of all its privileges, and one of the chief of these is the complete confidence of all his fellow-members. When he communicates a paper, whether it be by himself or by someone not a member of the academy, it is accepted without question. The only limitation in the privileges of members is with regard to the space that they are entitled to claim in the *Comptes rendus*. A paper by a member or foreign associate of the academy may fill six pages per number, and his communications in the year may fill fifty pages in all, and this as a matter of right.

It is unnecessary to occupy more space in order to show what a powerful engine the Academy of Sciences is in the production and encouragement of work, or to indicate how easily the Royal Society may successfully rival it. Let every fellow of the society, whether he be on the council or not, have complete confidence in his fellow-fellows and give practical effect to it, and the thing is done. The rest will follow of itself.

J. Y. BUCHANAN.

January 23.

The Radiation from an Electron describing a Circular Orbit.

THE complete formula for the radiation may be useful to some of those who are now indulging in atomic speculations. It is derived from the general formula I gave a year ago in NATURE (October 30, 1902), expressing the electromagnetic field everywhere due to an electron moving anyhow. Put in the special value of R required, which is a matter of elementary geometry, and the result is the complete finite formula. But only the part depending on R^{-1} is required for the radiation; and, in fact, we only want the r^{-1} term (if r = distance from the centre of the orbit), if the ratio of the radius of the orbit to the distance is insensible, and that, of course, is quite easy, on account of the extreme smallness of electronic orbits. The magnetic force is given by

$$H_\phi = \frac{Qun}{4\pi rv}\alpha^3 \cos\theta \cos\phi_1, \qquad (1)$$

$$H_\theta = \frac{Qun}{4\pi rv}\alpha^3(\sin\phi_1 - \beta), \qquad (2)$$

subject to

$$\alpha = \frac{1}{1-\beta\sin\phi_1}, \quad \beta = \frac{u}{v}\sin\theta, \qquad (3)$$

$$\phi_0 = \phi_1 + \beta\cos\phi_1 = \phi - nt + nr/v. \qquad (4)$$

There is no limitation upon the size of u/v, save that it must be less than 1. But there is a limitation regarding the acceleration. If the change in the acceleration is sensible in the time taken by light to traverse the diameter of the electron, it will sensibly alter the results. The size of the electron itself will then have to be considered. But this is very extreme. To explain the symbols: the (surface) charge is Q moving at speed u and angular speed n in a circle in the plane perpendicular to the axis from which θ is measured. It revolves positively round this axis, and its position when $t=0$ is $\phi=0$. Also, r, θ, ϕ are the usual spherical coordinates of the point of observation, and H_ϕ, H_θ are the ϕ and θ components of the magnetic force at that point at the moment t. The coefficient α^3 shows the Doppler effect on **H**. The difference between ϕ_0 and ϕ_1 must be noted.

It will be readily seen what an important part the Doppler effect plays if, as has been sometimes assumed, subatomic motions of electrons involve values of u which are not insensible fractions of v. For instance, in the plane of the orbit, $H\phi=0$, and

$$H_\theta = \frac{Qun}{4\pi rv}\frac{\sin\phi_1 - u/v}{[1-(u/v)\sin\phi_1]^3} \qquad (5)$$

The effect is to compress H in one half and expand it in the other half of a period, with corresponding strengthening and weakening of intensity, and also with a shifting of the nodes towards the compressed part. When u/v is made large, there is a great concentration at $\phi_1=\phi_0=\frac{1}{2}\pi$, $2\frac{1}{2}\pi$, $4\frac{1}{2}\pi$, &c., with only a weak disturbance of opposite sign between them. That is, there is a tendency to turn the original simply periodic vibration into periodic pulses, which become very marked as u increases towards v. The radiation of energy is very rapid. It involves (*l.c.*) the factor $(1-u^2/v^2)^{-2}$. This becomes so great as seemingly to shut out the possibility of anything more than momentary persistence of revolution. But there might be a solitary partial revolution, or nearly complete, in cometary fashion, which would generate a single pulse, if there cannot be a sequence of several at speeds nearly equal to that of light.

Three suggestions have been made about the X-rays. Röntgen suggested a longitudinal ether disturbance. This has not found favour, because it requires a new theory of electricity. Schuster suggested very rapid vibrations. This is tenable, because in the inside of an atom rudimentary calculations show that vibrations much more frequent than light are easily possible with revolving electrons. Stokes suggested collisional pulses. This is tenable too, for the collisions must produce electromagnetic pulses. I think X-rays are mixed Stokes pulses and Schuster vibrations, the latter arising from the atoms of the body struck. Now a pulse is not the same as a continued vibration, though it may be analysed into the sum of various sorts of continued vibrations, just as the distorted simply periodic vibration in (5) above may be. There ought, then, to be a physical difference between the effects of collisional pulses and continued very rapid vibrations. Apart from the emission of electrons and matter, there might be six sorts of radiation at least, say, light vibrations, below light, above light, collisional pulses, cometary pulses, and possibly periodic pulses. The last may have to be excluded for the reason mentioned. The cometary pulses would resemble the collisional pulses, though less dense. The above light vibrations need not require u/v to be more than a small fraction, though even then their maintenance is a difficulty. They require renewal again and again, perhaps in a collisional manner. There is a good deal to be found out yet in the relations of electricity to matter. There is also sometimes a good deal of misconception as to the relations of theory to fact. A purely dynamical theory of electricity, like Maxwell's, can give no information about the connection between electricity and matter. For example, Zeeman's experiment, as interpreted by Lorentz, brought out the striking fact that it was the negative electricity that revolved, not seemingly the positive, and the fact harmonises with J. J. Thomson's negative corpuscles. Theory could never predict such a fact, because it is not in the theory. It could not be there, because it has no dependence upon the dynamics of electricity in the theory. The same may be said of various other new facts much discussed of late. Now, though the theory cannot predict such facts, it is useful, of course, as a guide in framing hypotheses to account for the new facts, for it is no use flying in the face of solid theory. Whether the solid theory itself (not meaning that the ether is solid) will need to be altered remains to be seen. There is no sign of it yet, though I cannot believe the ethereal theory is complete.

To analyse the dopplerised vibrations expressed by (1), (2) into simply periodic vibrations seemed to involve very complicated work at first, save just for two or three terms. But there is a trick in it, which, when found, allows the complete expansions to be developed in a few lines. First show that (this is the trick)

$$\alpha^3 \cos\phi_1 = -\frac{d^2}{d\phi_0^{\,2}}\cos\phi_1, \qquad \alpha^3(\sin\phi_1-\beta) = -\frac{d^2}{d\phi_0^{\,2}}\sin\phi_1. \quad (6)$$

Next, by the theorem known as Lagrange's, $\sin\phi_1$ can be at once put in the form of a series involving the derivatives of various powers of $\cos\phi_0$. Do not find the derivatives from them, but put $\cos^n\phi_0$ in terms of the sum of first powers of cosines by the well known circular formula. The full differentiations, not forgetting those in (6), may then be done at sight in one operation. The result is

$$\alpha^3(\sin\phi_1-\beta)=\sin\phi_0-\beta\,.\,2\cos 2\phi_0-\frac{3}{8}\beta^2(9\sin 3\phi_0+\sin\phi_0)$$
$$+\frac{4}{3}\beta^3(4\cos 4\phi_0+\cos 2\phi_0)+\frac{\beta^4}{\lfloor 4}\frac{1}{2^4}\Big(5^5\sin 5\phi_0+5\cdot 3^4\sin 3\phi_0$$
$$+10\sin\phi_0\Big)-\frac{\beta^5}{\lfloor 5}\frac{1}{2^5}\Big(6^6\cos 6\phi_0+6.4^4\cos 4\phi_0+15\cdot 2^4\cos 2\phi_0\Big)$$
$$-\ldots \quad (7)$$

and so on to any extent. Then, to find the other one, differentiate the series in (7) with respect to ϕ_0 and divide the nth term by n. Thus

$$\alpha^3\cos\phi_1=\cos\phi_0+2\beta\sin 2\phi_0-\frac{\beta^2}{8}\Big(27\cos 3\phi_0+\cos\phi_0\Big)-\ldots \quad (8)$$

and so on. This analysis of the vibrations is useful in some special developments, but of course the original distorted simple vibration is the most significant. In fact, the result of the analysis exhibits the common failing of most series developments that the resultant meaning is not evident.

Another way. Use Bessel's series for the sine and cosine of ϕ_1, and then carry out (6). It is remarkable that the relation between the eccentric and mean anomaly in a planetary orbit should be imitated, for the dynamics is quite different.

When I was a young child I conceived the idea of an infinite series of universes, the solar system being an atom in a larger universe on the one hand, and the mundane atom a universe to a smaller atom, and so on. I do not go so far as that now, but only observe that there is a tendency to make the electrons indivisible, and all exactly alike. But they must have size and shape, and be therefore divisible. Unless, indeed, they are infinitely rigid. Or they may vary in shape without dividing. There are infinite possibilities in the unknown. Kaufmann's measurements go to show that the mass of an electron, if there is any, is only a small fraction of its effective electromagnetic mass, although that is not a definite quantity subject to the Newtonian second law. But it is too soon to say that the electron has no mass at all, that is, to be quite sure that negative electricity is absolutely separable from matter, though it seems likely. It would be well to have, if possible, similar measurements made on positive electricity. If permanently attached to matter, it should not exhibit the increased inertia with increased speed in a sensible manner.

January 11. OLIVER HEAVISIDE.

Atmospheric Electricity.

YOUR correspondent Mr. George Simpson truly points out that the sun's α rays would be stopped by the upper atmosphere, whereas his β rays would penetrate much further; and perhaps he may have also noticed that an energetic separation of these oppositely charged rays would be effected by the earth's magnetic field, the negative being conveyed toward the poles, and the positive remaining near the tropics along with the maximum sunshine.

Consequently quadrantal earth-currents would be generated, and likewise a Leyden jar action would be set up in the tropical region of the lower atmosphere, sufficient to account for prevalent tropical thunderstorms. Some magnetic perturbations could also be accounted for.

OLIVER LODGE.

Nomenclature and Tables of Kinship.

A CIRCULAR letter, arranged like the following, is about to be issued for carrying out certain inquiries into heredity, and I am anxious, before taking a more definite step, to have it criticised and to receive suggestions. I send it to NATURE not only for my own advantage, but because I think it will interest those readers who occupy themselves in analysing experiences in breeding animals of any kind, although this table has been specially designed to receive hereditary facts concerning man.

The processes that it is desired to facilitate are, in outline, as follows:—Some marked peculiarity is determined on to be made the subject of study. It may be an excess or deficiency of some normal character, or it may be a trait, a feature, a disease, or a monstrosity, the process being the same in all these cases. The inquirer then endeavours to trace its hereditary distribution. He fixes upon some individual who possesses the peculiarity in a highly marked degree, and traces the frequency and intensity with which it occurs among his kinsmen. He tries to do so exhaustively by compiling the facts relative to those kinsmen in each and every degree to as great a distance of kinship as he is able, or cares, to go. He follows a similar course in respect to many other individuals belonging to as many different families, and finally he obtains average results by well-known methods. I am speaking solely of inquiries

Distribution of the Peculiarity X *in the Family of* A. B.

fa=Father or father's, according to its place; similarly, *me*=Mother; *bro*=Brother; *si*=Sister; *so* (or *son* where more euphonious)=Son. The links in the chain of kinship are to be read as leading outwards from A.B. Thus, *me da* signifies "A.B.'s mother's daughter is." *fa bro son* means "A.B.'s father's brother's son is."

Ordinary names for generalised kinships	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Titles showing the precise chain of kinships	Adults alone: Total No. of sons and daus	Adults alone: Initials of those whose X deserves record	Names in full of those whose initials appear in the preceding column
Grandfather	*fa fa*	1		*me fa*	1		
Grandmother	*fa me*	1		*me me*	1		
Uncles	*fa bro*			*me bro*			
Aunts	*fa si*			*me si*			
Father	*father*	1		—	—	—	
Mother... ...	*mother*	1		—	—	—	
Brothers ...	*brother*			—	—	—	
Sisters	*sister*			—	—	—	
Half-brothers	*fa son*			*me son*			
Half-sisters	*fa da*			*me da*			
Nephews ...	*bro son*			*si son*			
Nieces	*bro da*			*si da*			
First cousins Male ...	*fa bro son*			*me bro son*			
	fa si son			*me si son*			
First cousins Female...	*fa bro da*			*me bro da*			
	fa si da			*me si da*			

Maiden name of the wife	Year of marriage	Number who survived infancy: sons	Number who survived infancy: daus	Initials of those whose X deserves record

directed to what I would call the *actuarial* side of heredity, because they are analogous to those made by actuaries with medical experiences to determine the just rates of insurance in respect to expectation of life and other vital phenomena.

The ambiguity and cumbrousness of the ordinary terms of kinship are serious obstacles in carrying out these researches; it is also very difficult to present the results in a compact form by any established method. I have endeavoured to overcome both difficulties, the latter by the arrangement of the present table, and the former by the use of syllables, which give a perfectly distinctive description, and which, in addition to the advantage of brevity, have those of being easily intelligible, euphonious, even though they may be a trifle absurd, and capable of the most extended application. The details of the peculiarity X, as they appear in the several persons named in the last column of the table, are supposed to be entered in a corresponding number of paragraphs on a separate sheet. After more trials and failures than would be easily credited, I think I have at last succeeded fairly well. Still, as I began by saying, I should be very grateful for useful suggestions. The table admits of indefinite extension, with no alteration of method. It will, of course, be understood that each successive step in the line of descent introduces a new element that may seriously affect the previous influences. Much might be added, but I think that with the aid of a little reflection the arrangement of the table will explain and justify itself.

FRANCIS GALTON.

The Source of the Energy of Radium Compounds.

IF I understand Prof. Rutherford's communication aright (NATURE, January 7, p. 222), he concludes from the constancy of radio-active results with a solid radium salt and the same diluted that the energy of radium compounds cannot be derived from external sources. The matter is of such wide scientific interest that I ask your permission to present concisely the contra argument.

(1) When a coloured solid is dissolved the amount of absorption of light effected by the solid is equal to the amount of light absorbed by its solution. Thus I have shown that a plate of solid bichromate of potash 0·71 millimetre in thickness effects the same absorption of light as 6 centimetres of solution containing 0·0309 gram of the salt per cubic centimetre, as in each case the same number of bichromate molecules or molecular aggregates is acting on the light. To be perfectly clear, taking the specific gravity of bichromate of potash as 2·617, we have in the former case a rectangular bundle of rays 1 square centimetre in section passing through $0{\cdot}71 \times 0{\cdot}2617 = 0{\cdot}1858$ gram of solid, while the bundle of rays in the latter case passes through $6 \times 0{\cdot}0309 = 0{\cdot}1854$ gram of dissolved bichromate (see *Chem. News*, October 5, 1877).

(2) It has been amply demonstrated that the absorption of X-rays follows the same general laws as the absorption of light; thus the amount of both kinds of radiation absorbed increases (1) with the thickness of the body passed through, and (2) with the molecular weight in a comparable series of bodies ("The Old Light and the New," 1896, pp. 73–80).

Therefore if it be postulated that the energy of radium is due to the absorption of "an unknown external radiation" "similar in character to the radiations which are emitted," viz. the γ rays, then the mere act of dilution of a milligram of radium bromide will not affect its constancy of absorption, and therefore also will not materially influence its radio-activity.

WILLIAM ACKROYD.

Borough Laboratory, Halifax, Yorks.

γ-Rays from Radium.

FROM the letter of Prof. Rutherford in NATURE of January 7 it is improbable that γ rays from radium are Röntgen rays generated by self-bombardment. The γ rays must therefore arise from radium directly, and not as a secondary effect of bombardment.

It may be useful here to recall a remark made by Sir George Stokes at a meeting of the physical colloquium of the Owens College, Manchester, shortly before his death. Commenting on Becquerel rays, he likened the discharge of kathode rays to the discharge of a gun, the impact of kathode projectiles on a target creating an ethereal disturbance recognised as Röntgen rays. But, he said, in the same way as there is an explosive disturbance in the gun where the bullets issue, so there must also be a violent ethereal disturbance, not only where kathode rays strike, but also where they issue.

Is it not just this disturbance where β rays issue which is now being detected in γ rays, and is it not quite consistent with this view that the explosive disturbance of the atom which produces α and β rays should at the same time generate something akin to Röntgen rays?

J. R. ASHWORTH.

105 Freehold Street, Rochdale, January 16.

Phosphorescence of Photographic Plates.

I HAVE frequently observed the phenomenon described in your correspondent's letter published in NATURE of January 14 on treating plates which had been exposed to the action of Röntgen rays, with a solution of alum.

I first noticed it in June, 1898, and the temperature of the dark room was 23°. The film being "hardened" was that on an "Ilford Special Rapid Plate," which had been subjected to a somewhat protracted development with pyrogallol; on pouring a 7½ per cent. solution of common alum over the plate, the liquid lit up with a pale phosphorescence, not unlike that seen on stick phosphorus on a warm night, which continued for about ten seconds and then faded away.

Plates developed with ferrous oxalate also glow occasionally under similar conditions, and phosphorescence seems to take place only when the film has not been exposed to ordinary light, and when the surrounding air is exceptionally warm. JAMES F. RONCA.

Clapham, S.W., January 23.

WITH reference to the letter from Mr. T. A. Vaughton in your issue of January 14 regarding the phosphorescence of silver bromide, it is worth noticing that this is not a function of the silver haloid salt.

Whilst working here for Dr. W. J. Russell, F.R.S., I chanced to empty some spent pyro developer and a dilute solution of alum into the sink of the dark room at the same time, when the whole liquid at once glowed with a brilliant phosphorescence.

This takes place whenever a dilute aqueous solution containing pyro, a soluble sulphite, and an excess of alkali is made acid. It occurs even when the amount of pyro is very small, but it is essential that the solution be alkaline. If the pyro be mixed with sodium sulphite alone, although the latter be in sufficient quantity to ensure faint alkalinity, the solution remains colourless and does not phosphoresce; an oxidation of the pyro seems to be necessary.

Either a dilute solution of a mineral acid, of an organic acid, or of an acid salt can be used to acidify the pyro.

This phenomenon is not a new one, but so far as I am aware has never been studied. O. F. BLOCH.

The Davy Faraday Research Laboratory,
Albemarle Street, W., January 20.

M. Blondlot's *n*-Ray Experiments.

ABOUT three months ago I independently discovered that a feebly luminous phosphorescent zinc sulphide screen when brought near the body increased in brightness.

I mentioned this fact to Mr. H. A. Taylor, remarking that I believed it to be the effect of an undiscovered ray given off by the flesh; he suggested, however, that heat was the cause of the phenomenon.

Further trials showed this to be the case; by laying the back of the screen against a fluted jar filled with warm water the zinc sulphide would brighten up along the edges of the fluting and clearly indicate the pattern; on removing the screen the light would fade, showing the pattern now as dark lines against a lighter background.

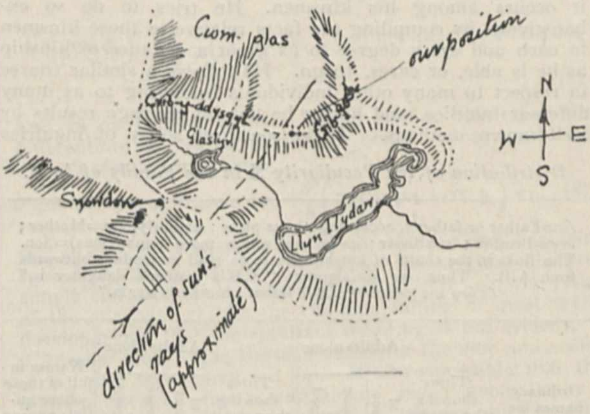
With care screens of sulphide of zinc or of calcium may be made highly sensitive to warmth, and by this means it might be possible to photograph many dark bodies simply by means of the heat rays given off, provided a suitable lens was employed. S. G. BROWN.

4 Great Winchester Street, London, E.C., January 23.

Curious Shadow Effect.

I SHOULD feel obliged, if not troubling you, if you could tell me where I could obtain information with regard to the following:—

During the Christmas holiday my brother and I were in North Wales, and happened to be on the ridge that lies north of Llyn Llydaw; the sun was about 1h. from time of setting, and was low enough to clear the lower edge of the thin clouds which came from a northerly direction. The hollow (Cwm Glas) to the north of the ridge was, every now and then, filled up with thin mist on which our shadows were projected; surrounding the shadow was a faint oval-shaped rainbow, which, as the sunlight strengthened, became brighter, and a second bow outside the one nearest to the figures appeared, though very faintly. Although my companion was within a few feet of me, we each saw our *own* shadows only. We also saw, when the mist was further from us, a shadow of the ridge itself with our two figures on it, in this case the figures appearing much smaller than in the other effect, and without any bow.



These phenomena are, I believe, not rare on this ridge, certain conditions, such as a bright low-down sun behind one, and a fairly opaque mist in front, being, of course, necessary.

The point on which I desire information is why the bows should be of this oval form, and why they should appear at all?

The *shadow* of one's figure I can more readily understand.

The little pencil sketch enclosed may perhaps explain my description. H. M. WARNER.

44 Highbury Park, N., January 14.

Destructive Action of Rain upon Animal Life.

THE protracted and heavy rains during periods of the past year must have imposed a severe strain upon the smaller and more fragile forms of animals, such as, for instance, plant lice, mites, many of the smaller species of insects, spiders, &c. Even if adults are able to withstand the destructive effects of torrents of rain, it is difficult to understand how very immature examples, or individuals that have recently undergone ecdysis, can survive. During prolonged and heavy rain over a mixed tract of country the available shelter is relatively very small. Practically the whole surface soil becomes sodden, and, in the open at any rate, almost the whole vegetation is drenched. In some plants, as is well known, the flowers and certain areas of the leaves and other parts afford shelter, but even taking this into account, it would seem that the injury must be very great. In the county of Sussex during ordinary June or July weather the number of small creatures harbouring in such a position as, say, a patch of rank herbage near water is truly astonishing. During the last ten years I have often visited such positions in heavy rain, and I am convinced that great mortality is caused, but I have not been able to satisfy myself whether this is due to drowning, burial in the soil, the impact of falling drops, or to some other cause or combination of causes.

Over an area not subject to violent meteorological fluctuations, the fauna will assume a condition of equilibrium. Any sudden and wide departure from the mean conditions for the particular season of the year will have an immediate and profound effect. I venture to write, therefore, in the hope that someone will pay special attention to the effects of such periods of abnormal rainfall as we have had during the last few months. The subject does not appear to have received the attention it merits, and the inquiry might profitably be extended so as to cover other meteorological effects. W. RUSKIN BUTTERFIELD.

4 Stanhope Place, St. Leonards-on-Sea, January 17.

Subjective Images.

THE letter on the above subject (p. 271) reminds me of one that I sent to NATURE in 1871 (vol. iv. p. 122) describing a phenomenon complementary to that observed by Mgr. Molloy. I was induced to write it in consequence of a communication by Mr. T. Ward (NATURE, vol. iv. p. 68), who observed that the white chalk lines on a blackboard appeared to be blue when the sun was shining on his eyes; I noticed that the printing in a book looked bright red when I was walking on a chalk road, the book being shaded by an umbrella.

There appears to be a connection between the three phenomena, but I will not venture to suggest an explanation; possibly the persistence of colours may be different in different eyes. HERBERT MCLEOD.

January 23.

IN response to Dr. Molloy's appeal, I may mention that a correspondent of *Work* having asked the reason for the colours in Benham's artificial spectrum top, I made, in the number for April 6, 1895, a suggestion which is practically the same as his explanation. This was that the optic nerves which according to the Young-Helmholtz theory produce the sensation of violet, are the most easily excited of the three sets, and that those producing the sensation of green, having the greatest inertia, are least easily excited and retain the impression for a longer time than the other two. In the number of the same journal for January 11, 1896, other phenomena were cited which might be explained by the same hypothesis. ALEX. THURBURN.

Keith.

IT seems probable that the effect mentioned by Dr. Gerald Molloy in your issue of January 21 is the same effect—produced in a different way—as that I spoke of in my letter published in NATURE of January 14.

In the instance he mentions we have black letters on a white marble slab, viewed by eyes in a partially dazzled state from the effect of strong sunlight. In the case to which I directed attention, these conditions are almost reproduced, viz. the blackened silver bromide on a white porcelain dish under a dazzling red light. Before the developing solution is added, the bromide under the red light appears as a grey powder in a white dish, but on adding the developing solution it is blackened, and when the liquid is poured off the change from black to bright green may be conveniently observed. The angle at which the dish is viewed seems not to be without influence on the brightness of the colour. Under the best conditions the bromide has the appearance of masses of uncut emeralds. T. A. VAUGHTON.

Ley Hill House, Sutton Coldfield, January 23.

Abysmal Deposits.

I BELIEVE there is some difficulty in accounting for the difference in the distribution of living Foraminifera at the surface of the sea and of deposits of their skeletons at the bottom. As is well known, the abysmal deposits contain no Foraminifera, while the much vaster pelagic deposits consist chiefly of them. The difference in depth has suggested that in the case of the pelagic deposits the free carbonic acid in the water has not had time to dissolve the sinking skeleton, while it has had time before a skeleton can reach the greater depths occupied by the abysmal deposits. But surely if this were the whole truth some effect would have been produced by the time the skeleton had sunk 2000 or 2500 fathoms or even less, so that it ought to be impossible to find, as we do, perfect skeletons in the globigerina ooze.

I wish to suggest a theory which is new, so far as I know, viz. that solution does occur, but does not begin until the organic matter protecting the carbonate of lime has all putrefied away. Hence the solution may be begun and ended in the excess of depth which the abysmal parts of the ocean-bed have over the pelagic parts.

H. ROBSON.

29 Hurlbutt Street, Newington Butts, S.E.

Spelling Reform.

IN your review of Dr. Joseph Bowden's "Elements of the Theory of Integers," there is included a severe condemnation of the very moderate instalment of spelling reform which the author appears to have introduced into his work. A discussion on the general question of spelling reform would, of course, not be suitable to your pages, and I therefore confine myself to making a respectful remonstrance against your reviewer's sweeping condemnation of what I conjecture to be an attempt to remedy a few of the glaring inconsistencies and anomalies of the current English spelling. Other languages have, from time to time, reformed their spelling so as to bring it more into harmony with the pronunciation, and this has been the case in our own time with German. It can scarcely be doubted that, sooner or later, the same will be the case with English. In that event the spellings you quote will certainly be adopted, with the exception of "*fixd*," which will, of course, be spelt *fixt*. T. B. S.

Edinburgh, January 15.

MAY I point out that Dr. Bowden's book purports to deal with the "Elements of the Theory of Integers," and not with questions of spelling reform? Neither on the title-page nor in the preface does the author make any claim to address his work to those members of the community who prefer to have their thoughts expressed in a written language differing from that of their fellow beings. Failing any such indication, it must be assumed that the work is intended to be read and criticised by English speaking and English writing readers of the present day, to whom the author's spelling of the words in question must appear to be grossly incorrect. I quite agree with T. B. S. that "a discussion of the general question of spelling reform," as exemplified by the modern German equivalent of *red*, would "not be suitable to your pages."

THE REVIEWER.

RESEARCHES RELATING TO RADIUM.

THE year just passed has witnessed a widespread interest among all classes of people in Mme. Curie's discovery of radium, and attention has been generally directed to the nature of the new property of matter which it exhibits to such a surprising degree. The far-reaching consequences of M. Becquerel's discovery of radio-activity for the element uranium on our ideas with regard to the relations between energy and matter, although they have been long recognised by those immediately connected with the development of the subject, are now universally admitted. The million-fold more powerful radium appeals to the practical as well as to the academic imagination, and the problems raised by the new property have been brought into universal prominence. Owing to the excellent work of Giesel in improving the methods of extracting the new element from its ores, and to the enterprise of the Chinin-Fabrik, of Brunswick, many during the past year have had the opportunity of satisfying themselves by experiment that the marvellous properties attributed to radium have not been exaggerated.

Considering the short time that has elapsed since the discovery, and the difficulty experienced in the past in obtaining the element, our knowledge of its properties at the present time is surprisingly complete. Attention will here be mainly directed to outstanding features which need further inquiry. In the first place, in spite of the many years of painstaking labour devoted to the determination by Mme. Curie, doubt still lingers as to the atomic weight of the new element. The case is a remarkable one, and has never arisen before in the determination of an atomic weight. On the one hand we have Mme. Curie's experimental value 225, and on the other an indirect value, 257·8, arrived at by Runge and Precht from spectroscopic data. Each of these determinations rests upon evidence which cannot be lightly set aside, and the discrepancy still remains to be explained. We have the authority of M. Demarçay for the purity of the preparations employed by Mme. Curie, for the former states that the spectroscopic trace of barium present could have had no effect on the atomic weight determination.

In ordinary circumstances the value 225 would probably be accepted as trustworthy to a unit in either direction. Runge and Precht's result, on the other hand, cannot be ascribed to chance relationships between the lines in the spectrum, possessing no real physical significance. For they succeeded in sorting the lines into related series, the lines in each series being resolved in the same way in a magnetic field. The series for radium are strictly analogous to those previously recognised in the spectra of the other alkaline-earth elements, and the connection between the atomic weight of the element and the distance apart of the lines in the series, which is the same for the different series of the same elements, holds very exactly for the cases of magnesium, calcium, barium and strontium. For radium, however, the number 257·8 is indicated. The evidence drawn from the chemical nature of radium and from the character of its spectrum agrees, however, in making the new element a member of the alkaline-earth family, and the experimental number is the only one which admits of this classification in the periodic table. The higher value, if it allows of the element being placed in the group of divalent metals at all, would make radium analogous to mercury and cadmium, so that it seems as if the experimental number should be accepted and the spectroscopic value regarded as abnormal for some unknown reason. The question is of considerable importance, and it is to be hoped that new experimental determinations will soon be available.

An explanation of the property of radio-activity was put forward by Prof. Rutherford and the writer about a year and a half ago as a result of the discovery of thorium X and of the behaviour which the thorium from which it is separated exhibits. This has since been developed and extended to afford a working hypothesis applicable to every detail of the phenomenon. The radio-elements are regarded as slowly disintegrating, a definite proportion of the total changing in the case of each element in the unit of time, the change being marked by the expulsion of rays. On account of the fact that the disintegration proceeds *per saltum* through several stages, and once started proceeds from stage to stage comparatively rapidly, the infinitesimal amounts of the transition-forms of matter can be detected and studied on account of the rays they emit in passage to the next succeeding stage. On this view thorium X, the uranium X of Crookes, the emanations of radium and thorium, and the active matter resulting from the further change of the latter, which gives rise to the phenomenon of "induced" or "excited" activity, are all transition-forms in the *per saltum* disintegration of the parent elements into more stable systems. The emanations are perhaps the most remarkable of these forms, as they are gaseous, and in consequence have been the most narrowly studied since the original discovery of the thorium emanation by Rutherford in 1899. The energy given out is, on this view, derived from the store of internal energy of the changing atom, and is, for any given mass of matter changing, enormous compared with that involved in any previously known change. It is in consequence of this fact that the excessively minute changes which produce radio-activity can be detected and investigated.

With regard to the nature of the radiations, the advances made by Rutherford in our knowledge of the nature of the α rays are among the most important. The β rays are known from the work of J. J. Thomson and Becquerel to consist of high velocity kathode rays, or negatively charged particles of mass about one-thousandth of the hydrogen atom projected with a velocity approaching that of light. The γ rays are in all probability X rays of high penetrating power which accompany the production of the β rays. Rutherford was the first to recognise that these two types are relatively unimportant, and that the α rays represent at least 99 per cent. of the total energy radiated. The analysis of the rays from a radio-element into its several parts, the greater part usually coming from the various transition-forms, which can be removed by chemical means, and only a small part from the parent element itself, has borne out this conclusion. For in the majority of cases known α rays are alone expelled in the disintegration. The discovery of the magnetic and electric deviability of the α ray of radium to an extent about one thousand times less, and in the direction opposite to that suffered by the β ray in similar circumstances, enabled Rutherford to settle the question as to their nature by showing them to consist of projected particles carrying a positive charge, about one thousand times the mass of the kathode ray particle and therefore comparable in size to the hydrogen atom, travelling with a velocity about one-tenth that of light.

This discovery has two bearings. On the one hand it confirms in a remarkable manner the view of the nature of electricity adopted by J. J. Thomson as the result of his investigations of the conduction of electricity through gases, that the negative charge can be dissociated from the atom, whereas the positive charge is always associated with a particle of atomic dimensions. On the other, it provided at once a mental picture of the precise change suffered by the atom of a radio-element, which the discovery of thorium X and the investigation of its behaviour had established. To take the case of radium as an example. The α particle expelled is an integral part of the heavy radium atom, which after disintegration forms a new and lighter atom, viz. that of the emanation. This suffers a second disintegration, expelling more α particles and changing into the matter which causes the "excited activity." Owing to the average life of the emanation atom being short—only 5·79 days—its energy is liberated so rapidly that a correspondingly small quantity can be detected. The energy manifestations from the emanation are very surprising, although it is not present in sufficient quantity to be detected by ordinary means.

An interesting feature at the present time arises from the fact that since the α rays given out by a radium compound are derived from several distinct atoms, the parent radium atom, and the successive products of its disintegration, it is to be expected, as Rutherford has pointed out, that the velocity of the α particles will vary within certain limits. Becquerel, however, states that the α radium rays in his experiments were deflected as a homogeneous pencil. Moreover, according to the same authority, they possess the remarkable property of being the more difficult to deviate for any given strength of field the greater the distance of air traversed. Both these observations seem contrary to what we should expect, and the latter especially is difficult to account for.

With regard to the "spinthariscope" effect of the α ray when it impinges on a zinc-blende screen, discovered by Crookes, it appears probable from the work of Becquerel, Tommasina and others that the scintillations are not caused, as was at first thought, by the direct impact of the individual α particle, but are due to cleavages provoked in the crystals of the blende by the bombardment, each cleavage, rather than each impact, giving rise to a flash of light.

The spontaneous heat evolution of radium to the extent of 100 gram-calories per gram of radium per hour, which was established some months ago by Curie and Laborde by direct calorimetric experiments, although it is the fact about radium which has appealed most strongly to the general imagination, hardly came as a surprise to those who were aware of the other properties of the element. Rutherford and McClung in 1901 estimated the energy radiated from a gram of uranium oxide as at least 0.03 calorie per gram per year, and it was known that this must be increased at least a million times for the case of radium. In addition, the well known chemical actions of the radium rays—the conversion of oxygen into ozone, and the decomposition of water into its elements—showed that their energy must be very considerable. The recent discovery of Rutherford and Barnes that more than 70 per cent. of the energy evolved from radium is due to the insignificant amount of emanation and the products of its further change, less than 30 per cent. being due to the element itself, follows as a direct consequence of the disintegration theory. It furnishes, it would seem, an almost unanswerable argument against the view that the energy evolved from radium is derived from an external source of unknown nature.

The view that radio-activity proceeds independently of temperature, which was originally arrived at by Becquerel by his study of the radiations of uranium, and is now generally recognised, was confirmed by M. Curie last year by some careful measurements of the rate of decay of the penetrating radiation from a sealed glass tube containing the radium emanation. He showed that the rate of the decay was not affected by variations of temperature between 450° C. and −180° C. Since it is the universal experience, not only for variations in temperature, but also for all other agents, that the rate of disintegration is constant and unaffected by molecular forces, it follows that the causes at work which produce disintegration are at present entirely unknown. It appears certain that it cannot be brought about by any agencies with which we are familiar. Sir Oliver Lodge has suggested that the unstable condition results from the incessant radiation of the internal energy of the atom, the latter being a necessary consequence of the electronic theory of atomic structure.

The discovery by Sir William Ramsay and the writer that radium is continuously producing helium in sufficient quantities to be spectroscopically recognised marks a new phase in the development of radio-activity by bringing the problem within the range of the ordinary methods of chemical investigation. From the disintegration theory it followed that the accumulation, during past ages, of the final products of the change of the radio-elements must exist in the natural minerals in which these elements are found. The existence of helium in the radio-active minerals, and its absence from those which do not contain the radio-elements, coupled with the fact that this gas forms no compounds but exists in the minerals "occluded" in a curious and unexplained way, pointed strongly to the view that it had been formed as one of the products of the change of one of the radio-elements during past ages, and mechanically imprisoned within the mineral. This led to the experiments being undertaken. The gradual growth of the helium spectrum in a sealed tube in which the radium emanation was originally condensed by liquid air and all other gases removed by the pump, excludes the view that radium may form a slowly decomposing compound with helium. The amount produced, as theory requires, is excessively minute, and its detection with the small quantity of radium available was due to the extreme delicacy of its spectrum reaction, and to the refined methods of gas manipulation developed by Ramsay in his investigation of the rare gases of the atmosphere. The suggestion that has been made that the α particle is an atom of helium has not yet been experimentally proved.

These direct confirmations of the theoretical predictions show that our knowledge of radio-activity has passed from a purely descriptive basis. The numerous unrelated and inexplicable experimental facts which have accumulated during the seven years the property has been known have during the past year been co-ordinated harmoniously as the effect of a definite and consistent cause. Radio-activity, in consequence, claims to-day to rank as an independent science. It is a property which may be best described as added on. It manifests itself without affecting or being affected by the ordinary chemical and physical nature of the matter in question, and therefore belongs to the domain neither of physics nor of chemistry. There is in consequence reason for considerable satisfaction that the theory of atomic disintegration to which radio-activity has directly led is also in the nature of an addition to, rather than a controversion of, accepted scientific doctrines. Nothing could be further from the truth than the idea that it upsets in any way the atomic theory of chemistry. On the contrary, as the bearing of the conception comes to be more clearly seen, it will probably be recognised that it provides the atomic theory with a measure of confirmation and new evidence which advances it a little further in the direction of that direct experimental proof which we are so frequently being reminded it is impossible for any theory to attain.

FREDERICK SODDY.

OBSERVATIONS OF GLACIERS AND AVALANCHES.[1]

BOTH the pamphlets mentioned below are issued by the Commission Française des Glaciers. The former mainly consists of a study of the glaciers about the head-waters of the Arc, a region which, forty years ago, had been visited only by a few Alpine climbers, who found the official maps far from accurate above the snow line; following this are notes about glaciers of the Grandes Rousses, a snowy ridge

1 "Rapport sur les Observations Glaciaires en Haute-Maurienne, dans les Grandes-Rousses et l'Oisans, dans l'été de 1902." Par M. Paul Girardin. Revue de Glaciologie. No. 2. Année 1902. Par M. Charles Rabot. Pp. 121; illustrated. (Paris: Typographie Philippe Renouard, 1903.)

"Observations sur l'Enneigement et sur les Chutes d'Avalanches, exécutées par l'Administration des Forêts dans les Departements de la Savoie. Pp. 15. (Paris: Au siège du Club Alpin Français, 1903.

between the Maurienne and Dauphiné. In the former region the glaciers are not large, though fairly continuous along the western side of the watershed between France and Italy; the highest peaks just exceeding 12,000 feet, and the passes between them being about 10,000 feet. M. Girardin in his remarks directs attention to a point not always sufficiently remembered, that the size of a glacier depends even more upon the form of its birthplace than the altitude. Of this, Dauphiné, rather to the south of the region noticed by him, affords an excellent example. The western end of the horseshoe of its higher peaks is formed by the Mont de Lans, a tabular mountain mass, which, though mostly well under 11,000 feet high, is clothed with a sheet of névé, terminating in glaciers, more extensive than those of the adjoining Râteau and Meije, which rise some 2000 feet higher. It is incidentally mentioned, and this fact is important, that the climate of Lanslebourg is much wetter than that of Modane, the dominant wind at the latter being W. or N.W., at the former E. or S.E., bringing vapour from the plain of the Po. As the district is so little known, we content ourselves with giving M. Girardin's general conclusions. They are:—(1) the glaciers of this region, after a rapid retreat (since 1860 approximately), have during the last few years either moved back very slowly or even halted; (2) this retreat has changed many of them from valley glaciers to plateau glaciers; (3) sometimes the glacier has gone back as a whole, sometimes it has melted away from the sunny side of a valley, thus changing the form of its terminal boundary, a matter to be remembered in speaking of the "retreat" of a glacier.

This report is followed by the *Revue de Glaciologie*, No. 2, giving a summary of observations about the increase or decrease of glaciers in many parts of the world, made or published in 1902, with occasional mention of earlier changes, and some interesting notes on the level of the snow-line. Evidently, though locally the retreat has been arrested or even changed into an advance, a period of growth has not yet really begun.

The second pamphlet largely consists of tables giving the snowfall and avalanches in parts of the French Alps during the winter of 1899–1900 and the two following years. These will ultimately be very valuable, but at present hardly suffice for drawing inferences. We may, however, mention that in the first period the snowfall in Savoy ranged from 85 mm. at Thonon to 1600 mm. at Sixt. The largest amount recorded is on the Col de Fréjus, in the Maurienne (almost above the great tunnel), the differences probably depending mostly on altitude but to some extent on geographical position. In that year the largest downfall in an hour was 68·6 mm., on this pass and its neighbourhood. The statistics of avalanches are for 1900–1, and for the following season. March is the worst month, then February and April. The falls were much more numerous and mischievous in the second year, during which fifty-six persons were overwhelmed by them, of whom eight perished, as against three in the former year.

JOHN SAMUEL BUDGETT.

BRITISH zoology in general, and the Cambridge School of Zoology in particular, has received a heavy blow in the tragic and untimely death of Mr. J. S. Budgett. It is only a few weeks since the readers of NATURE were informed of the brilliant success attending Mr. Budgett's researches during his last expedition, and zoologists—not of this country alone—were looking forward with the greatest interest to the publication of his full results. It was not to be. On Saturday, January 9, after his usual day's work in the laboratory at Cambridge, he fell ill with blackwater fever, and after a few days' illness he passed away on the morning of January 19, the very day on which he was to have read to the Zoological Society his account of the general results of his last expedition.

Mr. Budgett was born near Bristol thirty-one years ago, and here, at his home, Stoke Bishop, the earlier years of his life were passed. In his father's house Budgett had the great advantage of meeting as friends such men as Dr. W. H. Dallinger and the late Prof. W. K. Parker, and from them he received much inspiration and encouragement. He was particularly influenced by Parker. He possessed copies of Parker's monographs, and he set himself a task which few indeed would have attempted without an elaborate university training, the task of working over the development of the skull in a series of vertebrate types. By the exercise of limitless patience and admirable technical skill—he even designed a perfectly original and remarkably successful mechanical microtome for the cutting of serial sections—he produced a series of beautiful models of developing crania.

Mr. Budgett commenced his academic studies at University College, Bristol, under Lloyd Morgan and Reynolds, and thence passed on to Cambridge and entered Trinity College in 1894. There he went through the routine course of study for the natural sciences tripos—interfered with to some extent, from the point of view of mere academic success, by his accompanying Prof. Graham Kerr on an expedition to South America during 1896–7. On this expedition Budgett devoted himself to gaining a general acquaintance with the neotropical fauna, and also to broadening his knowledge of general morphology by carrying out dissections and making microscopic preparations of many of the more important animals. In addition to this he applied himself especially to the study of the Amphibia, amassing a large amount of information as well as valuable collections of developmental and other material. This material received preliminary treatment in a paper in the *Quarterly Journal of Microscopical Science*, but Budgett intended to work it up later in a comparative paper along with the material collected under similar physical conditions in West Africa.

On this first expedition Budgett's splendid qualities shone out conspicuously—his personal courage, his fortitude and cheerfulness under physical discomfort and suffering, and his absolute loyalty.

Already during his stay in South America Budgett had practically decided to take up the problem of the development of Polypterus, and immediately after graduating at Cambridge he set out with this object in view to the Gambia. Here he spent the greater part of a year in the first instance, returning again for a few months during 1900. During these expeditions Mr. Budgett did not manage to obtain the main object of his quest, but he did succeed in obtaining and preserving with the faultless technique so characteristic of him a mass of most valuable material. The hand of Death has intervened before time had been given for more than preliminary work on this material, but even this preliminary work contains results of much importance to vertebrate zoology—in particular a complete and accurate account of the genito-urinary organs of Polypterus, the demonstration that the crossopterygian fin is really a uniserial archipterygium, and finally a most valuable series of observations on the breeding habits and developmental features of Protopterus and of several interesting teleostean fishes.

Budgett still stuck pertinaciously to the main problem. Having been elected Balfour student, he started off again in June, 1902, this time to East Africa in the hope of there finding a locality with physical conditions more favourable to the prosecution of his research. Finding, however, that conditions were less rather than more favourable, Mr. Budgett returned down the Nile to England. In June, 1903, he started again for West Africa, and took up his quarters at a point in the Niger delta where he knew Polypterus to be abundant. Here at last he succeeded, by means of artificial fertilisation, in obtaining a fine series of the long wished for eggs and larvæ. He returned to England and settled down to work out his material in the laboratory of his friend and teacher, Mr. Adam Sedgwick, and there he was at work on that fateful Saturday when there came to him the first premonition of impending illness.

Budgett's personality had a peculiar charm. Unassuming, modest to a fault, his diffidence at times brought him moods of severe depression. Latterly, however, he had been cheered and encouraged by the appreciation of his work by those to whom he most looked up.

He was a zoologist of the best type. He was a keen and accomplished observer in the field, and always recognised to the full that the first and main interest in an animal lies in the fact that it is an organism which *lives*. But in addition he was a most accomplished laboratory investigator. With great interest in laboratory technique he combined tireless patience in research and almost fastidious accuracy. His artistic powers were shown in the charming sketches which he brought back from his various expeditions, and they are again apparent in the beautiful preparations with which he enriched the museum at Cambridge.

He has gone, but he has left behind an enduring memorial in the work he has done and in the affectionate memories which will be treasured by his many friends.

NOTES.

LORD RAYLEIGH has been created a foreign Knight of the Prussian Order Pour le Mérite for sciences and arts by the German Emperor.

THE remains of James Smithson, the Englishman who founded the Smithsonian Institution in Washington, reached New York on January 20, having been conveyed from Genoa in the *Prinzessin Irene*. The United States despatch-boat *Dolphin* awaited the arrival of the vessel in order to act as an escort of honour from the lower bay to the city. Smithson's remains were taken to Washington in the *Dolphin*; and on January 25 the transfer of the coffin, draped with the American and British flags, was witnessed by Sir Mortimer Durand, the British Ambassador, Mr. Loomis, Acting Secretary of State, and a number of members of the Senate and House of Representatives. Escorted by a troop of cavalry and a marine band, the remains were conveyed to the Smithsonian Institution, where a suitable tomb will be erected.

PROF. WEISMANN'S seventieth birthday was celebrated in Freiburg on January 17, when a large and representative gathering assembled to do him honour. A bust by Kowazik, of Frankfort, had been subscribed for by biologists in various parts of the world, and was presented in the name of the subscribers by Prof. H. E. Ziegler, of Jena; it is to be placed in the zoological institute of the university. A special number of the *Zoologische Jahrbücher*, containing papers by various naturalists, was presented by Prof. Spengel, of Giessen, and from the Grand Duke of Baden Prof. Weismann received the highest order conferable, that of the Cross and Star of Bertold I. To all interested in the advance of biological science, and more especially to those who know him also as a man of wide culture and high ideals, it will be a satisfaction to learn that Weismann retains unabated his freshness, vigour, and untiring energy.

THE President of the Board of Trade has appointed a committee to inquire and report as to the statutory requirements relating to the illuminating power and purity of gas supplied by the metropolitan gas companies, and as to the methods now adopted for testing the same, and whether any alteration is desirable in such requirements or methods, and, if so, whether any consequential alteration should be made in the standard price of gas. The members of the committee are:—Lord Rayleigh, F.R.S. (chairman), Sir William de W. Abney, K.C.B., F.R.S., Dr. Robert Farquharson, M.P., Mr. William King, and Mr. J. Fletcher Moulton, M.P. Mr. Herbert C. Honey, of the Board of Trade, has been appointed secretary to the committee.

WE regret to announce that the Rev. Dr. Salmon, F.R.S., Provost of Trinity College, Dublin, since 1888, died on Friday last at eighty-four years of age.

MR. F. E. BEDDARD, F.R.S., has been elected a corresponding member of the Königliche Böhmische Gesellschaft de. Wissenschaften.

A REUTER message from New York on January 22 states that the University of California has been informed of the discovery of remarkably fine remains of an ichthyosaurus in Chile.

A DESPATCH from Buenos Ayres announces that the *Français*, with Dr. Charcot's Antarctic Expedition on board, reached Ushuaia, Patagonia, on January 15, and left for the south after coaling.

DR. LORENZO CAMERANO, of the Royal Zoological Museum, Turin, Dr. Fritz Sarasin, and Dr. Paul B. Sarasin, of Basel, have been elected foreign members of the Zoological Society of London.

A PREHISTORIC Society of France has just been founded at Paris with the object of studying questions of palæo-ethnology. The president for 1904 is M. Émile Rivière, and the monthly meetings are held at 93 Boulevard Saint-Germain.

MR. W. SAVILLE-KENT has been engaged to investigate and advise towards the further development of the pearl, shell and other fisheries pertaining to certain Polynesian Island properties, and will leave England in a few weeks' time to take up his new appointment.

THE death is announced of Prof. Georg Wagner, professor of chemistry in the polytechnic at Warsaw, aged fifty-four.

THE Guy medal of the Royal Statistical Society has been presented to M. Yves Guyot for his paper on "The Sugar Industry on the Continent."

THE St. Petersburg Physico-Chemical Society has projected a new Arctic expedition to be undertaken for the following objects:—observations of solar radiation and atmospheric refraction, of cloud movements, and of atmospheric electricity in connection with the extinction of ultra-violet light; determination of the phenomena of terrestrial magnetism and of electric currents in the ocean; chemical analyses of the composition of the air and water; and examinations of the polar ice.

WE regret to see the announcement of the death of Dr. William Francis, which occurred early last week. Dr. Francis was in his eighty-seventh year, and had been in failing health but a short time. He was almost the oldest, if not the oldest, fellow of the Chemical Society, and was joint editor of the *Annals and Magazine of Natural History* and of the *Philosophical Magazine*. In the latter capacities he came in contact with most of the eminent scientific men of the nineteenth century.

To commemorate the twenty-fifth anniversary of the introduction and commercial development of the incandescent lamp, the friends and associates of Mr. Thomas A. Edison have taken steps to found a medal which will be entrusted to the American Institute of Electrical Engineers. It is proposed to present the medal fund at the annual dinner of the institute on February 11, which is Mr. Edison's birthday.

IT is reported from St. Petersburg that on January 16 Dr. Turtchinowitch, director of the laboratory for the preparation of plague remedies at the Imperial Institute of Experimental Medicine, was taken ill after having been engaged in experimenting with bubonic plague cultures, and died of plague on January 20. It has been established that two assistant physicians who were working with Dr. Turtchinowitch have also acquired the disease.

ON Thursday next, February 4, Mr. A. D. Hall will deliver the first of three lectures at the Royal Institution on "Recent Research in Agriculture." On Saturday, February 6, Mr. C. Waldstein will lecture on "The Study of Style in Greek Sculpture," and on February 13 his subject will be "Culture and Sculpture." On Saturday, February 20, Lord Rayleigh will begin his course of six lectures on "The Life and Work of Stokes." The Friday evening discourse on February 19 will be delivered by Mr. C. T. R. Wilson on "Condensation Nuclei."

THE Tanganyika Committee (Prof. Ray Lankester, Sir John Kirk, Sir W. Thiselton-Dyer, Mr. Boulenger, and Dr. Sclater) has determined to send out another naturalist for the further investigation of the "Tanganyika problem," and has selected Mr. W. A. Cunnington, of Christ's College, Cambridge, for this purpose. Mr. Cunnington will leave for Tanganyika (*viâ* Chinde and Zomba) in March, and will pay special attention to the lacustrine flora of the lake, of which, as yet, little is known, but will not neglect other subjects relating to the lake-basin.

A SCIENTIFIC expedition for the exploration of northern Nigeria, conducted by Lieut. Boyd Alexander and Captain G. B. Gosling, of the Rifle Brigade, is in preparation, and will shortly leave England. Lieut. Claud Alexander, who holds the diploma of the Royal Geographical Society, will act as surveyor and map-maker. The party will proceed up the Niger and Benué, and establish a station somewhere in the central hill-country of northern Nigeria, where collections of natural history will be made, and the surrounding country explored and mapped. Lieut. Boyd Alexander, who has already had much experience in African travel on the Zambezi, in the Gold Coast Colony, and in Fernando Po, is a thoroughly competent man, and has obtained the sanction of the War Office to his expedition.

WE regret to see announced the death of Mr. Walter G. Doggett, the naturalist of the Anglo-German Boundary Commission under Major Delmé Radcliffe, who has lost his life while crossing the Kagera River in Uganda. Mr. Doggett, who was the son of a well-known taxidermist at Cambridge, served on Sir Harry Johnston's staff as naturalist and photographer both in Nyasaland and in Uganda, and will be found frequently mentioned in Sir Harry's work on the latter country. Doggett made the ascent of Ruwenzori in the Special Commissioner's company, and amongst many other objects, obtained there specimens of a remarkable new bramble which has been named after him *Rubus Doggetti*. He was the first person to discover the existence of the shoe-bill (*Balaeniceps rex*) on the shores of Lake Victoria.

IT appears from a telegram dated Yakutsk, January 15, and communicated to the Russian Press, that on that date the boatswain Byegacheff, one of the members of Lieut. Kolchak's Expedition which was sent out in search of Baron Toll, returned to Yakutsk. The expedition did not find the Arctic traveller either in the New Siberia Islands or in Bennett Land. It only found in the latter place some papers left by Baron Toll stating that he was leaving Bennett Land on November 8, 1902, and going southwards. He consequently expected to reach the mainland of Siberia somewhere near Nizhne-Kolymsk, but as nothing was heard of Baron Toll during last summer, one cannot but entertain the gravest apprehensions as to his position. Lieut. Kolchak is expected soon to reach Yakutsk, as well as the other search party under Brusneff, so that we shall probably have more detailed news in a few days.

THE Royal Society catalogue of scientific papers from 1884 to 1900, completing the century, is making progress. It appears that 111,000 titles have already been prepared by the referees in the various subjects, while 68 serials containing more than 91,000 titles have been completely dealt with for both the authors' catalogue and the subject index. It is part of the scheme to make a single subject index for the whole of the nineteenth century; nearly 82,000 of the 400,000 papers dealt with in the existing catalogue have now been classified for this index. The index will be in seventeen sections, published separately, each section containing, in one or more octavo volumes, a single science indexed according to the schedules of the international catalogue; when published, these volumes cannot fail to be of great use to workers in science. The committee of the Royal Society is making strenuous efforts to expedite the work. Its chief difficulty has been in obtaining a sufficient staff of experts, and attention is invited to its advertisement asking for additional helpers.

THE annual general meeting of the Iron and Steel Institute will be held on Thursday and Friday, May 5 and 6. The council will shortly proceed to award Carnegie research scholarships, and candidates must apply before February 29. The awards will be announced at the general meeting. In accordance with previous announcements, the autumn meeting will take place in New York on October 24–26. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, and Buffalo, returning to New York on November 10. An influential committee has been formed in the United States for the reception of the institute, Mr. Charles Kirchhoff being the president and Mr. Theodore Dwight the hon. secretary.

As the result of a meeting held in London several months ago, a society has been formed for the promotion of scientific studies in sociology. It is hoped that when the Sociological Society becomes adequately organised it will materially help to fill a serious gap in the cultural apparatus for national education and research. One of the founders of the society has given 1000*l*. towards the endowment of sociological teaching in London University. With that exception there is at present no provision in British universities for studies specifically sociological. This country is also alone among leading nations in having neither a journal of sociological studies nor a special library of sociological literature. In addition to directing attention to these national deficiencies, the Sociological Society is making particular efforts to organise a reference library of sociology and to establish a journal of sociology. Particulars referring to the society's origin, purpose and programme may be obtained by application to the secretary, 5 Old Queen Street, Westminster, S.W.

EARLY in September, 1900, Galveston was devastated by a storm and a great wave which overwhelmed the bank on which the city is built. To prevent the recurrence of this disaster, the whole city—buildings, streets, boulevards, parks, theatres, residences and quays—in fact, everything now resting on the present ground level, are, says *Transport*, to be lifted up 17 feet in the air, and the space between the old and the new levels will be filled in, so that the city will be actually that number of feet higher than it is at present. The cost of this undertaking is estimated to be some three and a half million dollars, and the contract for lifting the city has been awarded to Messrs. Goedhart Brothers, of New York City, in cooperation with Mr. Lindon W. Bates, the engineer who devised the scheme for making Galveston flood-proof.

THE Autocopyist Company has sent us one of its "Black Boxes." This is really a form of small portable changing bag, and should be found useful to every photographer, whether amateur or professional, whilst travelling. The term "box" is rather a misnomer, for it is really not a box at all. The black cloth, forming the dark space, is very ingeniously made to fold up or out by means of two sets of wire frames after the principle of an umbrella, the lower portion having a larger circumference than the upper; when expanded the whole arrangement is placed on a bench or table and is ready for use. There are two sleeves for the insertion of the arms and one for the head, all of which have elastic extremities to fit tight to keep out the light. There is also a small window covered with red cloth, and a separate celluloid red sheet to place over this window. Altogether this portable dark room looks as if it would prove very serviceable, for it is well made, light, and closes up into a small compass.

THE Deutsche Seewarte (Hamburg) has recently made an addition to its useful contributions to maritime meteorology by the publication of a quarterly pilot chart for the North Sea and Baltic. The first issue is for the present winter, and every available space is occupied by valuable information for navigators and others. The mean frequency of wind direction for various parts of the different coasts is shown by wind-stars giving percentages of the observations by lines radiating from a central circle in which is shown the number of calms; the percentage of wind direction for any point of the compass can be easily measured from a given scale. The mean tracks of storms are laid down in the usual way, together with the average minima of barometric pressure. Three subsidiary charts show (1) the mean isobars and prevalent wind direction; (2) the average air temperature; (3) the mean temperature of the sea surface and average prevalence of fog. The reverse side of the chart is occupied by a series of maps showing the tidal currents on the coasts of the British Islands and north-west Europe for each hour following the flood and ebb tides at Dover. In addition to the data exhibited by the charts, the text contains much useful information relating to the prevalence of storms, ice and other matters.

THE Meteorological Office Atlantic pilot chart for February contains an interesting article by Dr. Shaw on "Buys Ballot's Law and Trajectories of Air." Several diagrams are given representing the air movements during the passage across our islands of two cyclonic systems, that of November 12–13, 1901, moving at the rate of 15 miles an hour, attended by hard gales and heavy rain, and that of March 24–25, 1902, moving at the rate of 25 miles an hour, attended by strong winds and gales and but little rain. The circumstances in the two cases differ also in the general disposition of atmospheric pressure and the behaviour of the barometer in the surrounding regions. There is, consequently, a wide divergence in the air trajectories of the two systems. From a consideration of the facts presented we are "led to associate changes of surface velocity with exchange of air between the surface and the upper regions, unless they can be accounted for by alterations of area. Exchanges between the surface and the upper air are connected with temperature change and generally also with rainfall, and thus the vicissitudes of the air along its trajectories may have a very close connection with the special character of the weather changes associated with the passage of depressions." To the mariner the questions raised are of more than passing interest, for the article touches upon the question of ascending and descending air currents, which can be established or verified by the effects produced upon meteorological instruments or upon the surface of the sea. Every sailor has observed how the wind in some storms beats down the sea, while in others it raises a tumultuous sea. There is reason to suppose that in the former case the wind is a descending current, in the latter an ascending current. It is to be hoped that officers will supply careful notes on these different characteristics of wind and sea, as the subject is one of great importance from a meteorological point of view, and up to the present has not been investigated.

AN interesting paper on a familiar subject, the relation of temperature to the keeping property of milk, has reached us from Storrs, Connecticut. The view of the writer, Mr. H. W. Conn, the well-known dairy bacteriologist, is that the keeping of milk is more a matter of temperature than of cleanliness. He points out that at 50° F. milk may not curdle for two weeks, whereas at 70° F. it may keep but forty-eight hours, and at 95° F. but eighteen hours. This curdling is due to the action of bacteria, and the effect of temperature on their multiplication is surprising. Thus at 50° the ordinary milk organisms increase about 5-fold in twenty-four hours, but at 70° they may multiply 750-fold in the same time. The optimum temperature for different species varies considerably. At 70° the ordinary *B. lactis acidi* develops rapidly, while at 95° the undesirable lactic ferment *B. lactis aerogenes* develops quickly and the ordinary form does not. At 50° neither of the lactic ferments makes much growth, but putrefactive bacteria develop, and though these may not make the milk sour, they make it unwholesome. Milk which has been kept sweet by exposure to low temperatures should be viewed with suspicion.

THE fourth report of the Royal Commission on Sewage Disposal, which has just been published, deals with the pollution of tidal waters, with special reference to contamination of shell-fish. The Commissioners state that they are satisfied that a considerable number of cases of enteric fever and other illness are caused by the consumption of shell-fish which have been exposed to sewage contamination. Of the remedies suggested, the opinion is expressed that no general enactment as to the treatment of sewage before its discharge into tidal waters or as to the seizure of unwholesome food would meet the necessities of the case, but that the remedy must be sought in connection with the waters, foreshores, pits, ponds, and layings themselves. It is considered that the only way in which the evil can be effectively dealt with is by placing tidal waters under the jurisdiction of some competent authority, and conferring on that authority power to prevent the taking of shell-fish for human consumption from any position in which they are liable to risk of dangerous contamination, and to enforce restrictions as regards pollution and as regards the waters, beds, &c., in which shell-fish are fattened or stored. At the end of the report several pages are devoted to a consideration of the bacteriological methods employed in the examination of shell-fish. It is stated that Dr. Houston, the bacteriologist to the Commission, has examined more than 1000 oysters, some taken from the purest waters in the country, and has found that nearly all, from whatever laying, contain the *Bacillus coli*. Doubt is therefore raised as to the value that may attach to the *B. coli* test, and it is considered that further research is necessary in order to establish a bacteriological standard of purity.

IN the December issue of the *Proceedings* of the American Academy (vol. xxxix., No. 10) Mr. F. C. Carlton records the results of experiments with regard to the cause and nature of the periodical colour-change in the skin of the Florida chamæleon-iguana (*Anolis carolinensis*). The extreme variations in the colour of this lizard are dark brown and pea-green, the former (in captive specimens at any rate) assumed in daylight and the latter at night. The brown condition is produced by the migration of pigment-granules from the centre to the terminal branches and processes of the "melanophores," the green stage, which is one of rest, being the result of the withdrawal of the same granules to the centre of the latter bodies. In three fundamental points the colour-change differs from that of the true chamæleons.

THE November (1903) issue of the *American Naturalist* contains the second of the series of articles on the adaptations of mammals to particular modes of life, the present section, by Mr. L. I. Dublin, dealing with arboreal types. With the exception of the Monotremata, all the terrestrial orders have arboreal representatives, the number of such forms being greatest in the Chiroptera (where all adopt this mode of life) and Primates, and least in the Ungulata, where there are only the tree-hyraces. Arboreal mammals may be divided into two main groups, in the first of which terrestrial progression is retained in a greater or less degree, while in the second it is wholly lost. Among the modifications for this kind of life, in addition to those of the feet and tail, the author specially notices the frequent increase of the number of the vertebræ, and the development of dermal spines and scales, as in the Anomaluridæ and Gymnura, which aid in climbing. The inclusion of the latter genus among arboreal mammals appears to indicate some new information in the possession of the author.

THE *Journal* of the Royal Statistical Society for December 31, 1903, contains an important paper on the metric system by Mr. Alexander Siemens, together with a report of the discussion. It is illustrated by tables showing the trade of metrical and non-metrical countries for the year 1900, that year marking a culminating point in most countries. Mr. Siemens puts forward powerful arguments in favour of adopting the metric system, and concludes by saying that "it is quite certain that the action of Great Britain in this matter would immediately be followed by Greater Britain, the United States, and Russia, so that international unity of weights and measures would become an accomplished fact for which James Watt started his agitation 120 years ago."

WE have received the "Naturalist's Directory" for 1904–5 from Mr. L. Upcott Gill, by whom the annual is published. It gives the names and addresses of naturalists, natural history agents, societies, field clubs and museums of the British Isles, and the information has been corrected to the present date.

DR. A. LAWRENCE ROTCH writes to correct the following mistakes made by him in his letter on "The Unusual Sky Colours and the Atmospheric Circulation," published in NATURE of December 24, 1903 (p. 173). In the first paragraph, line twenty-four, for "southern" read "northern," and in the second paragraph, line eight, for "unlike" read "like."

THE new edition of Hazell's "Annual"—that for 1904—is the nineteenth issue of this valuable book of reference. As usual, the alphabetical arrangement is adopted, but this year many of the separate entries of former years have been collected in the form of more complete articles. Thus the information given respecting scientific societies and the advances made in various branches of scientific knowledge during 1903 is brought together in a convenient manner in some thirteen successive pages. A complete index much assists reference to the large amount of statistical and other information given in the volume.

THE Natural History Society of Northumberland, Durham, and Newcastle-upon-Tyne, held a conversazione on January 19 at the Hancock Museum, Newcastle-upon-Tyne. Experimental and lantern demonstrations in a variety of subjects were given during the evening. These and the exhibitions included:—the inactive atmospheric gases; their spectra and some of the apparatus used in determining their physical properties, by Sir William Ramsay; objects illustrating certain properties of the emanations of radium, by Sir William Crookes; the bactericidal emanations from radium, by Mr. Henry Crookes; models of turbine machinery from the Parsons' Marine Steam Turbine Co., Ltd., and many others. The meeting was an excellent indication of the interest in scientific research which exists in this northern district.

IN the *Sitzungsberichte* of the Vienna Academy of Sciences Dr. Langstein gives an account of his researches on the carbohydrates of serum-globulin. The experiments establish the fact that *d*-glucose is one of the primary decomposition products of blood-globulin, and the existence of a close relationship between albumen and glycogen is shown. Reference is made to the possible connection between the observed facts and the abnormal physiological processes taking place in cases of diabetes.

IN a paper entitled "An Enquiry into the Working of Various Water-softeners," read before the Institution of Mechanical Engineers on December 18, 1903, Messrs. Stromeyer and Baron describe and illustrate by means of diagrams seventeen continuous water-softeners. Analyses of the unsoftened and softened waters are given which permit of a fair comparison being made as to the suitability of the various types for special purposes. Of the seventeen softeners, fourteen are fitted with filters, two of them having sand filters, and the others woodwool, or sponge filters.

WE have received vol. ii. of the *Transactions* of the North Staffordshire Ceramic Society. The Society has a membership of thirty, and seven papers have been read before the members during the session. Of special interest is a paper by Messrs. Hopwood and Jackson on the nature and origin of the abnormal red, blue and black colorations of fire-clay ware. The red colorations are found to be due to the conversion of the iron in the clay substance into free ferric oxide, the black principally to free carbon, whilst the external vitreous blue films of blue-fired clay-wares are found to consist of a basic ferrous silicate.

THE much debated question regarding the dual nature of chromium solutions as manifested in the green and violet colour is again discussed by Messrs. Richards and Bonnet in a recent number of the *Proceedings* of the American Academy. The authors' experiments and previous observations seem to be most easily explainable on the assumption that the violet solutions of, say, chromium sulphate contain the salt in a state comparable to that of other normal salts, whilst the green solutions are due to hydrolysis resulting in the production of free acid and one or more complex basic salts.

IN the quarterly statement of the Palestine Exploration Fund Mr. W. Ackroyd discusses the cause of the saltness of the Dead Sea. Facts are brought forward which seem to indicate that the saltness cannot be entirely due to accumulation of chlorides derived from the Palestine rocks by solvent denudation or the cutting off of an arm of the Red Sea by the rising of Palestine in past ages followed by evaporation of the solution. The author brings evidence forward in favour of a third cause, which is perhaps more important than either, viz. the atmospheric transportation of salt from the Mediterranean.

A THIRD revised edition of part ii. of "Machine Design," by Prof. Forrest R. Jones, of Cornell University, has been published in this country by Messrs. Chapman and Hall. This part of the work deals with the form, strength, and proportions of parts, and the new issue has been increased by about eighty pages of new matter.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, presented by Mrs. Hughes; a White-collared Mangabey (*Cercocebus collaris*) from West Africa, presented by Mr. H. Ion; a Chacma Baboon (*Papio porcarius*) from South Africa, presented by Mr. James Adams; a Levaillant's Cynictis (*Cynictis penicillata*) from South Africa, presented by Lady Constance Ryder; a Spotted Ichneumon (*Herpestes nigropunctatus*) from Nepal, presented by Mr. S. D. Pritchard; two Herring Gulls (*Larus argentatus*), European, presented by Mr. F. H. Haines; a Barn Owl (*Strix flammea*), British, presented by Master C. Fox; a — Sheep (*Ovis* sp. inc) from Baluchistan, two Waxwings (*Ampelis garrulus*), European; a Grey Squirrel (*Sciurus cinereus*) from North America, a Brazilian Tortoise (*Testudo tabulata*) from South America, two Ceylonese Terrapins (*Nicoria trijuga*) from India, two Derbian Sternotheres (*Sternothoerus derbianus*) from West Africa, deposited; a Humboldt's Lagothrix (*Lagothrix humboldti*), a Red-faced Ouakari (*Ouacaria rubicunda*) from the Upper Amazons, purchased.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN FEBRUARY:—

Feb. 1. 12h. Saturn in conjunction with the sun.
4. 8h. 41m. Minimum of Algol (β Persei).
7. 5h. 30m. ,, ,, ,,
8. 6h. 17m. Transit (ingress) of Jupiter's Sat. IV. (Callisto).
9. 15h. Ceres in conjunction with moon. Ceres 0° 8′ N.
,, 21h. Mercury at greatest elongation. 25° 52′ W.
12. 16h. Venus in conjunction with moon. ♀ 4° 8′ S.
14. Venus. Illuminated portion of disc =0·797.
24. 5h. 57m. to 7h. 15m. Moon occults α Tauri (Aldebaran, Mag. 1·1).
25. 17h. Mercury in conjunction with Saturn. Mercury 0° 49′ S.
,, 17h. Mars in conjunction with Jupiter. Mars 0° 30′ N.
27. 7h. 13m. Minimum of Algol (β Persei).
29. 8h. 53m. to 9h. 46m. Moon occults o Leonis (mag. 3·8).

VARIABILITY OF THE MINOR PLANET IRIS.—A telegram from Prof. Pickering, through the Kiel Centralstelle, announces that Prof. Wendell has discovered a periodic variability in the brightness of the minor planet (7) Iris. The period of the changes is six hours, and the range of variability about one-quarter of a magnitude.

HARVARD MERIDIAN PHOTOMETER OBSERVATIONS.—Part i. vol. xlvi. of the Harvard College Observatory *Annals* contains the tabulated results of the meridian photometer observations made by Prof. Solon. I. Bailey at Arequipa and Cambridge (Mass.) during the years 1899–1902. Chapter i. contains the reduced observations of some 4500 stars situated south of −30° declination made at the southern station during 1899, the stars observed being generally selected from the Argentine General and Cordoba Zone Catalogues.

One of the chapters contains the results of a series of observations made at Cambridge (1900–1902) in order to produce a catalogue of standard stellar magnitudes for regions regularly distributed throughout the sky. To this end the sky was divided into 432 regions, each approximately 10° square, and one star of about the fifth magnitude was photometrically observed in each region, care being taken to select, wherever possible, a star having a first-type spectrum. All the stars were compared with λ Ursæ Minoris and other standard comparison stars, and on reducing the observations it was soon apparent that the results obtained from λ were systematically different from those obtained from the other stars. This difference indicates an increase of two-tenths of a magnitude in the brightness of λ Ursæ Minoris, which may either be due to a personal equation depending on the colour or to a real variation in the star.

LIGHT CHANGES OF ε AURIGÆ.—In Nos. 3918, 3919 and 3920 of the *Astronomische Nachrichten* Herr H. Ludendorff publishes the results of an exhaustive research as to the most probable data for the light variation of ε Aurigæ.

He first gives and discusses the observational results of Argelander, Heis, Schwab, Plassman, and thirteen other observers, and then, applying suitable weights to the various results, obtains a mean result by the method of least squares. The resulting elements obtained from this analysis are

$$T = 2415476 \text{ days} = \text{April } 1, 1901,$$
$$t = 207\text{d}. \quad t_m = 313\text{d}.,$$
$$T = 2415840 = \text{March } 31, 1902,$$

where T = the epoch at which the light commences to decrease from its normal magnitude, t = the time taken for the complete decrease to minimum or the corresponding increase to maximum, t_0 = the duration of the constant minimum, and T_0 = the epoch of the mean minimum.

Summarising the results the author finds that the star has a normal magnitude of 3·35, decreases 0·73 mag. in 207 days, remains at constant minimum for 313 days, and then returns to the normal magnitude again in 207 days. After these changes it remains constant for 25·13 years. Thus the complete period for this star becomes 27·12 years, or 9905 days, of which only 1·99 years are occupied by the actual variation.

SCIENTIFIC INVESTIGATION AND PROGRESS.[1]

AT the weekly services of many of our churches it is customary to begin with the reading of a verse or two from the Scriptures for the purpose, I suppose, of putting the congregations in the proper state of mind for the exercises which are to follow. It seems to me we may profit by this example, and accordingly I ask your attention to Article i. of the Constitution of the American Association for the Advancement of Science, which reads thus:—"The objects of the association are, by periodical and migratory meetings, to promote intercourse between those who are cultivating science in different parts of America, to give stronger and more general impulse and more systematic direction to scientific research, and to procure for the labours of scientific men increased facilities and a wider usefulness."

The first object mentioned, you will observe, is "to promote intercourse between those who are cultivating science in different parts of America"; the second is "to give a stronger and more general impulse and more systematic direction to scientific research"; and the third is "to procure for the labours of scientific men increased facilities and a wider usefulness." Those who are familiar with the history of the association are well aware that it has served its purposes admirably, and I am inclined to think that those who have been in the habit of attending the meetings will agree that the object which appeals to them most strongly is the promotion of intercourse between those who are cultivating science. Given this intercourse and the other objects will be reached as a necessary consequence, for the intercourse stimulates thought, and thought leads to work, and work leads to wider usefulness.

While in 1848, when the association was organised and the constitution was adopted, there was a fair number of good scientific investigators in this country, it is certain that in the half century that has passed since then the number of investigators has increased very largely, and naturally the amount of scientific work done at present is very much greater than it was at that time. So great has been the increase in scientific activity during recent years that we are apt to think that by comparison scientific research is a new acquisition. In fact there appears to be an impression abroad that in the world at large scientific research is a relatively new thing, for which we of this generation and our immediate predecessors are largely responsible. Only a superficial knowledge of the history of science is necessary, however, to show that the sciences have been developed slowly, and that their beginnings are to be looked for in the very earliest times. Everything seems to point to the conclusion that men have always been engaged in efforts to learn more and more in regard to the world in which they find themselves. Sometimes they have been guided by one motive and sometimes by another, but the one great underlying motive has been the desire to get a clearer and clearer understanding of the universe. But besides this there has been the desire to find means of increasing the comfort and happiness of the human race.

A reference to the history of chemistry will serve to show how these motives have operated side by side. One of the first great incentives for working with chemical things was the thought that it was possible to convert base metals, like lead and copper, into the so-called noble metals, silver and gold. Probably no idea has ever operated as strongly as this upon the minds of men to lead them to undertake chemical experiments. It held control of intellectual men for centuries, and it was not until about a hundred years ago that it lost its hold. It is very doubtful if the purely scientific question whether one form of matter can be transformed into another would have had the power to control the activities of investigators for so long a time, and it is idle to speculate upon this subject. It should, however, be borne in mind that many of those who were engaged in this work were actuated by a desire to put money in their purses—a desire that is by no means to be condemned without reserve, and I mention it not for the purpose of condemning it, but to show that a motive that we sometimes think of as peculiarly modern is among the oldest known to man.

[1] Address by Prof. Ira Remsen, retiring president of the American Association for the Advancement of Science, delivered at St. Louis, December 28, 1903.

When the alchemists were at work upon their problems, another class of chemists was engaged upon problems of an entirely different nature. The fact that substances obtained from various natural sources and others made in the laboratory produce effects of various kinds when taken into the system led to the thought that these substances might be useful in the treatment of disease. Then, further, it was thought that disease itself is a chemical phenomenon. These thoughts, as is evident, furnish strong motives for the investigation of chemical substances, and the science of chemistry owes much to the work of those who were guided by these motives.

And so in each period as a new thought has served as the guide we find that men have been actuated by different motives, and often one and the same worker has been under the influence of mixed motives. Only in a few cases does it appear that the highest motives alone operate. We must take men as we find them, and we may be thankful that on the whole there are so many who are impelled by one motive or another, or by a mixture of motives, to take up the work of investigating the world in which we live. Great progress is being made in consequence, and almost daily we are called upon to wonder at some new and marvellous result of scientific investigation. It is quite impossible to make predictions of value in regard to what is likely to be revealed to us by continued work, but it is safe to believe that in our efforts to discover the secrets of the universe only a beginning has been made. No matter in what direction we may look we are aware of great unexplored territories, and even in those regions in which the greatest advances have been made it is evident that the knowledge gained is almost insignificant as compared with that which remains to be learned. But this line of thought may lead to a condition bordering on hopelessness and despondency, and surely we should avoid this condition, for there is much greater cause for rejoicing than for despair. Our successors will see more and see more clearly than we do, just as we see more and see more clearly than our predecessors. It is our duty to keep the work going without being too anxious to weigh the results on an absolute scale. It must be remembered that the absolute scale is not a very sensitive instrument, and that it requires the results of generations to affect it markedly.

On an occasion of this kind it seems fair to ask the question: What does the world gain by scientific investigation? This question has often been asked and often answered, but each answer differs in some respects from the others, and each may be suggestive and worth giving. The question is a profound one, and no answer that can be given would be satisfactory. In general it may be said that the results of scientific investigation fall under three heads—the material, the intellectual and the ethical.

The material results are the most obvious, and they naturally receive the most attention. The material wants of man are the first to receive consideration. They cannot be neglected. He must have food and clothing, the means of combating disease, the means of transportation, the means of producing heat and a great variety of things that contribute to his bodily comfort and gratify his æsthetic desires. It is not my purpose to attempt to deal with all of these and to show how science is helping to work out the problems suggested. I shall have to content myself by pointing out a few of the more important problems the solution of which depends upon the prosecution of scientific research.

First, the food problem. Whatever views one may hold in regard to that which has come to be called "race suicide," it is certain that the population of the world is increasing rapidly. The desirable places have been occupied. In some parts of the earth there is such a surplus of population that famines occur from time to time, and in other parts epidemics and floods relieve the embarrassment. We may fairly look forward to the time when the whole earth will be overpopulated unless the production of food becomes more scientific than it is now. Here is the field for the work of the agricultural chemist who is showing us how to increase the yield from a given area, and, in case of poor and worn-out soils, how to preserve and increase their fertility. It appears that the methods of cultivating the soil are still comparatively crude, and more and more thorough investigation of the processes involved in the growth of plants is called for. Much has been learned since Liebig founded the science of agricultural chemistry. It was he who pointed out some of the ways by which it is possible to increase the fertility of a soil. Since the results of his investigations were given to the world the use of artificial fertilisers has become more and more general.

But it is one thing to know that artificial fertilisers are useful and it is quite another thing to get them. At first bone dust and guano were chiefly used. Then as these became dearer, phosphates and potassium salts from the mineral kingdom came into use.

At the Fifth International Congress for Applied Chemistry, held at Berlin, Germany, last June, Dr. Adolph Frank, of Charlottenburg, gave an extremely interesting address on the subject of the use of the nitrogen of the atmosphere for agriculture and the industries, which bears upon the problem that we are dealing with. Plants must have nitrogen. At present this is obtained from the great beds of saltpetre found on the west coast of South America—the so-called Chili saltpetre—and also from the ammonia obtained as a by-product in the distillation of coal, especially in the manufacture of coke. The use of Chili saltpetre for agricultural purposes began about 1860. In 1900 the quantity exported was 1,453,000 tons, and its value was about 60,000,000 dollars. In the same year the world's production of ammonium sulphate was about 500,000 tons, of a value of somewhat more than 20,000,000 dollars. Of these enormous quantities about three-quarters find application in agriculture. The use of these substances, especially of saltpetre, is increasing rapidly. At present it seems that the successful cultivation of the soil is dependent upon the use of nitrates, and the supply of nitrates is limited. Unless something is done we may look forward to the time when the earth, for lack of proper fertilisers, will not be able to produce as much as it now does, and meanwhile the demand for food is increasing. According to the most trustworthy estimations indeed, the saltpetre beds will be exhausted in thirty or forty years. Is there a way out? Dr. Frank shows that there is. In the air there is nitrogen enough for all. The plants can make only a limited use of this directly. For the most part it must be in some form of chemical combination, as, for example, a nitrate or ammonia. The conversion of atmospheric nitrogen into nitric acid would solve the problem, and this is now carried out. But Dr. Frank shows that there is another, perhaps more economical, way of getting the nitrogen into a form suitable for plant food. Calcium carbide can now be made without difficulty, and is made in enormous quantities by the action of a powerful electric current upon a mixture of coal and lime. This substance has the power of absorbing nitrogen from the air, and the product thus formed appears to be capable of giving up its nitrogen to plants, or, in other words, to be a good fertiliser. It is true that this subject requires further investigation, but the results thus far obtained are full of promise. If the outcome should be what we have reason to hope, we may regard the approaching exhaustion of the saltpetre beds with equanimity. But, even without this to pin our faith to, we have the preparation of nitric acid from the nitrogen and oxygen of the air to fall back upon.

While speaking of the food problem, a few words in regard to the artificial preparation of foodstuffs. I am sorry to say that there is not much of promise to report upon in this connection. In spite of the brilliant achievements of chemists in the field of synthesis it remains true that thus far they have not been able to make, except in very small quantities, substances that are useful as foods, and there is absolutely no prospect of this result being reached within a reasonable time. A few years ago Berthelot told us of a dream he had had. This has to do with the results that, according to Berthelot, are to be brought about by the advance of chemistry. The results of investigations already accomplished indicate that, in the future, methods will perhaps be devised for the artificial preparation of food from the water and carbonic acid so abundantly supplied by nature. Agriculture will then become unnecessary, and the landscape will not be disfigured by crops growing in geometrical figures. Water will be obtained from holes three or four miles deep in the earth, and this water will be above the boiling temperature, so that it can be used as a source of energy. It will be obtained in liquid form after it has undergone a process of natural distillation, which will free it from all impurities, including, of course, disease germs. The foods prepared by artificial methods will also be free from microbes, and there will consequently be less disease than at present. Further, the necessity for killing animals for food will no longer exist, and mankind will become gentler and more amenable to higher influences. There is, no doubt, much that is fascinating in this line of thought, but whether it is worth following depends upon the fundamental assumption. Is it at all probable that chemists will ever be able to devise methods for the artificial preparation of foodstuffs? I can only say that to me it does not appear probable in the light of the results thus far obtained. I do not mean to question the probability of the ultimate synthesis of some of those substances that are of value as foods. This has already been accomplished on the small scale, but for the most part the synthetical processes employed have involved the use of substances which themselves are the products of natural processes. Thus, the fats can be made, but the substances from which they are made are generally obtained from nature and are not themselves synthetical products. Emil Fischer has, to be sure, made very small quantities of sugars of different kinds, but the task of building up a sugar from the raw material furnished by nature—that is to say, from carbonic acid and water—presents such difficulties that it may be said to be practically impossible.

When it comes to starch, and the proteids which are the other chief constituents of foodstuffs, the difficulties are still greater. There is not a suggestion of the possibility of making starch artificially, and the same is true of the proteids. In this connection it is, however, interesting to note that Emil Fischer, after his remarkable successes in the sugar group and the uric acid group, is now advancing upon the proteids. I have heard it said that at the beginning of his career he made out a programme for his life work. This included the solution of three great problems. These are the determination of the constitution of uric acid, of the sugars and of the proteids. Two of these problems have been solved. May he be equally successful with the third! Even if he should be able to make a proteid, and show what it is, the problem of the artificial preparation of foodstuffs will not be solved. Indeed, it will hardly be affected.

Although science is not likely, within periods that we may venture to think of, to do away with the necessity of cultivating the soil, it is likely to teach us how to get more out of the soil than we now do, and thus put us in a position to provide for the generations that are to follow us. And this carries with it the thought that, unless scientific investigation is kept up, these coming generations will be unprovided for.

Another way by which the food supply of the world can be increased is by relieving tracts of land that are now used for other purposes than the cultivation of foodstuffs. The most interesting example of this kind is that presented by the cultivation of indigo. There is a large demand for this substance, which is plainly founded upon æsthetic desires of a somewhat rudimentary kind. Whatever the cause may be, the demand exists, and immense tracts of land have been and are still devoted to the cultivation of the indigo plant. Within the past few years scientific investigation has shown that indigo can be made in the factory from substances the production of which does not for the most part involve the cultivation of the soil. In 1900, according to the report of Dr. Brunck, managing director of the Badische Anilin- und Soda-Fabrik, the quantity of indigo produced annually in the factory "would require the cultivation of an area of more than a quarter of a million acres of land (390 square miles) in the home of the indigo plant." Dr. Brunck adds:—"The first impression which this fact may be likely to produce is that the manufacture of indigo will cause a terrible calamity to arise in that country; but, perhaps not. If one recalls to mind that India is periodically afflicted with famine, one ought not, without further consideration, to cast aside the hope that it might be good fortune for that country if the immense areas now devoted to a crop which is subject to many vicissitudes and to violent market changes were at last to be given over to the raising of breadstuffs and other food products." "For myself," says Dr. Brunck, "I do not assume to be an impartial adviser in this matter, but, nevertheless, I venture to express my conviction that the Government of India will be rendering a very great service if it should support and aid the progress, which will in any case be irresistible, of this impending change in the cultivation of that country, and would support and direct its methodical and rational execution."

The connection between scientific investigation and health is so frequently the subject of discussion that I need not dwell upon it here. The discovery that many diseases are due primarily to the action of microscopic organisms that find their way into the body and produce the changes that reveal themselves in definite symptoms is a direct consequence of the study of the phenomenon of alcoholic fermentation by Pasteur. Everything that throws light upon the nature of the action of these microscopic organisms is of value in dealing with the great problem of combating disease. It has been established in a number of cases that they cause the formation of products that act as poisons, and that the diseases are due to the action of these poisons. So also, as is well known, investigation has shown that antidotes to some of these poisons can be produced, and that by means of these antidotes the diseases can be controlled. But more important than this is the discovery of the way in which diseases are transmitted. With this knowledge it is possible to prevent the diseases. The great fact that the death rate is decreasing stands out prominently and proclaims to humanity the importance of scientific investigation. It is, however, to be noted in this connection that the decrease in the death rate compensates to some extent for the decrease in the birth rate, and that, if an increase in population is a thing to be desired, the investigations in the field of sanitary science are contributing to this result.

The development of the human race is dependent not alone upon a supply of food, but upon a supply of energy in available forms. Heat and mechanical energy are absolutely essential to man. The chief source of the energy that comes into play is fuel. We are primarily dependent upon the coal supply for the continuation of the activities of man. Without this, unless something is to take its place, man is doomed. Statistics in regard to the coal supply and the rate at which it is being used up have so frequently been presented by those who have special knowledge of this subject that I need not trouble you with them now. The only object in referring to it is to show that, unless by means of scientific investigation man is taught new methods of rendering the world's store of energy available for the production of heat and of motion, the age of the human race is measured by the extent of the supply of coal and other forms of fuel. By other forms of fuel I mean, of course, wood and oil. Plainly, as the demand for land for the production of foodstuffs increases, the amount available for the production of wood must decrease, so that wood need not be taken into account for the future. In regard to oil, our knowledge is not sufficient to enable us to make predictions of any value. If one of the theories now held in regard to the source of petroleum should prove to be correct, the world would find much consolation in it. According to this theory petroleum is not likely to be exhausted, for it is constantly being formed by the action of water upon carbides that in all probability exist in practically unlimited quantity in the interior of the earth. If this be true, then the problem of supplying energy may be reduced to one of transportation of oil. But given a supply of oil and, of course, the problem of transportation is solved.

What are the other practical sources of energy? The most important is the fall of water. This is being utilised more and more year by year since the methods of producing electric currents by means of the dynamo have been worked out. There is plainly much to be learned before the energy made available in the immediate neighbourhood of the waterfall can be transported long distances economically, but advances are being made in this line, and already factories that have hitherto been dependent upon coal are making use of the energy derived from waterfalls. The more rapidly these advances take place the less will be the demand for coal, and if there were only enough waterfalls conveniently situated, there would be no difficulty in furnishing all the energy needed by man for heat or for motion.

It is a fortunate thing that, as the population of the earth increases, man's tastes become more complex. If only the simplest tastes prevailed, only the simplest occupations would be called for. But let us not lose time in idle speculations as to the way this primitive condition of things would affect man's progress. As a matter of fact, his tastes are becoming more complex. Things that are not dreamed of in one generation become the necessities of the next generation. Many of these things are the direct results of scientific investigation. No end of examples will suggest themselves. Let me content myself by reference to one that has of late been the subject of much discussion. The development of the artificial dye-stuff industries is extremely instructive in many ways. The development has been the direct result of the scientific investigation of things that seemed to have little, if anything, to do with this world. Many thousands of workmen are now employed, and many millions of dollars are invested, in the manufacture of dye-stuffs that were unknown a few years ago. Here plainly the fundamental fact is the æsthetic desire of man for colours. A colourless world would be unbearable to him. Nature accustoms him to colour in a great variety of combinations, and it becomes a necessity to him. And his desires increase as they are gratified. There seems to be no end to development in this line. At all events, the data at our disposal justify the conclusion that there will be a demand for every dye that combines the qualities of beauty and durability. Thousands of scientifically trained men are engaged in work in the effort to discover new dyes to meet the increasing demands. New industries are springing up and many find employment in them. As a rule the increased demand for labour caused by the establishment of these industries is not offset by the closing up of other industries. Certainly it is true that scientific investigation has created large demands for labour that could hardly find employment without these demands.

The welfare of a nation depends to a large extent upon the success of its industries. In his address as president of the British Association for the Advancement of Science given last summer, Sir Norman Lockyer quotes Mr. Chamberlain thus:—"I do not think it is necessary for me to say anything as to the urgency and necessity of scientific training. . . . It is not too much to say that the existence of this country, as the great commercial nation, depends upon it. . . . It depends very much upon what we are doing now, at the beginning of the twentieth century, whether at its end we shall continue to maintain our supremacy or even equality with our great commercial and manufacturing rivals." In another part of his address Sir Norman Lockyer says:—"Further, I am told that the sum of 24,000,000*l*. is less than half the amount by which Germany is yearly enriched by having improved upon our chemical industries, owing to our lack of scientific training. Many other industries have been attacked in the same way since, but taking this one instance alone, if we had spent this money fifty years ago, when the Prince Consort first called attention to our backwardness, the nation would now be much richer than it is, and would have much less to fear from competition."

But enough on the purely material side. Let us turn to the intellectual results of scientific investigation. This part of our subject might be summed up in a few words. It is so obvious that the intellectual condition of mankind is a direct result of scientific investigation that one hesitates to make the statement. The mind of man cannot carry him much in advance of his knowledge of the facts. Intellectual gains can be made only by discoveries, and discoveries can be made only by investigation. One generation differs from another in the way it looks at the world. A generation that thinks the earth is the centre of the universe differs intellectually from one that has learned the true position of the earth in the solar system, and the general relations of the solar system to other similar systems that make up the universe. A generation that sees in every species of animal and plant evidence of a special creative act differs from one that has recognised the general truth of the conception of evolution. And so in every department of knowledge the great generalisations that have been reached through the persistent efforts of scientific investigators are the intellectual gains that have resulted. These great generalisations measure the intellectual wealth of mankind. They are the foundations of all profitable thought. While the generalisations of science belong to the world, not all the world takes advantage of its opportunities. Nation differs from nation intellectually as individual differs from individual. It is not, however, the possession of knowledge that makes the efficient individual and the efficient nation. It is well known that an individual may be very learned and at the same time very inefficient. The question is, what use does he make of his knowledge? When we speak of intellectual results of scientific investigation, we mean not only accumulated knowledge, but the way in which this knowledge is invested. A man who simply accumulates money and does not see to it that this money is carefully invested is a miser, and no large results can come from his efforts. While, then, the intellectual state of a nation is measured partly by the extent to which it has taken possession of the generalisations that belong to the world, it is also measured by the extent to which the methods by which knowledge is accumulated have been brought into requisition and have become a part of the equipment of the people of that nation. The intellectual progress of a nation depends upon the adoption of scientific methods in dealing with intellectual problems. The scientific method is applicable to all kinds of intellectual problems. We need it in every department of activity. I have sometimes wondered what the result would be if the scientific method could be employed in all the manifold problems connected with the management of a Government. Questions of tariff, of finance, of international relations would be dealt with much more satisfactorily than at present if the spirit of the scientific method were breathed into those who are called upon to deal with these questions. It is plain, I think, that the higher the intellectual state of a nation the better will it deal with all the problems that present themselves. As the intellectual state is a direct result of scientific investigation, it is clear that the nation that adopts the scientific method will in the end outrank both intellectually and industrially the nation that does not.

What are the ethical results of scientific investigation? No one can tell. There is one thought that in this connection I should like to impress upon you. The fundamental characteristic of the scientific method is honesty. In dealing with any question science asks no favours. The sole object is to learn the truth, and to be guided by the truth. Absolute accuracy, absolute fidelity, absolute honesty are the prime conditions of scientific progress. I believe that the constant use of the scientific method must in the end leave its impress upon him who uses it. The results will not be satisfactory in all cases, but the tendency will be in the right direction. A life spent in accordance with scientific teachings would be of a high order. It would practically conform to the teachings of the highest types of religion. The motives would be different, but so far as conduct is concerned the results would be practically identical. I need not enlarge upon this subject. Unfortunately, abstract truth and knowledge of facts and of the conclusions to be drawn from them do not at present furnish a sufficient basis for right living in the case of the great majority of mankind, and science cannot now, and I do not believe it ever can, take the place of religion in some form. When the feeling that the two are antagonistic wears away, as it is wearing away, it will no doubt be seen that one supplements the other, in so far as they have to do with the conduct of man.

What are we doing in this country to encourage scientific investigation? Not until about a quarter of a century ago can it be said that it met with any encouragement. Since then there has been a great change. Up to that time research was sporadic. Soon after it became almost epidemic. The direct cause of the change was the establishing of courses in our universities for the training of investigators somewhat upon the lines followed in the German universities. In these courses the carrying out of an investigation plays an important part. This is, in fact, the culmination of the course. At first there were not many following these courses, but it was not long before there was a demand for the products. Those who could present evidence that they had followed such courses were generally given the preference. This was especially true in the case of appointments in the colleges, some colleges even going so far as to decline to appoint anyone who had not taken the degree of doctor of philosophy, which is the badge of the course that involves investigation. As the demand for those who had received this training increased, the number of those seeking it increased at least in the same proportion. New universities were established and old ones caught the spirit of the new movement until from one end of the country to the other centres of scientific activity are now found, and the amount of research work that is done is enormous compared with what was done twenty-five or thirty years ago. Many of those who get a taste of the work of investigation become fascinated by it and are anxious to devote their lives to it. At present, with the facilities for such work available, it seems probable that most of those who have a strong desire and the necessary industry and ability to follow it find their opportunity somewhere. There is little danger of our losing a genius or even one with fair talent. The world is on the lookout for them. The demand for those who can do good research work is greater than the supply. To be sure the rewards are not as a rule so great as those that are likely to be won by the ablest members of some other professions and occupations, and so long as this condition of affairs continues to exist there will not be so many men of the highest intellectual order engaged in this work as we should like to see. On the other hand, when we consider the great progress that has been made during the last twenty-five years or so, we have every reason to take a cheerful view of the future. If as much progress should be made in the next quarter century, we shall, to say the least, be able to compete with the foremost nations of the world in scientific investigation. In my opinion this progress is largely dependent upon the development of our universities. Without the opportunities for training in the methods of scientific investigation there will be but few investigators. It is necessary to have a large number in order that the principle of selection may operate. In this line of work as in others, many are called, but few are chosen.

Another fact that is working advantageously to increase the amount of scientific research done in this country is the support given by the Government in its different scientific bureaus. The Geological Survey, the Department of Agriculture, the Coast and Geodetic Survey, the National Bureau of Standards and other departments are carrying on a large amount of excellent scientific work, and thus helping most efficiently to spread the scientific spirit throughout the land.

Finally, two exceedingly interesting experiments in the way of encouraging scientific investigation are now attracting the attention of the world. I mean, of course, the Carnegie Institution, with its endowment of 10,000,000 dollars, and the Rockefeller Institute, devoted to investigations in the field of medicine, which will no doubt be adequately endowed. It is too early to express an opinion in regard to the influence of these great foundations upon the progress of scientific investigation. As both will make possible the carrying out of many investigations that would otherwise probably not be carried out, the chances of achieving valuable results will be increased. The danger is that those who are responsible for the management of the funds will be disappointed that the results are not at once of a striking character, and that they will be tempted to change the method of applying the money before those who are using it have had a fair chance. But we who are on the outside know little of the plans of those who are inside. All signs indicate that they are making an earnest effort to solve an exceedingly difficult problem, and all who have the opportunity should do everything in their power to aid them.

In the changes which have been brought about in the condition of science in this country since 1848, it is safe to say that this association has either directly or indirectly played a leading part. It is certain that for the labours of scientific men increased facilities and a wider usefulness have been procured.

FIREBALLS IN JANUARY.

APART from the rich shower directed from the region of Bode's asterism Quadrans, or northern limits of Boötes, on the opening nights of January, the meteors visible in this month have usually attracted little attention. Observers who have watched the cold winter sky have, indeed, generally remarked a scarcity of meteors amongst the beautiful constellations displayed at this season of the year. Zezioli, it is true, was more successful in the clear atmosphere of Italy, for on the closing nights of January, 1868, he saw a plentiful swarm of shooting stars falling from Corona and Ursa Major, and one or two other observers have occasionally recorded meteoric activity of somewhat special character, but, with the exception of its New Year's shower, the month commonly furnishes us neither with any plentiful displays nor with an abundance of meteors giving evidence of a multitude of attenuated streams.

But in recent years January has certainly shown itself rather noteworthy on account of the brilliant fireballs which have appeared. This month in 1901, 1903 and 1904 proved rich in these startling visitors. About ten were seen in 1901, five were well observed and their real paths computed in 1903, and seven appeared between January 8–22, 1904. We must also remember the great fireballs of 1894 January 25, 1898 January 21, and the pair which were quite conspicuous in bright sunshine on the early afternoons of 1900 January 9 and 1901 January 6 respectively.

A comparison of the various dates shows that the apparitions have marked two periods of the month, viz.

January 6 to 15, and
January 23 to 29.

In future years it will be desirable to watch for fireballs at these special epochs. No particular shower appears to have been responsible for their production in past years. The radiant points seem to have been widely separated, and prove that our brilliant January meteors have little if any community of origin, but may rather be regarded as isolated cosmic rovers. If they individually represent meteoric showers, such showers must form the relicts of rich, old-time systems now thinned out beyond visible recognition by frequent *rencontres* with the planets.

It is characteristic of many vividly luminous fireballs that they have very slow, long and nearly horizontal flights. Their average heights are about 67 miles at first, and they disappear either at about 46 or 29 miles. Their radiant-points are usually not far from the horizon, and placed in unusual westerly positions where no ordinary radiants of shooting stars are ever detected. In 1903 very brilliant meteors were seen on January 10, 13, 14, 25 and 28, and in 1904 on January 8, 9, 10, 13, 15, 18 and 22. The one alluded to in NATURE for January 14 as seen by Mr. W. E. Rolston at Fulham on January 9, 8h. 27m., was also observed by Mr. G. F. Oldham at Tunbridge Wells, moving from $110^{\circ}+36^{\circ}$ to $128^{\circ}+37^{\circ}$ in four seconds. The real height of the object during its luminous career was from 60 to 41 miles over the east coast of Kent (Folkestone to Ramsgate), radiant point at $41^{\circ}+5^{\circ}$, and velocity certainly not more, and very probably less, than 6 miles per second. There was another fireball on the following night, Sunday, January 10, at 8h. 32m., observed at Oxford and Llanelly. It descended from a radiant in the east region of Aries over Monmouthshire from a height of 67 to 31 miles. Yet another fireball was recorded on January 15 at Bridgwater and Banbury. It fell from a height of 63 to 27 miles from a radiant near the zenith in the region bordering Perseus and Auriga.

It is fortunate to have secured duplicate observations of these fine objects, and more of them may be expected to appear before the close of the month.

In February fireballs have often been seen on the 3rd, 7th and 10th. These dates will nearly correspond with February 5, 9 and 12 in 1904. There is also a pretty rich shower of meteors from near Capella sometimes observed between February 7 and 23.

W. F. DENNING.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

PROF. EDUARD STUDY, of Greifswald, has been appointed to the chair of mathematics at Bonn in succession to the late Prof. Lipschütz.

ON Thursday, February 11, Prof. Armstrong will give an address at the Battersea Polytechnic on "The Placing of 'Domestics' on a Scientific Practical Basis."

CORNELL University will, says *Science*, receive more than 40,000*l*. from the estate of the late Mr. F. W. Guiteau, of Irvington-on-the-Hudson, which is nearly 10,000*l*. more than was announced at the time of Mr. Guiteau's death last year. The money will be used as a fund for the assistance of needy students, and will be lent them without interest.

DR. GEORG SCHROETER has been appointed professor of organic chemistry in the University of Bonn; Mr. F. Kreutzberg, of Düsseldorf, has been appointed professor of applied mathematics at the new Academy of Posen; Dr. Leo Marchlewski, professor of chemistry at Cracow; Mr. L. Farny, professor in the Zürich Polytechnic; Dr. W. Kötz, professor of chemistry at Göttingen; and Dr. Erich Müller, professor in the chemical department of the Dresden High School.

A PETITION, which it is intended to present to the central educational authorities of the United Kingdom, is being circulated for signature among the registered medical men of the British Isles. The petition directs attention to the serious physical and moral conditions of degeneracy and disease resulting from the neglect and infraction of the elementary laws of hygiene, and urges the central authorities for education to consider whether it would not be possible to include in primary and secondary schools such teaching as may lead all children duly to appreciate healthful bodily conditions. The petition then reviews the steps taken in this direction by English-speaking nations, and shows that great prominence is given in many British colonies to instruction in the laws of health, and concludes by urging the necessity of ensuring that the training of all teachers shall include adequate instruction in these subjects.

AT the annual meeting of the Mathematical Association held on January 23, Prof. A. R. Forsyth, the president, who occupied the chair, in referring to the report of the Committee on the Teaching of Elementary Mathematics, said that in the various stages of the consideration of changes in the regulations at Cambridge University the report of the association proved to be of substantial value. The most interesting event outside the association was the production of the report of the syndicate at Cambridge and the discussion of that report. Some slight modifications were introduced into it, and then it was adopted by the University of Cambridge without a single dissentient. Therefore there had come a change not indeed in teaching, but in the conditions under which teaching could be carried on. If the first working of the regulations was carried out in the spirit in which they were proposed, if the teachers would take the advantage that was offered by the greater ease of the regulations, he thought a substantial improvement would come in the mathematical teaching of the country. Mr. E. M. Langley exhibited models of regular and semi-regular solids, including the four *polyèdres étoiles* of Poinsot. Mr. C. S. Jackson read an account of a recent discussion on the possibility of fusion of the teaching of mathematics and science. Mr. J. C. Palmer dealt with a geometrical note, and Mr. C. A. Rumsey read a paper on advanced school courses of mathematics.

IN the course of an address at the Mansion House on Monday, at the distribution of prizes to the successful students of the City and Guilds Institute, Sir William White remarked that as regards higher technical education we were as a nation in a critical condition. What was wanted was coordination of educational agencies on a carefully considered plan. There must be conference between teachers and the representatives of the professions, businesses, and manufactures if the best results were to be obtained. He was extremely hopeful of the results which would follow the work of an advisory committee at the Institution of Civil Engineers containing representatives of all the great engineering associations in this country, the duty of which it would be to report as to the best mode of training British engineers in the future. We had at present no proper system of secondary education preparing students for entering technical institutes. In this respect the Germans had certainly stolen a march upon us. We should cease arguing for ever whether the classical side or the modern side of education was the best. The simple solution was that they should go on side by side. There should be a more generous recognition by employers of the necessity and value of the services of trained men. It was a sad thing to know that some of the researches originally made in this country had been first turned to practical account abroad. He knew one case where British manufacturers were to this day paying large royalties in connection with a process of steel manufacture which was actually initiated in England. He looked forward to a system of technical education in London and throughout the country which would show the world that England was still the leader in industry and in resource.

SOCIETIES AND ACADEMIES.

LONDON.

Mathematical Society, January 14.—Dr. E. W. Hobson, vice-president, in the chair.—The following papers were communicated:—Various systems of piling: Prof. J. D. **Everett.** The method of "steps" for dealing with the structure of piles of equal spheres is applied to various arrangements which are of especial interest in crystallography.—The notion of lines of curvature in the theory of surfaces: Dr. G. **Prasad.** The object of the paper is to investigate conditions under which certain known theorems in the theory of surfaces can be extended to the case in which the coordinates of points on the surface are defined by non-analytical functions. The theorems in question are:—(1) The only surface of constant positive curvature is a sphere; (2) no surface of constant negative curvature with continuously varying tangent plane can extend to infinite distances.—Electric radiation from conductors: H. M. **Macdonald.** It is shown that in general, when electrical oscillations on a conductor are taking place, no surface can be drawn to cut the lines of electric force at right angles and to be everywhere close to the surface of the conductor. If such a surface could be drawn there would be no decay of the oscillations by radiation. It is shown that surfaces can be drawn to have the property in question everywhere except near the nodal points of the oscillation, and it is concluded that the radiation takes place mainly in the neighbourhood of the nodes. It is pointed out further that the ordinary theory of electrical waves along wires involves an invalid limiting operation, by which the wires are treated as indefinitely thin and the electric force is taken, nevertheless, to be everywhere at right angles to the wires; and the correction of the ordinary theory required to avoid this operation is discussed.—Groups of the order $p^{\alpha}q^{\beta}$: Prof. W. **Burnside.** By a consideration of certain properties of the group-characteristics of groups of the orders in question, it is shown that all these groups are soluble.—The solution of partial differential equations by means of definite integrals: H. **Bateman.** The paper deals with various generalisations of the known solutions of Laplace's equation by means of definite integrals.—Open sets and the theory of content: Dr. W. H. **Young.** Two definitions of the content of an open set are given, and are shown to be in agreement for that class of open sets which has the property that the content of the set, obtained by adding to any member of the class any set of non-overlapping intervals, is equal to the sum of the contents of the component sets. This class contains all known open sets, and all those obtainable from them by any of the ordinary processes.—Upper and lower integration: Dr. W. H. **Young.** All functions, whether integrable or not, possess upper integrals and lower integrals. The problem of determining them is reduced in the paper to that of ordinary integration. It is shown that an upper n-ple integral of a discontinuous function can be expressed in terms of $\int I dk$, where I is the content of the set of points at which the maximum of the function is not less than k, and the integral is taken between suitable limits.—List of primes of the form $4n+1$ between 10^8 and 10^8+10^5: Dr. T. B. **Sprague.**

PARIS.

Academy of Sciences, January 18.—M. Mascart in the chair.—The application of the general theory of the flow of sheets of water infiltrated in the soil to large springs of permeable strata, and, in particular, to several of those supplying Paris: J. **Boussinesq.** The mathematical theory previously worked out by the author has been applied to the three sources of Dhuis, Cérilly, and Armentières. It is found that for important springs in permeable ground the basin of supply is considerably extended downwards below its edge.—On the first numbers of the photographic catalogue of the sky published by M. Trépied: M. **Lœwy.**—On the dispersion of the n-rays and on their wavelength: R. **Blondlot.** The dispersion was studied by means of aluminium prisms and lenses, and it was recognised that the radiation was separated into eight bundles, the refractive indices of which varied from 1·04 to 1·85. The wave-lengths were determined by two methods: by a diffraction grating and by the formation of Newton's rings. The results of the two methods were concordant within the limits of experimental error, the wave-lengths determined proving to be much shorter than those of light. These radiations would appear to be different from the rays of very short wave-length discovered by M. Schumann, inasmuch as the latter are strongly absorbed by air and the n-rays are not.—On the peroxides of zinc: M. **de Forcrand.** A discussion of the results of M. Kuriloff with regard to the formula of peroxide of zinc.—On a characteristic property of the families of Lamy: Alphonse **Demoulin.**—On the *genre* of the derivative of an entire function and on the exceptional case of M. Picard: A. **Wiman.**—The action of radium bromide on the electrical resistance of bismuth: R. **Paillot.** The radiations emitted by radium bromide diminish the electrical resistance of bismuth. The action is practically instantaneous, rapidly falling off with the distance of the radium tube from the bismuth and vanishing when this distance amounts to 1 cm.—On a self-recording differential speed measurer: J. **Richard.**—The influence of the physical nature of the anode on the constitution of electrolytic peroxide of lead: A. **Hollard.** If the lead were deposited as the dioxide, the analytical factor would be 0·866 to convert the dioxide into lead. Experiments with an anode of roughened platinum gave a factor of 0·853, this being independent of the amount of lead in solution.—The chemical nature of colloidal solutions: Jacques **Duclaux.**—A method of separating alumina and iron by the use of formic acid: A. **Leclère.** A modification of the hyposulphite of sodium method, in which the aluminium is separated as the basic formate.—The estimation of chlorates, bromates, and iodates: Léon **Débourdeaux.**—The preparation of primary alcohols by means of the corresponding amides: L. **Bouveault** and G. **Blanc.** The higher fatty amides, reduced by sodium in boiling ethyl alcoholic solution, give yields of from 25 to 30 per cent. of the theoretical. Normal hexyl, normal nonyl, and phenylethyl alcohols were prepared in this way.—The synthesis of sugars, starting from trioxymethylene and sulphite of soda: A. **Seyewetz** and M. **Gibello.**—A new method of synthesis of tertiary alcohols by means of organomagnesium compounds: V. **Grignard.** The magnesium compound R.MgX is converted into $R.CO_2.MgX$ by the action of carbon dioxide, and this is then treated with an additional molecule of R′.MgX, the object being to prepare the ketone R.CO.R′. The reaction was found, however, to result in the production of the tertiary alcohol $R.R'_2.OH$. The new alcohols prepared by this method include diethylisoamyl carbinol, isobutyldiisoamyl carbinol, and phenyldiethyl carbinol.—The influence of radium rays on the development and growth of the lower fungi: J. **Dauphin.** The radium rays arrest the growth of the mycelium of Mortierella, but the spores and mycelium are not killed, but are in a latent state, and, replaced under normal conditions, can germinate and continue to grow.—Researches on the transpiration of the leaves of Eucalyptus: Ed. **Griffon.** In opposition to the views generally expressed, it is found that the leaves of Eucalyptus have not an unusually large transpiratory capacity compared with other leaves. The effects of the growth of this tree in marshy soil are more probably due to its power of rapidly producing a large mass of foliage than to any specially large transpiratory effects.—The utilisation of entomophytic fungi for the destruction of larvæ: C. **Vaney** and A. **Conte.**—On the excrescences of the leaves of the vine: P. **Viala** and P. **Pacottet.** These abnormalities are not observed in vineyards, but are produced by forced culture under glass.—On a trachyte in the French Soudan: H. **Arsandaux.** The case described is the first example of volcanic rock in the western French Soudan. Two types of alkaline trachyte and one basalt were found.—The increase of useful work in traction by the use of elastic apparatus: MM. **Ferrus** and **Machart.**—Remarks by M. **Marey** on the preceding paper.—The relation between the appearance of secondary sexual characters and the interstitial testicular gland: P. **Ancel** and P. **Bouin.**—The action of various substances on the glycogeny of the liver: MM. **Doyon** and **Kareff.**—The determination of the value of intraorganic combustion in the parotid gland of the ox in a state of activity and repose: G. **Moussu** and J. **Tissot.**—On the stimulation of nerves by discharges of condensers: M. **Cluzet.**—On certain congenital anomalies of the head, determining a symmetrical transformation of the four extremities (acrometagenesis): V. **Babès.**—On the destruction of the winter egg of Phylloxera: G. **Cantin.**

DIARY OF SOCIETIES.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—Observations on the Sex of Mice—Preliminary Paper: Dr. S. M. Copeman, F.R.S., and F. G. Parsons.—Observations upon the Acquirement of Secondary Sexual Characters indicating the Formation of an Internal Secretion by the Testicle: S. G. Shattock and C. G. Seligmann.—On the Part played by Benzene in Poisoning by Coal Gas: Dr. R. Staehelin.—On the Islets of Langerhaus in the Pancreas: H. H. Dale.—The Morphology of the Retrocalcarine Region of the Cortex Cerebri: Prof. G. Elliot Smith.

ROYAL INSTITUTION, at 5.—The Flora of the Ocean: G. R. M. Murray, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—The Edison Accumulator for Automobiles: W. Hibbert. (Adjourned discussion.) To be opened by Dr. J. A. Fleming, F.R.S.—On the Magnetic Dispersion in Induction Motors, and its Influence on the Design of these Machines: Dr. H. Behn-Eschenburg. (Adjourned discussion.)

FRIDAY, JANUARY 29.

ROYAL INSTITUTION, at 9.—The Marshes of the Nile Delta: D. G. Hogarth.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Metallurgy as Applied in Engineering: Archibald B. Head.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Extra Meeting. Sixth Report to the Alloys Research Committee on the Heat Treatment of Steel: the late Sir William C. Roberts-Austen, K.C.B., F.R.S.. Completed by Prof. W. Gowland. (Continued discussion.)

SATURDAY, JANUARY 30.

ROYAL INSTITUTION, at 3.—British Folk Song: J. A. Fuller-Maitland.

ESSEX FIELD CLUB, at 6.30 (Essex Museum of Natural History, Stratford).—Evidences of Prehistoric Man in West Kent: J. Russell Larkby.—Recent Observations concerning London City Walls, the Walbrooke and Moorfields: F. W. Reader.

MONDAY, FEBRUARY 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—A Résumé of the Report, Minutes of Evidence, and Appendices of the Royal Commission on Arsenical Poisoning: Julian L. Baker.

SOCIETY OF ARTS, at 8.—Oils and Fats—their Uses and Applications: Dr. J. Lewkowitsch (Cantor Lectures II.).

ARISTOTELIAN SOCIETY, at 8.—Reality: Shadworth H. Hodgson.

TUESDAY, FEBRUARY 2.

ROYAL INSTITUTION, at 5.—The Development of Animals: Prof. L. C. Miall, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Sanding-up of Tidal Harbours: A. E. Carey. (Discussion).—Tonnage Laws and the Assessment of Harbour Dues and Charges: H. H. West.

MINERALOGICAL SOCIETY, at 8.—On a New Sulphostannite of Lead from Bolivia, and its Relations with Franckeite and Cylindrite: G. T. Prior.—On the Gnomonic Net: Harold Hilton.

ZOOLOGICAL SOCIETY, at 8.30.—On the Subspecies of *Giraffa camelopardalis*: R. Lydekker, F.R.S.—On a Collection of Mammals from Namaqualand: Oldfield Thomas, F.R.S.—On the Arteries of the Base of the Brain in Certain Mammals: F. E. Beddard, F.R.S.

FARADAY SOCIETY, at 8.—Notes on Aluminium Welding: Sherard Cowper-Coles.—Some Applications of the Theory of Electrolysis to the Separation of Metals from One Another: A. Hollard.

WEDNESDAY, FEBRUARY 3.

SOCIETY OF ARTS, at 8.—Steam Cars for Public Service: Thomas Clarkson.

GEOLOGICAL SOCIETY, at 8.—The Rhætic Beds of the South Wales Direct Line: Prof. S. H. Reynolds and A. Vaughan.—On a Deep-Sea Deposit from an Artesian Boring at Kilacheri, near Madras: Prof. H. Narayana Rau.

ENTOMOLOGICAL SOCIETY, at 8.—On the Habits of some Mantidæ: Captain C. E. Williams.—Systematic Observations upon the Dermatoptera: Malcolm Burr.—Descriptions of New Species of Cryptinæ, from the Khasia Hills, Assam; and a New Species of Bembex: Peter Cameron.—On a New Species of Heterogynis: Dr. T. A. Chapman.—On some New or Imperfectly Known Forms of South African Butterflies: Roland Trimen, F.R.S.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Annual Meeting, followed by Note on the Quantitative Estimation of Mechanical Wood Pulp in Paper: C. F. Cross and E. J. Bevan.—Note on Chinese Tallow Seed Oil: L. Myddelton Nash.—Note on the Analysis of Jam: Raymond Ross.

THURSDAY, FEBRUARY 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: The Reduction Division in Ferns: R. Gregory.—Cultural Experiments with "Biologic Forms" of the Erysiphaceæ: E. S. Salmon.—On the Origin of Parasitism in Fungi: George Massee.—On Mechanical and Electrical Response in Plants: Prof. J. C. Bose.—On the Effects of Joining the Cervical Sympathetic Nerve with the Chorda Tympani: Prof. J. N. Langley, F.R.S., and Dr. H. K. Anderson.

ROYAL INSTITUTION, at 5.—Recent Research in Agriculture: A. D. Hall.

CHEMICAL SOCIETY, at 8.—The Tautomeric Character of the Acidic Thiocyanates—Preliminary Note: R. E. Doran.—The Resolution of $\alpha\beta$-Dihydroxybutyric Acid into its Optically Active Constituents: R. S. Morrell and E. K. Hanson.

LINNEAN SOCIETY, at 8.—Account of Researches in the Physiology of Yeast: Prof. Sydney H. Vines, F.R.S.—Further Researches on the Specialisation of Parasitism in the Erysiphaceæ: E. S. Salmon.

RÖNTGEN SOCIETY, at 8.30.—Discussion on the Production of Photographic Reversal through the Action of Various Radiations.

SATURDAY, FEBRUARY 6.

ROYAL INSTITUTION, at 3.—Study of Style in Greek Sculpture: Dr. C. Waldstein.

CONTENTS.