THURSDAY, AUGUST 13, 1891.

THE INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.

THIS Congress, the work of which we refer to in another column, which is now in full swing, promises to be one of the most important meetings of the kind that has ever been held, not only in point of numbers, but also on account of the far-reaching results likely to accrue from it.

A remarkable combination of circumstances has contributed to its success. In the first place, it is held in the country which has been the pioneer of sanitary work; and then it has the patronage of Her Majesty the Queen, who, it is well known, takes a deep personal interest in its success; and has as its President, not merely in an honorary sense, His Royal Highness the Prince of Wales, who presided and gave an admirable address of welcome at the splendid opening meeting on Monday in St. James's Hall.

This is the seventh of a series of similar Congresses which have been held in various parts of Europe, and one is tempted to ask what they have accomplished. An answer is at once forthcoming. The all-important question of quarantine has been discussed at several of these Congresses. Not to go farther back than the Congress at The Hague, held in 1884, we find, from the excellent reports issued by the editors of the *Lancet*, that then the feeling in Europe was so strongly opposed to the English views as to the inutility of quarantine and the superiority of our method of medical inspection, that the English delegate was not even allowed to explain the English position in the matter, but the discussion was peremptorily closed, on the ground that the subject had been sufficiently discussed on the previous day. At the Vienna Congress, in 1887, quarantine was again discussed under the subject of cholera; and the veteran Pettenkoffer told the members of various countries present that they had only to follow the example of England, in looking after their systems of water-supply and sewerage, and in isolating cases of infectious disease, and they would be no more afraid of cholera than the English were, even with their continual communication with India, the home of that disease, and would have no need of quarantine, with all its vexatious and ineffective restrictions, and all its unnecessary interference with commerce. Now, Continental opinion is almost entirely on our side, and it is doubtful whether there will be any serious discussion on the matter.

But there are many other subjects with which the Congress will interest itself, and about which such an interchange of views as can only be obtained at an International Congress must be of the greatest benefit. The whole subject of bacteriology has grown up within the last few years, and one of the most important and best attended Sections of the Congress is devoted to it, many of the highest authorities on this subject having been attracted here to take part in the discussion under the presidency of Sir Joseph Lister. The abnormal prevalence of diphtheria, not only in our own large towns, but also in those of other parts of Europe and in America, in many cities of which, especially in the Western States of North America, it has become a veritable plague, is likely to occasion an important discussion in Section I., under the presidency of Sir Joseph Fayrer. The mention of his name leads us to observe that India is well to the front in this Congress, for not only have a number of delegates been sent by her Provinces and Native States, but they have also largely contributed to the funds of the Congress.

Influenza, too, our new plague, about which we seem to know so little, might be discussed, as to its mode of spread and methods of prevention, with great advantage at a meeting where so much experience from all parts of the world is focussed.

An especial feature in this Congress is, as might be expected in England, the prominence which is given to engineering and architecture in connection with hygiene, there being two separate Sections devoted to these branches of the subject.

The division of demography, too, which has been so much talked about on account of its name, which was up to the present time unfamiliar to English ears, and which has been defined by some wag as "the art of drawing the public," has attracted, under the presidency of Mr. Francis Galton, many of the most eminent statisticians of Europe, whose discussions cannot fail to promote the attainment of more uniformity in the methods of statistical inquiries.

This is an age of Congresses, and if they are, as it is universally agreed that they are, of any use at all, it is self-evident that the most useful and the most important are the international ones.

A LIFE OF DARWIN.

Charles Darwin: His Life and Work. By Charles Frederick Holder. (New York and London: G. P. Putnam's Sons, 1891.)

BETWEEN the voluminous "Life and Letters" of his father, by Prof. Francis Darwin, and the brief epitome of Darwin's work, by Mr. G. T. Bettany, published in 1887 in the "Great Writers" series, there has hitherto been a gap which has only been partially filled by such books as Grant Allen's "Charles Darwin" in the series of "English Worthies." In the first of the works mentioned, our great naturalist is chiefly allowed to speak for himself, while in the second we have a digest of his scientific achievements. Although it has been generally considered that the life of Darwin from the time of the return of the *Beagle* was too uneventful to make an interesting biography, we have always been of opinion that there existed sufficient material for a popular "Life" of the very greatest interest provided that this material could be skilfully and judiciously worked up. The work under notice supplies this want, and American and English readers are now provided with a biography which is both entertaining and accurate.

Of course the material out of which Mr. Holder has woven his story is for the most part to be found in Darwin's own writings, or in the "Life and Letters," and readers who turn to the pages of this book with the hope of finding new matter may be disappointed. But the very circumstance that out of the familiar records of the voyage of the *Beagle*, and the later writings of Darwin, the author has been enabled to construct such a very readable volume, is the best tribute to his skill.

The task which Mr. Holder took up was by no means an easy one; the difficulty which he had to confront did not arise from paucity of material, but from a superabundance of records, owing to the very complete account of his own travels and observations which Darwin has bequeathed to us. To extract the salient points from these records, and to dress them up in the writer's own language, was a labour requiring considerable literary ability. Mr. Holder has shown that he was well qualified for the undertaking, and it is refreshing—after the "Summary of the Darwinian Theory," and similar productions to which we have recently been treated in this country—to find that an American naturalist is able to write an account of Darwin and his work in language expressing his own ideas on the subject, instead of stringing together a lot of disconnected quotations from Darwin's writings. Not the least praiseworthy feature of the book is the comparatively small number of extracts from the writings of his hero; the author is wise enough to recognize the fact that most reading naturalists may be supposed to be familiar with the text of the "Naturalist's Voyage," the "Origin of Species," and other Darwinian classics.

The present volume is one of the "Leaders in Science" series, published by the firm of Putnam's Sons. The author says in the preface:—

"When the publishers proposed to me the subject of the present volume, a life of Charles Darwin for American and English readers, I was particularly gratified with the suggestion that the work should be adapted to young readers as well as old. It has always seemed to me that the life of Charles Darwin was one eminently fitted to be held up as an example to the youth of all lands. He stood as the central figure in the field of natural science in this century, and while it is yet too early to present his life with any approximation of its results upon the thought of the future, it is apparent to everyone that his influence upon the intellectual growth of the country, and upon biological science in particular, has been marked and epoch-making.

"In the preparation of the work I have not attempted an analytical dissertation upon Darwin's life-work, neither have I discussed his theories or their possible effect upon the scientific world, but have simply presented the story of his life, that of one of the greatest naturalists of the age; a life of singular purity; the life of a man who, in loftiness of purpose and the accomplishment of grand results, was the centre of observation in his time; revered and honoured, yet maligned and attacked as few have been."

Having thus defined his object, the author proceeds to narrate his story, beginning with the boy Darwin, passing on to his Cambridge career, and then leading us through the scenes of his wanderings as naturalist to the *Beagle*. The major portion of the volume (twelve out of the twenty chapters) is thus pleasantly filled up; all the little personal incidents which give colour to the individuality of the man are skilfully brought in, and here and there the author interposes observations of his own which help to throw light on the questions discussed and the facts recorded by Darwin. Having in view the taste of his younger readers, a number of full-page illustrations have been introduced, some being reproduced from Spry's "Voyage of the *Challenger*," others from Gosse's "Romance of Natural History," others from Brehm's "Natural History," from Figuier's works, and from the *Century Magazine*. Many of the illustrations are new, the frontispiece, representing Darwin in his garden with the squirrels running up him, being well worthy of notice.

The working period of Darwin's life from the return of the *Beagle* to his death is dealt with in three chapters, in the course of which the author relates the history of the "Origin of Species," and the impetus given to the publication of that work by the independent discovery of the principle of natural selection by "Alfred Russel Wallace, a young Welsh naturalist, who was then travelling in the Malay country." This incident is of course familiar to all, but as an old story retold by a transatlantic admirer of Darwin it reads even now with the charm of freshness. The later works are referred to in chronological order, and in a succeeding chapter we have a catalogue of the honours conferred upon Darwin during his life. The seventeenth chapter contains an account of the Darwin family, beginning with William Darwin, of Marton, near Gainsborough, in 1500, and concluding with Erasmus, elder brother of Charles Darwin, the friend of Carlyle, who was described by the latter in his "Reminiscences," and whose amiable character was more fully portrayed by Miss Julia Wedgwood in the *Spectator* in 1881. The latter description from the pen of Miss Wedgwood is given by Mr. Holder *in extenso*.

The narrative, as such, ends with the death of Darwin in 1882, and the reader will turn with renewed interest to the eighteenth and nineteenth chapters, containing Mr. Holder's account of the Darwinian theory. The principles of this theory are fairly well expounded, considering the small amount of space which has been devoted to them. Natural selection is illustrated by a happily chosen and original example from the animal kingdom, viz. the adaptive coloration of the fauna of the Sargasso Sea. Another illustration of the principle is drawn from the vegetable world, viz. the evolution of a hairy seed adapted for aërial transport. The questions of geological time and the palæontological evidences of organic evolution are also touched upon, and here we think the author might have used more judgment. The formation of the chalk, for example, is not quite satisfactorily given, and the statement that the chalk cliffs of Dover have been elevated "by some convulsion of nature" (p. 185) will jar upon the geological susceptibilities of his readers. In a work intended for popular reading it would also have been safer to avoid any estimate of the time required for the denudation of the Weald, the more especially as Darwin himself admitted the unsoundness of such estimates by omitting this section in the later editions of the "Origin." The ancestry of the horse, and Prof. Marsh's discovery of the *Odontornithes*, are well brought in in connection with the palæontological evidence. We may point out in passing that the diagram illustrating the evolution of the horse, which fronts p. 62, is referred to both on pp. 189 and 190 as "the accompanying diagram," which is obviously an oversight.

In tracing the history of pre-Darwinian evolution, the author mentions the views of Bonnet, the doctrines of

Thales and Anaxagoras, the speculations of Leibnitz, De Maillet, Wright, Lambert, Herschel, and La Place. Of Buffon he says :—

"Buffon was the naturalist of the day in the time of Louis XV. and Louis XVI.,—a period somewhat famous for the restrictions which were placed upon men, and the denunciations with which new and advanced ideas were received. Thus advanced thinkers found that their theories in many instances, instead of leading them on to fame, but opened the doors of the Bastile.

"It is not improbable that Buffon was in accord with the feeling of the time, as while his great discursive work—'Histoire Naturelle,' of 1749-88—fully outlines the theory of evolution, in which he was a believer, it is done in an ironical, partly satirical manner, so that he could, if attacked, retreat by claiming that it was a satire on the advanced scientific thought of the time ; . . . he was ready to believe that from a single unit in the beginning might have descended all the various forms of existing animal and plant life. It is curious to note that this pioneer evolutionist suddenly corrects himself and says : 'But no ; it is certain from revelation that every species was directly created by a separate fiat.' We may suspect that this secession from a position so broadly taken was forced upon the evolutionist. Perhaps the clergy gave him close and suggestive attention, and he was offered the choice between the Bastile, the Sorbonne, and apology to offended orthodoxy. Be this as it may, Buffon was one of the early delineators of the modern theory of evolution, and despite his peculiar attitude, history accords him this recognition."

The works of Wolff, of Goethe, Geoffroy St. Hilaire Oken, Pander, Von Baer, Schleiden and Schwann, Von Mohl and Max Schultze, Lord Monboddo and Erasmus Darwin, are all referred to in due order ; and a well-bestowed paragraph of praise is given to Lamarck. Later writers, such as Robert Chambers, Von Humboldt, Owen, Asa Gray, Herbert Spencer, and Youmans, bring us down to the birth of modern Darwinism.

To English readers the last (twentieth, but erroneously headed eighteenth) chapter will be one of the most interesting. It is entitled "The Darwin Memorial," and contains a series of addresses by American men of science, delivered at a special memorial meeting of the Biological Society of Washington soon after the death of the illustrious naturalist in 1882. The address of Dr. Theodore Gill, of the Smithsonian Institution, is a masterpiece of eloquence, treating of "The Doctrine of Darwin," and contrasting the doctrines of special creation and evolution. The address by William Dall, of the United States National Museum, is equally eloquent, and treats of Darwin in the form of a biographical sketch. Dr. John Powell, the Director of the United States Geological Survey, follows with an admirable address on "Darwin's Contributions to Philosophy." We cannot refrain from transcribing some of his remarks :—

"But Darwin's investigations have not ended research or completed philosophy. He brought scientific men to the frontiers of truth, and showed them a path across the border. Yet more than this he did. He pointed out one of the fundamental methods of research. Before his time philosophers talked about deductive methods and inductive methods. Darwin has taught us that both are fruitless. . . . By inductive methods, men are to collect facts, unbiased by opinions or preconceived theories. They are to gather the facts, put them together, arrange and combine them to find higher and still higher generalizations. But there are facts and facts—facts with value, and facts without value. The indiscriminate gathering of facts leads to no important discoveries. Men might devote themselves to counting the leaves on the trees, the blades of grass in the meadows, the grains of sand on the sea-shore ; they might weigh each one and measure each one, and go on collecting such facts until libraries were filled and the minds of men buried under their weight, and no addition would be made to philosophy thereby. There must be some method of selecting, some method of determining what facts are valuable and what facts are trivial. The fool *collects* facts ; the wise man *selects* them. Amid the multiplicity of facts in the universe, how does the wise man choose for his use? The true scientific man walks not at random through the world, making notes of what he sees ; he chooses some narrow field of investigation ; . . . his investigations are always suggested by some hypothesis—some supposition of what he may discover. He may find that his hypothesis is wrong, and discover something else ; but without an hypothesis he discovers nothing. . . . Working hypotheses are the instruments with which scientific men select facts. By them, reason and imagination are conjoined, and all the powers of the mind employed in research."

The succeeding address, by Dr. C. V. Riley, gives an account of Darwin's entomological work, and comprises a graphic description of the naturalist in his home, drawn from personal reminiscences of a visit to Down. Dr. Lester Ward follows with his address on "Darwin as a Botanist," in the course of which he discusses, among other points, the bearing of Darwin's researches on the power of movement in plants on the great question wrapped up in the expression "tendency to vary." Dr. Frank Baker contributes the next address, on the expression of the emotions, and in this we again meet with a spirited advocacy of the Darwinian method :—

"But not as a fact-gatherer do we find him greatest. Many others have struggled with ant-like toil to amass piles of facts, which, like the ant-heap, remain but sand after all. Darwin brings to his work an informing spirit, the genius of scientific hypothesis. Breathed upon by this spirit, the dry bones of fact come together 'bone to his bone,' the sinews and the flesh come upon them, they become alive and stand upon their feet, 'an exceeding great army.' He searches always for the principles which underlie the facts and make them possible, realizing that the *phenomena*, the things which are seen, are temporal and transitory ; the things which are not seen, the cosmical forces which govern and control, are eternal."

A Darwinian bibliography, by Frederick W. True, the Librarian of the United States National Museum, and an appendix giving a list of Darwin's works, conclude a volume of which enough has been said to commend it to all readers, whether youthful or adult, and which we on this side of the Atlantic cannot but appreciate as a most inspiriting picture of the life and work of the man who, of all others, has helped to emblazon our country's fame on the scientific scroll of the nineteenth century.

R. MELDOLA.

PINES AND FIRS OF JAPAN.

Monographie der Abietineen des Japanischen Reiches. Bearbeitet von Dr. Heinrich Mayr. Mit 7 Colorirten Tafeln. (Munchen : M. Nieger'sche Universitäts Buchhandlung, 1890.)

FROM the time of Kaempfer and that of Thunberg to our own day, the Japanese Conifers have been the objects of special predilection on the part of botanists.

Zuccarini figured and described several that had been collected by Siebold, Lindley, Andrew Murray, Maximowicz, Franchet, and others, contributed greatly to the elucidation and delimitation of the several species. Robert Fortune, John Gould Veitch, and Charles Maries introduced many to our gardens. Horticulture has, indeed, rendered great service in this matter. The trees in question are valuable for ornamental purposes, and potentially as timber trees. The consequence of this is that collectors have accumulated specimens in large numbers and in different stages of growth. They have, moreover, supplied our nurserymen with seed, so that young plants are now numerous in our nurseries and plantations.

The study of the seedling plants, in their progress from the seed-bed towards maturity, has afforded valuable evidence concerning the morphology of the group and its probable genealogy, its filiation and classification. Cultivation has, for instance, shown that many of the very curious forms known under the name of Retinospora are, in reality, stages of growth of one, or at least of a few, species of Thuya, of Cupressus, or of Juniperus, so that the so-called genus is purely fictitious. In like manner *Abies bifida* and *Abies firma* have been proved to belong to one and the same species.

To fill up the gaps in our knowledge, and to correct errors arising from inadequate or imperfect material, it was necessary that the trees should be studied by a trained observer in the forests themselves. This was the more necessary as, to a large extent, our knowledge has been derived from plants cultivated by the Japanese and, in some cases, not a little distorted in the process. The earlier botanists had little or no opportunities of studying the native flora for themselves. Even Fortune was largely dependent on the Japanese nurserymen. John Veitch collected for himself on Fusi-yama, and Maries penetrated even to the forests of Yesso. Dr. Mayr, the latest writer on these plants, has enjoyed opportunities denied to his predecessors. After a distinguished career in Munich, Dr. Mayr proceeded to the United States, visiting the forests in all parts of the Union, and producing, as a result, a work which the best judges speak of in terms of high appreciation. Subsequently, our author visited Japan to organize the Forest Department, and fill the office of Professor of Forestry in the Imperial University of Tokio. In the execution of his duties Dr. Mayr travelled through the various provinces, and derived much information from the native foresters. One result is before us in the shape of a volume, printed in German at Tokio, and illustrated with seven coloured plates. The group specially studied by Dr. Mayr is remarkable for the relatively large number of endemic species. Thus, Dr. Mayr enumerates six species of Abies, all of which are peculiar to the Japanese islands. Five species of Picea are nearly as much restricted in geographical area. Tsuga, a genus represented in both the North-eastern and the North-western States of America, as well as in the Himalayas, has two species peculiar to Japan. The genus Larix, which also has a wide distribution in the northern hemisphere, has two species native to Japan, and not extending far beyond its limits. Six species of Pinus are enumerated by Dr. Mayr, and these also are almost exclusively Japanese, though some are found on the mainland adjoining.

The Japanese islands, then, form a centre of distribution of a group of species of a distinct character, differing markedly from a similar group of Chinese nativity, but approximating to the Californian and to the East American coniferous floras, and having representatives in other parts of Northern Asia and of Europe. The distinct character of the Japanese Coniferæ and their relationships are even more prominently brought into view when the other tribes of Conifers are considered. Dr. Mayr confines himself, however, to the Abietineæ, and we must here follow his example, in the hope that on another occasion we may be able to accompany him also through the other tribes.

In speaking of the distribution of these plants, Dr. Mayr alludes (1) to the tropical zone in which the genus Podocarpus is represented, but which does not specially concern us now; (2) to a sub-tropical zone in which are other two species of Podocarpus, as well as *Pinus Thunbergii*, which extends round the coast of all the islands, and less frequently *Pinus densiflora;* (3) a region of deciduous trees, such as chestnuts in the south or at the base of the mountains, or beeches and birches to the northward or at higher altitudes. Here grow especially the Cryptomeria, the various species of Chamæcyparis, Thuyopsis, and Sciadopitys. (4) The fourth zone, that of firs and spruces, occupies the high mountains in the centre of the island. Here are found *Abies Veitchii*, *Picea bicolor*, *P. Hondoensis*, and *Larix leptolepis*, which are peculiar to the main island, together with *A. Mariesi*, *A. sachalinensis*, *Picea ajanensis*, and *P. Glehni*, which extend northward, some even as far as the Sachalin and Kurile Islands. *Tsuga diversifolia* occurs from the region of the beech upwards to the Alpine zone. (5) The fifth, or Alpine region, also designated that of the Alpine pines, includes forms such as *Pinus pumila*, which is allied to the Swiss *P. Cembra*. We can only indicate these regions, as the discussion of their climatal features and plant population turns mainly upon plants different from those which form the staple of Dr. Mayr's present treatise.

Passing into detail, Dr. Mayr proceeds to describe each species separately, devoting much space to literary references, Japanese as well as European, and giving a description of the main peculiarities of the tree from an economic as well as from a botanical aspect.

A few new species are indicated, of the value of which we can hardly form a trustworthy opinion in the absence of authentic specimens. We venture, however, to doubt whether *Abies homolepis* is, as, however, others besides Dr. Mayr think, identical with *A. brachyphylla*. The leaf structure of the two is certainly different, and cultivation may yet reveal other differences. The names *bicolor*, *Alcockiana*, *ajanensis*, *jessoensis*, *japonica*, *microsperma*, as applied to one or more species of Picea, have been so variously understood by botanists, owing partly to accidental misplacement of labels, admixture of seeds, and to imperfect information, that it is very important to have an authoritative statement from such an observer as Dr. Mayr. If allowances be made for a large amount of variability within the conventional specific limitations, it would seem from the figure as if Dr. Mayr's *Pinus pumila* might be referred to *P. Cembra*, whilst *P. pentaphylla* is obviously a near ally of the East American *P. strobus*.

Dr. Mayr's "diagnose," however, is really a rather diffuse description in German, not conveniently adapted for the comparison of one form with another. In this absence of concise comparisons in Latin, modern botanists, especially German ones, compare unfavourably with their predecessors. On the other hand, Dr. Mayr establishes some sectional characters which may prove useful, such as the three sections into which he divides the genus Picea, viz. Morinda, Casieta, and Omorica, the last, indeed, having been already proposed by Willkomm.

Hybrid forms between *Pinus Thunbergii* and *P. densiflora* are mentioned, as well as a whole series of garden varieties which have either originated in Japanese gardens or have occurred as "sports" on the wild trees, and which have been propagated by grafting by the Japanese gardeners. These are likely to prove of scientific interest, and will be specially interesting for garden purposes.

Seven quarto coloured lithographic plates accompany the volume, giving details of the foliage and cones. We could have wished that representations of the trees themselves could have been supplied, and that an alphabetical index of species and varieties had been added to the classified table of contents. When we have so much that is valuable and interesting presented to us, it may seem ungracious to hint at deficiencies, but really in this case to ask for more shows how greatly we appreciate what we have, and is about the greatest compliment we can pay to the author. MAXWELL T. MASTERS.

ELEMENTARY HYDROSTATICS.

Solutions of Examples in Elementary Hydrostatics. By W. H. Besant, Sc.D., F.R.S., Fellow of St. John's College, Cambridge. (Cambridge: Deighton, Bell, and Co., 1891.)

THIS is a collection of solutions, or a *crib*, to the author's well-known "Elementary Hydrostatics," which has held the ground in elementary instruction unchallenged since 1863.

It was cruel, though, as Dr. Besant apologetically explains, unavoidable, to keep the world of instructors waiting so long for these much-needed solutions and explanations of the questions in his Hydrostatics.

The Solutions are stated to be almost entirely drawn up by Mr. A. W. Flux, who has found it necessary to explain that the equation $p = g\rho z$ must be interpreted as giving the pressure p in *poundals per square foot* (or in C.G.S. *barads*, might well have been added); but he has not explained that the effect of this reverential interpretation is to make ρ and w signify the same thing; so that two symbols are used to denote the same quantity, although one, ρ, is called the *density*, and the other, w, the *intrinsic weight*.

But in 1863 the word *poundal* was not known, nor was any mode of measuring force and pressure in use, except in terms of gravitation units.

It would take too long to recount the despair of the instructor and the confusion of the student at the different modes of reconciliation of the equations $p = g\rho z$ and $p = wz$, variously used as measuring the pressure at a depth of z feet.

Because thirty and more years ago it was thought convenient in dynamical equations to replace W/g by a single letter M, merely for purposes of convenience in writing and printing, it was and is still taught in our theoretical treatises that the equation $W = Mg$ is the expression of a subtle and fundamental law of Nature, to be introduced even into a treatise on Elementary Hydrostatics, presumably taken up before a student has commenced Dynamics, and before he can understand what acceleration in general, and the particular acceleration g, can mean.

What must, for instance, be the feeling of Tommy Atkins, when the Musketry Instructor begins on p. 1 of the official "Treatise on Military Small Arms," 1888, with this definition of Mass, taken in a garbled form from chapter ii. of the Hydrostatics and elsewhere.

"Mass: The *quantity of matter* in any body, the sum of all the particles of the body; it is proportional to the weight, whatever be the figure, or whether the bulk or magnitude be great or small; for the weight is equal to the mass multiplied by the force of gravity, or $W = Mg$, and the letters M and W are usually employed to denote the *mass* and *weight* respectively."

In short, this definition amounts to saying that *mass* is something we denote by the letter M, while *weight* is something we denote by the letter W; but we must always remember that $W = Mg$, where g is something unexplained, even when we measure mass in pounds and weight also in pounds; so that if g appears in one place, it will cancel again somewhere else, and not affect the ultimate numerical result.

But if, according to former instructions, we calculate the pressure from the equation $p = g\rho z$, we must notice that ρ, the density as defined in chapter ii., "Elementary Hydrostatics," is the weight in pounds of one-gth part of a cubic foot of the liquid, or $g\rho$ is the weight in pounds of one cubic foot of the liquid, so that $g\rho$ and w now measure the same quantity.

The unfortunate instructor was formerly called upon to reconcile these opposing statements, that w is sometimes the same as ρ, and sometimes as $g\rho$; now, however, he can take refuge behind the definite statements of this authorized collection of solutions.

But what is most wanted is a mathematical Censorship, to go through our hydrostatical treatises, expunging all the g's.

As to the mere mathematical geometrical part of the solutions, this is doubtless carried out with true Cambridge elegance, of which Dr. Besant is so well known an exponent; a trifle however, in comparison with the difficulty of the interpretation of the units in some extraordinary questions relating to the equations $W = sV$ and $W = g\rho V$, questions at one time considered a valuable test of clear thinking on the part of the student.

We counsel everyone who values his peace of mind to procure a copy of these Solutions, if called upon to interpret and expound the numerical results of the original "Elementary Hydrostatics."

A. G. GREENHILL.

OUR BOOK SHELF.

Plane Trigonometry for the Use of Colleges and Schools. With numerous Examples. By I. Todhunter, F.R.S. Revised by R. W. Hogg. (London: Macmillan and Co., 1891.)

TODHUNTER'S "Trigonometry" is a very familiar friend of ours, and we have now before us a bundle of letters which we received from the author in 1861 and 1862, in reply to our criticisms and corrections of the early editions. The first edition swarmed with small *errata*, for the pointing out of which we received warm thanks. It was a good book for some years, on account of the excellent collection of problems, but of late it sadly wanted bringing up to date. Mr. Hogg has done his work well, but possibly he would have produced a better independent book. The first 200 pages have undergone very little change, and we have only noted here and there an interpolated article. Chapter xviii., "Miscellaneous Propositions," contains several novelties (as contrasted with the last edition we have of the original work), such as geometrical proofs of familiar formulæ and graphs of the trigonometrical functions. There are numerous important additions in chapters xxi.-xxiv., which bring this part of the work more *en rapport* with present day requirements, notably Schlömilch's resolution of sin θ into factors, and a too brief account of hyperbolic functions. The prime feature is the addition of a very great number of excellent recent exercises in all parts of the subject. The work forms a good school-book, and will meet the requirements of a large number of students.

Lessons in Astronomy. By C. A. Young, Ph.D., LL.D. (Boston, U.S.A., and London: Ginn and Co., 1891.)

THIS is the third of a series of text-books recently prepared by Prof. Young for use in schools and colleges of different grades. The two previous ones have already been noticed in NATURE (vol. xxxix p. 386, and vol. xli. p. 485). The present work is described on the title page as "a brief introductory course without mathematics, for use in schoo's and seminaries." The three books have much in common, and each one has many good points. We cannot help feeling, however, that the steps between them are too small. Almost exactly the same ground is covered by each, and they differ chiefly in the amount of previous knowledge assumed. But the acquaintance with mathematics required for a thorough comprehension of the "General Astronomy" is by no means great, and even for the "Lessons" a certain knowledge of geometrical principles is essential. If we must needs have three books, the "General Astronomy" contains too little, and the "Lessons"—a book of some 350 pages—contains too much.

The chief variation calling for notice is in the portion dealing with uranography. This now forms chapter ii., and, with the aid of the maps, forms a fairly complete and easy guide to the constellations. The notes on the legendary mythology of the constellations, which have been added for the benefit of students not acquainted with classical literature, gives this chapter an additional interest.

The book is brought well up to date, and is a model of good printing.

Cosmical Evolution: a New Theory of the Mechanism of Nature. By Evan McLennan. (Chicago: Donohue, Henneberry, and Co., 1890.)

THE author states that the essential principle of the new theory is "that every known heavenly body is connected with its neighbouring heavenly bodies by means of real, material bonds, and that every phenomenon of the universe, without exception, is due solely to the action of bodies upon one another through, and by means of, these bonds which join them together" (p. 48).

Among the principal evidences in favour of the existence of this material planetary connection is that "we actually see them with the naked eye" in the zodiacal light and in the streamers of the solar corona.

The theory is of a very general nature, and includes not only cosmical but terrestrial phenomena, such as aërial and aqueous tides, terrestrial electricity and magnetism. The author is of opinion that "the greater tidal wave is due to the sun, and the lesser to the moon" (p. 291).

The conditions of prelunar and other races of mankind are also discussed (p. 360). The work consists of 399 pages. There is no index.

The Telescope: an Introduction to the Study of the Heavens. By J. W. Williams. (London: Swan Sonnenschein and Co., 1891.)

THE writer of this book is author of "British Fossils, and where to Seek Them," and "Land and Water Shells, &c." In his preface he quotes with approval the adage, "Ground your knowledge of any special group on a general knowledge of nature as a whole." This is perhaps why he now turns his attention from shells to astronomy. However this may be, the work has been carefully compiled, and is to be recommended as a safe guide. Some of the illustrations are excellent.

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.*]

Silver Lodes and Salt Lakes.

SINCE the discovery, some five or six years ago, of the extraordinary Broken Hill lode of silver-bearing ores, the public excitement on the subject in this part of the world has been attended with comparatively little scientific interest in regard to the geological features of the argentiferous country and the probable origin of deposits so vast and so remarkable in character; yet I believe that an examination of the main topographical and geological features of the eastern parts of South Australia and the western parts of New South Wales will probably throw more light upon the interesting subject of the origin of argentiferous lodes than the study of any other now known part of the globe; and, as I have had an opportunity of going closely into the matter during a recent visit to Broken Hill, I propose to lay briefly before your readers a few facts which seem to afford presumptive evidence in favour of the supposition that salt lakes and silver lodes are causally connected.

An examination of the ores *in situ* at Broken Hill, and especially in the portions of the lode which are known as blocks 10 and 11, reveals the fact that stratification almost exactly similar to that of an ordinary alluvial deposit is practically universal throughout the lode. So obvious has this been from the very beginning of the working, that almost every mining man who has had anything to do with Broken Hill has remarked upon the very obvious fact that the ores are to be ascribed to an aqueous origin. The fissure in which the lode occurs varies from a few feet to seventy or eighty yards in width, and has almost vertical walls. Within these boundaries the stratified deposits of carbonates and chlorides are intermingled with immense bodies of kaolin and sulphides, with a considerable amount of an interesting silicate of zinc also carrying silver and lead. The Barrier District is one of the driest in the whole of this very dry continent, and there is no river within about seventy or eighty miles. The few intermittent watercourses which exist in the locality do not suggest anything but a dry and arid climate. In fact, the greatest difficulty now met by the mines and by the town of Broken Hill, which contains about 27,000 inhabitants, is the scarcity of water, and the doubtful nature of any catching grounds that have been suggested. If, therefore, water was the agency by which the deposits of ore took place, it is evident that the conditions at the time must have been very different from what they are at present.

The key to the whole situation seems to lie in the fact, which has been so well pointed out by Mr. Alfred Russel Wallace and others, that the whole of the regions of Central Australia have emerged from the ocean at a period which, from a geological point of view, is comparatively recent. The axial lines of the watershed ranges appear to be rising at a more rapid rate than the neighbouring plains, and consequently some strange and interesting changes are taking place in the relations of the catchment areas of flood waters and their outlets. In the locality of Innamincka, almost due north from Broken Hill, there occurs a phenomenon which is obviously due to some such change of relations. The Strezlecki Creek runs to the south-west from Innamincka. Its bed holds immense deposits of drift-sand, and in the adjoining plains are to be seen many curious parallel ridges of sand-hills, all strongly suggestive of the action of drift water, such as at times passes across the surface of these vast interior plains at flood time. The Strezlecki Creek was apparently the outlet for most if not all of the water of Cooper's Creek at some period of time not at all remote. But at the present day it is only once in every four or five years that the stream runs at all. When a very high flood fills the bed of the Cooper to overflowing, the waters find their way over the low ridge of land which separates the present bed of the Cooper from that of the Strezlecki, and so on to Lakes Blanche and Gregory—those large salt evaporation pans which can scarcely with propriety be dignified with the name of lakes. The gradual elevation of the low ridge would appear to be the most probable explanation of this interesting phenomenon. Now, to the south of Broken Hill, and in the vicinity of the River Darling, there is to be found ample evidence of a somewhat similar occurrence. Vast accumulations of sand in parallel ridges are still to be seen crossing the plains, and a large river bed extends, from a place quite close to the junction of the Darling and Murray, northwards in the direction of Broken Hill. Whether this "Anabranch," as it is called, is really an old bed of the River Darling or not, I will not stay to inquire. It would, however, appear practically certain that some slight alteration in the level of the land has been responsible for the change in the direction of the flow of water.

The case is not an ordinary one of the diversion of a river owing to the accumulation of its own alluvium; and the sand ridges, which in places extend right down to the bed of the present river, suggest the action of water on a scale of magnitude very different from that which is at present to be seen. Here, then, we have both to the north and to the south of Broken Hill evidences of the existence in former times of floods of water, which at the present day are never at all to be seen on the southern side, and only once in every four or five years on the northern side. It is to be observed that both of these localities are within the line of country formed by the parallel mountain systems of the Flinders Range on one side and the Grey and Barrier Ranges on the other side. Between these two ridges the land slopes gradually to the west, and three salt lakes, of which the largest is Lake Frome, attest the fact that in all probability at one time vast quantities of sea-water were imprisoned by the rising of the land from the level of the ocean. But in South Australia these two ridges are joined by a band of high land, on which the present railway to Broken Hill has been laid. This band of country forms, along with the ranges at each side, a sort of *cul de sac*, from which at present the waters could have no escape to the southwards unless they rose to a higher level than is ever noticeable under existing conditions.

But this has not been the case in times gone by. The evidences of the action of water in the neighbourhood of the "Anabranch" make it to appear practically certain that at one time the flood waters, which swept through the salt lakes, must have poured over the ridge towards the River Darling, and found an outlet by that means. This, then, brings me to the most significant fact to which I wish to direct attention. The locality of Broken Hill is the lowest point in the axis of the line of country which forms what I have alluded to as the *cul de sac*. In the absence of any survey from which full data could be deduced, it is sufficient to take the levels of all the railway stations from the Flinders Range to Tarrawingie—a point forty-two miles north-east of Broken Hill. These show that the railway (which happens to follow the line of the ridge) dips gradually to Broken Hill, and then rises again towards Tarrawingie. The conclusion is therefore inevitable, from the data to which I have already referred, that Broken Hill is the locality at which the accumulations of flood-water from the great region of the salt lakes must have found their way across the connecting ridge and on towards the River Darling. I believe, if the localities of the silver lodes of Potosi and Comstock are examined, they will be found to bear somewhat the same relation to the extensive salt marshes south of Lake Titicaca, and to the salt, mud, and alkaline lakes respectively, that Broken Hill does to Lakes Frome, Blanche, and Gregory; but, in the case of the last-named, the time at which the action took place is apparently much more recent, and the evidences which it has left are, therefore, all the more evident. It is a significant fact that the whole of the horseshoe-shaped line of country, of which, as I have said, Broken Hill is the lowest point, is highly mineralized, and contains mines for gold, silver, copper, and lead; but of all these mines, the Broken Hill lode is really an epitome, containing, as it does, nearly every metal which is known to the practical miner, and some also of those which are more of scientific than of practical interest. In view of the existence, among other things, of large lateral shoots from this gigantic lode containing the largest specimens of native silver yet discovered in any part of the globe, it seems difficult to account for some of the phenomena present at Broken Hill without premising the agency of electro-deposition. Several of the arguments which were adduced by me in NATURE of March 20, 1890, in regard to the occurrence of gold, would appear to furnish equally strong presumptive evidence that earth-currents acting along the axis of the range have had something to do with the deposition of metals from their solutions during their passage across the ridge. My present purpose, however, goes no further than to call attention to the probable origin of the lode, which I believe is to be found in the minerals held in solution in the waters of some of the vast Australian lakes and evaporation pans. GEORGE SUTHERLAND.

Adelaide, South Australia.

A Magnificent Meteor.

AT 1.15 a.m., on July 31, I observed a most magnificent meteor—a veritable Andromedes. It was much larger than Jupiter, which was on my right, in the constellation Pisces, shining to the best advantage on a dark blue sky. After the retina of my eye got clear of the dazzling light of the meteor, I turned to Jupiter, which was in a favourable condition for comparison, the clouds being opportunely absent, but it looked at least three times smaller than the meteor, which, indeed, was entitled to be called a fire-ball. It illuminated the whole district with the brilliancy of the noonday sun. I traced it back through Mira Ceti, and to the right of Mesartum Arietis, into the direction of λ Andromedæ. This magnificent meteor exploded near the earth, without any detonation. The light was perfectly white. There was a very peculiar feature in the apparition of this meteor: it appeared to be very near to me, and between its body and the horizon behind it there seemed to be a vast distance. In its explosion it assumed very large dimensions, and the effulgence lasted for three seconds with undiminished splendour. In reality there were two explosions. The trail of light was dim, except immediately behind, where it was thick and bright, but of short duration.

On the night of July 31, and on the morning of August 1, there was a brilliant display of stars for this time of the year; the Milky Way was well defined from horizon to horizon, denoting a certain degree of frost. At present, Jupiter is the most conspicuous and most brilliant ornament in the nocturnal heavens; here in Scotland its glory is enhanced by the somewhat frosty nights which occasionally visit us about this season. DONALD CAMERON.

Paisley, August 3.

Bees and Honey-dew.

NEAR here is an avenue of alternate beech and oak trees, and, in walking through it, my attention has lately been drawn to a loud humming in the beeches, similar to that heard in lime trees when in flower, while the oaks are silent. The sound is, I find, produced from bees in search of the Aphis secretions on the leaves of the beeches, the under sides of which are sticky with the substance. The bees appear to be all of one type—a small size of the large humble-bee—with a white tail. They never settle on the under sides of the leaves direct, but just on the margins, and then creep underneath, when, after running about and exhausting the supply, they fly off to another leaf, exactly as if they were visiting flowers. The leaves of the oaks are clean, and have no "honey-dew" on them. F. M. BURTON.

Highfield, Gainsborough, August 5.

Dredging Products.

AMONGST the products of the dredgings which my friend the Rev. J. H. Crawford and I are procuring from the Voe here, I am glad to be able to record the presence of Actinotrocha. We only got two or three specimens at first, but to-day a large number was procured from the surface net. One or two have attained to the Phoronis condition since being brought in. They answer in all respects to *Actinotrocha branchiata*, but seem to be as a rule less pigmented than the specimen found in St. Andrews Bay.

Actinotrocha branchiata has now been found on both sides of Scotland and England, and also at Heligoland; but, besides being got in the North Sea and on the west coast of Britain (*vide* NATURE, vol. xxxiv.), it seems also to be found on the western side of the Atlantic, for Wilson records it from Chesapeake Bay. It is thus distinctly a northern form, but has a wider distribution than has hitherto been supposed.

ALEXR. MEEK.

Sullom, Northmavine, Shetland, August 4.

THE INTERNATIONAL CONGRESS OF HYGIENE AND DEMOGRAPHY.

NEVER before, perhaps, in the history of science has there been assembled together such a numerous gathering of eminent men of science of different nationalities, or representing so many countries, for the purpose of discussing scientific problems.

Although it is little to the national credit that the importance of international Conferences on Health was suggested by the Belgians and not by ourselves, the conditions we are under here must not be forgotten. All other civilized countries have strongly represented among their Ministers, and among administrators, men of knowledge and competence; and elsewhere such Congresses are treated as of national concern.

Here, even in the matter of health, such powerful and economical methods of obtaining and distributing knowledge, such as Congresses like the present afford, are absolutely ignored by the party politicians to whom we commit our national welfare.

There can be little doubt that most of the good which is certain to arise from the deliberations now going on must be ascribed to the Queen and Prince of Wales, who came forward as Patron and President of a Congress ignored, as we have said, by our party rulers. This has been pointed out by the *St. James's Gazette*:—"The Prince of Wales has rendered a not inconsiderable service to his country by good-naturedly pulling the Congress out of the fire, and rendering a partial success of what came near to being a sad *fiasco*. But for his complaisance in sacrificing his holiday in coming up to London to take the chair, no public personage would have been present to welcome the two or three thousand guests bidden to the metropolis, or to give attraction and dignity to the opening meeting. . . . There are three Ministers whose departments have relation to the subjects treated by the Congress: Mr. Ritchie, who is our *quasi* Minister of public health and relief; Mr. Chaplin, whose department deals with the hygiene and prevention of disease of animals; and Lord Cranbrook, who controls medical education. Not one of these Ministers was present yesterday. Not even the Registrar-General, the head of the department of vital statistics, or a representative of the Home Secretary, took part in yesterday's meeting. The Prince, however, saved the position."

The devoted and unpaid labours of many eminent men have, however, with this slight touch of national feeling in high quarters, already rendered the success of the Congress unparalleled, and it is really wonderful to see what they have done, in spite of the enormous difficulty of arranging for a large number of people in such a city as London. Even the facilities afforded by Burlington House and the University of London buildings do not include a hall large enough for an adequate reception room; at first, therefore, there were difficulties, largely owing to its absence. This will hardly be wondered at, when we state that the numbers enrolled already are about 3000, and that there are 40 delegates from the German Empire and 70 from India, only to give two instances.

In anticipation of the meeting, among other official documents too numerous to mention, was prepared a Hand-book to London, with special reference to the needs of the members. This is a volume of 250 pages, in French and English, with eight plates showing the position of hospitals, cemeteries, markets, and the like. This has been published by Messrs. Cassell. There is another volume of 233 pages, containing abstracts of the more important papers to be read. Nor have the English Committee been the only workers. We have "Denmark: its Medical Organization, Hygiene, and Demography," with numerous illustrations and maps, published in English by authority of the Danish Government in time for the International Congress. This has been published by Messrs. Churchill.

In spite of the abstentation of any notice on behalf of the Government, it is pleasant to note the way in which the Lord Mayor and the Corporation, the Royal Colleges of Physicians and Surgeons, and numerous other public bodies and private individuals have kept up the credit of the nation for hospitality. Among the *conversazioni* must be specially mentioned that at the Guildhall on Tuesday evening, when the Lord Mayor received the members of the Congress. It was a brilliant and impressive sight, enhanced by the uniforms of foreign officers, and the unfamiliar garbs of members of our own distant dependencies. The various social arrangements made by the organizing committee are recorded in a special pamphlet of fourteen pages.

The proceedings began on Monday by a meeting in St. James's Hall, presided over by the Prince of Wales. Sir Douglas Galton first presented the Report of the Permanent International Committee, and *inter alia* gave the following account of the general organization:—

"The work of the Congress has been arranged in two divisions, viz. hygiene and demography, and it has been found necessary to divide the former into nine sections, each under a separate president, and with separate organization. Committees have been organized in foreign countries to further the interests of the Congress in a more direct manner than could be done from England. Delegates have been appointed by all the Governments of Europe, and also by the United States, Mexico, Venezuela, Japan, Persia, Egypt, by the provinces and native states of the Empire of India, by the most important colonies, and also by numerous municipal authorities, universities, scientific and medical societies, and other institutions throughout the world, and large numbers of the most important authorities on the subjects to be treated of have sent communications to be laid before the Congress."

After the reading of this Report, the Prince of Wales opened the proceedings by a careful and sympathetic address. One part of it referred to the dangers to health inevitable to the conditions under which we live. He remarked in relation to these dangers:—

"It will be no trivial work if their sources and probable remedies can be clearly pointed out, and especially if this can be done, as in a Congress such as this it should be, in a strictly scientific manner, calmly and dispassionately, without any reference to either general or municipal politics, or for any other purpose than the promotion of health. It is only on conviction such as may thus be produced that the appointed sanitary authorities can compel the changes necessary to be made; for such changes are almost always inconvenient or injurious to some, and might even seem unjust to them, unless it be made quite clear that they would be very beneficial to the community. But my hope is that the work of this Congress may not be limited to the influence which it may exercise on sanitary authorities. It will have a still better influence if it will teach all people in all classes of society how much everyone may do for the improvement of the sanitary conditions among which he has to live. I say distinctly 'all classes,' for although the heaviest penalties of insanitary arrangements fall on the poor, who are themselves least able to prevent or bear them, yet no class is free from their dangers or sufficiently careful to avert them. Where could one find a family which has not in some of its members suffered from typhoid fever or diphtheria, or others of those illnesses which are especially called 'preventable diseases'? Where is there a family in which it might not be asked, 'If preventable, why not prevented?' I would add that the questions before the Congress, and in which all should take a personal interest, do not relate only to the prevention of death or of serious diseases, but to the maintenance of the conditions in which the greatest working power may be sustained."

The *Times*, in a leading article on the Prince's address, points out one very important practical matter in which we lag far behind many foreign countries, and which may serve as an excellent illustration of the Prince's words about inconvenience or apparent injustice to individuals. "The weak point of English sanitary law is in respect of regulations for the slaughter of animals. In London, for example, slaughterhouses are small private establishments, often situate up little alleys or courts, surrounded by dwelling-houses, and not only destitute of many conveniences which they should possess, but also affording great facilities for the slaughter of diseased animals, and for the distribution of their flesh as food. In many Continental cities public *abattoirs* have been established upon a large scale, and all private slaughtering is forbidden. At these *abattoirs* there is an abundance of space, of air, of light; there is an excellent water supply; and the slaughtering is conducted under the supervision of officials, governed by rules which not only protect cattle against unnecessary cruelty or ill-usage, but which provide for the systematic inspection of meat before it is permitted to be sold. We shall certainly hear a good deal, during the sitting of the Congress, as to the importance of preventing the consumption of the flesh of tuberculous animals; but this, however important it may be, can never be done while the innumerable small private slaughterhouses are suffered to remain."

At the conclusion of the Prince's address, speeches were delivered by representatives of France, Italy, Austria-Hungary, Saxony, and Prussia. It is pleasing to record that all bore high tribute to the part which has been played by England in the promotion of measures calculated to preserve and improve the public health. On this point, Dr. Brouardel (France) was indeed specially emphatic:—

"In the year 1837, the year of the coronation of Her Gracious Majesty, appeared the Act which rendered obligatory the registration of deaths. This Act inaugurated the era of administrative reforms concerning the public health which our valued colleague of the Local Government Board has rightly called 'the Victorian era.' This Act did not long remain alone. Under the impulse given by two of your most illustrious patriots, William Farr and Edwin Chadwick, you have organized a system of registration of the causes of diseases and of deaths. Certain important cities, before the law made it obligatory, obtained supplies of water beyond all suspicion of pollution, and adopted systems of removal of foul water and waste matters. In these cities, whose action cannot be too much praised, the sickness and death rates diminished rapidly; this furnished the necessary proof it was time for reform. Twenty years ago the Local Government Board was established, and in 1875 had submitted to Parliament a Bill for the protection of the public health. During its discussion in Parliament one of your greatest Ministers (Disraeli) pronounced in the House of Commons these memorable words, which should be repeated in all countries and in all Parliaments: 'The public health is the foundation on which repose the happiness of the people and the power of a country. The care of the public health is the first duty of a statesman.' Since this, each year you have made fresh improvements in your sanitary laws; if in your eyes they are not perfect, in the eyes of the nations who surround you they are an ideal towards which all their most ardent aspirations tend. It is your example they invoke when they claim from the public authorities the powers necessary to oppose epidemics, to combat the scourges which decimate their populations. You have taken the first rank in the art for formulating laws for the protection of health; this is not all that you have done in the domain of hygiene. Among the diseases which one can properly term pestilential, there are, thanks to the work of the hygienists of all countries, certain ones which from the present time may be considered as preventable: such are small-pox, typhoid fever, dysentery, and cholera. For one of these, the most terrible, the immunity conferred by vaccination is absolute. The person upon whom this immunity is conferred can pass through the most severe epidemics, and expose himself to all sources of contagion without being affected. Who is it who thus preserves from death, from blindness, from infirmity, millions of human beings of all countries and of all races? On May 18, 1796, a date which might well be the date of a great battle, Jenner inoculated with vaccine matter by means of two superficial incisions, the youth James Phipps. Protection against small-pox belongs to you; the world will be to you for ever obliged. Let us consider two other epidemic diseases. Is it possible to establish the conditions of propagation of typhoid fever without quoting the names of Budd or of Murchison? I am aware that in 1855 Dr. Michel de Chaumont had for the town in which he lived experimentally established the *rôle* played by drinking-water in the propagation of this disease. Unhappily, public opinion was not prepared, and his discovery was not listened to. In the work which we are considering, the efforts of the English school were most fruitful. May I recall the fact that it was the epidemic of cholera in 1866 in England, which gave birth to the theory of its propagation by drinking-water? Was it not at that date that, under the influence of your hygienists, the Lords of the Privy Council issued an order formulating the laws of prevention which we adopt to-day? Certain it is that even in England these discoveries have not immediately borne all their fruit. The anti-vaccination leagues are not yet dead. Proofs accumulated during a century have not sufficed to cure that mental blindness which is congenial. . . . Can France be represented in a Congress of Hygiene without recalling the name of M. Pasteur? For centuries we have asserted that epidemic diseases were propagated by means of contact, by the air, by the effluvia, by miasmata. The idea of morbific germs, if not the name, is even found in the works of Hippocrates, but in what an uncertain sense. The theory of contagion has passed from century to century with strange modifications; the uncertainty of the methods of research and the difficulties of observation bound up together truth and error. It remained for Pasteur to prove the existence of these germs, their form, their life, their mode of action, and by their attenuation to solve the problem of immunity. Thanks to his work, and thanks to those of his pupils, realities have succeeded to contingent possibilities. We know some of our enemies, their habits, and their mode of penetrating the body; up to this time man was conquered by these infinitesimal beings, but, thanks to recent discoveries, he will be their conqueror. When, at the beginning of a century, one can inscribe the name of Jenner, and at its end that of Pasteur, the human race may rejoice. More has been done for it against misery, disease, and death than in any one of the centuries which have preceded it. You, gentlemen, you have been the initiators; this title will never be disputed with you. When a great people has given such an example; when, by her gracious patronage, Her Majesty the Queen, and when, by his presence, His Royal Highness the Prince of Wales, testify that for them this era of reforms is not closed, it is only right that those who try to imitate them, and to give their country similar institutions, should come to bring to that people, and to their Sovereign, the homage of their profound respect."

Dr. Van Coler, the Medical Director-General of the Prussian Army, the representative of the German Government, followed suit, and showed the aid rendered to armies by the improvements in sanitary science. We give the following short extracts from his speech:—

"It is indeed with a feeling of joyous pride that from this place and in this country, where we have to trace the very cradle of all modern science of public health, I am permitted to point out how the many efforts made in the direction of hygiene radiating from England were, especially in Germany, hailed with much delight; where they received the most careful attention, and where they ever since have been most actively promoted. . . . If from our army, diseases like malaria, small-pox, dysentery, have completely, or almost completely, disappeared; if typhus fever and diphtheria become more and more diseases of the past, we have to be thankful for these attainments to the development and application of hygiene. . . . It is now an established fact that infectious diseases are by no means a necessary evil in the army. They are simply diseases which can be avoided, which can be powerfully opposed, and against which the science of our days battles victoriously with ever-increasing success."

Dr. Körösi's address will be welcome to many, as he exactly defined demography—which is a puzzle to many outsiders—and pointed out the early work done by members of the Royal Society:—

"This branch of science, the very nucleus of statistical work, which, in fact, is quite a science in its own right, has chosen the task to investigate the laws which regulate the life, increase, and decrease of nations. Its work, therefore, comprises three main parts: statistics of natality, of mortality (this part including biometry, the science of measuring the duration of human life), and of the increase of population. And when inquiring now who were the founders of this new science, we shall hear unanimously quoted the names of England's sons—Graunt, Petty, Halley, Malthus. Gentlemen, to-morrow, when we are to begin our work, we shall meet within the venerable hall of the Royal Society. The representatives of demography must feel a deep emotion when entering those rooms, which are so intimately connected with the history of their science, for this is the place where, 220 years ago, demography was created. It was in those halls, in their very first youth then, but soon conspicuous to the whole world by the genius of Newton, that appeared the work of Graunt which forms the starting-point of demography; and here the King himself, admirably appreciating the work done, recommended the author to be received as a member of the learned Society. It was there that shortly afterwards Sir William Petty, by his eminent power, raised the new science to political importance and to popularity, and in the same place, again, in 1693, the famous Halley became the founder of the most important part of demography, of biometry, by working out the first table of mortality. And now the young science, which two centuries ago left those halls shy and even without a name, has found its way over the whole globe. Having been worked out in Germany, having received a name and new ideas in France, and having been enlarged and imbued with a more scientific character by Quetelet, having got its well-equipped office in every country of the civilized world, we are proud to see now its numerous representatives meet at the same place where two centuries ago this science was born. After a triumphant career of 220 years, it returns to its home, to the old rooms in which it awoke to light, and again the Throne of England receives it with favour and benevolent interest. For demography not less than for all statistical work, it is of the highest importance that its representatives, scattered as they are over the whole globe, should fully understand each other, for only so we can accomplish our aim, that our observations comprise equally all countries of the world, that our researches are conducted and worked out on the same principles everywhere, and that we may unite the incomplete and often discrepant descriptions of the single nations to a full descriptive history of the whole of civilized mankind. This great aim fully deserves the praise the illustrious Prince Consort bestowed upon it from this very place thirty years ago. He said, 'The importance of the Congresses cannot be over-rated; they not only awaken public attention to the value of these pursuits, bring together men of all countries who devote their lives to them, and who are thus enabled to exchange their thoughts and varied experiences, but they pave the way to an agreement among different Governments and nations to follow up these common inquiries in a common spirit by a common method and for a common end.'"

The meeting was subsequently addressed by Sir James Paget, Dr. G. Buchanan (of the Local Government Board), and others.

The Sectional work of the Congress began on Tuesday. The Divisions and Sections are as follow:—

Division I.—Section 1. Preventive Medicine. President, Sir Joseph Fayrer, K.C.S.I.—Section 2. Bacteriology. President, Sir Joseph Lister, Bart.—Section 3. The Relation of the Diseases of Animals to those of Man.—Section 4. Infancy, Childhood, and School Life.—Section 5. Chemistry and Physics in Relation to Hygiene. President, Sir Henry Roscoe, M.P.—Section 6. Architecture in Relation to Hygiene. President, Sir Arthur W. Blomfield, A.R.A.—Section 7. Engineering in Relation to Hygiene. President, Sir John Coode, K.C.M.G.—Section 8. Naval and Military Hygiene. President, Lord Wantage, K.C.B., V.C.—Section 9. State Hygiene. President, Lord Basing.

Division II.—Demography. President, Mr. Francis Galton.

We shall endeavour next week to give an idea of the results of the many important discussions which may be anticipated, but it is already clear that it will be impossible for us to give anything like a full report, for the programme of work to be gone through is enormous. The addresses of the various presidents on the opening day were in themselves important communications, and well fitted to give tone to the subsequent discussions.

PROGRAMME OF TECHNOLOGICAL EXAMINATIONS.

A SIGN of the general advance in technical education is shown in the new Programme of Technological Examinations just published by the City and Guilds of London Institute. The Programme contains 37 pages of additional matter, and the number of different subjects of examination has now reached sixty. The Council appear to be genuinely desirous of adapting the examinations to the conditions of the more important trades as practised in the principal centres of industry. To this end, many of the sixty subjects are divided into different sections, corresponding to the separate branches of the same trade, or to the practice of the trade in separate localities.

In the new Programme we notice many important additions. A practical test, which is the surest preventive of cram, and excludes those who are not engaged in the trade from presenting themselves for examination, has been added to the syllabus of nearly all the subjects. Thus, next year, for the first time, there will be practical examinations in such widely different subjects as photography and boot and shoe manufacture. In many subjects dealing largely with the practical applications of science the syllabus has been entirely re-written. This is the case with "Electrical Engineering," which is now divided into two main subjects—"Telegraphy" and "The Transmission of Power"—the former being again subdivided, in the honours grade, into "Telegraphy" and "Telephony," and the latter into "Electrical Instruments," "Electric Lighting," and "Dynamos, Motors, &c." The subject of "Mechanical Engineering" is similarly divided into different sections. The Programme has been increased by the addition of a syllabus of instruction in "Goldsmiths' Work," in which subject a large class has been already established in Birmingham, and of a syllabus in "Ship Carpentry and Joinery," which is intended to meet the requirements of artisans engaged in the different shipbuilding yards throughout the country.

The continuous increase in the number of candidates for these examinations, and in the number of students receiving instruction in the different centres throughout the country, shows that there is a genuine demand among artisans for practical and concrete instruction dealing, in the first place, with the facts with which they are familiar in their every-day work, and, afterwards, with the scientific principles explanatory of those facts. From the table found on p. 17 of the Programme, it appears that this year 7322 candidates presented themselves, as against 6667 in the previous year, and that the number of students under instruction increased from 12,022 to 13,202.

The memorandum issued to County Councils, to which we have already referred in these columns, is re-published in the Programme. It draws the attention of County and Borough Councils to the fact that, after the examination in May 1892, the grants hitherto paid on the results of the examination will be withdrawn, and that a substantial portion of the funds thus set free will be devoted to the improvement of the machinery of the examinations. Indications of the direction in which these improvements will be made will be found in the new Programme. It is important that the managers of technical classes should fully understand that, in future, the maintenance of such classes will depend entirely on local support. The large sums placed at the disposal of County Councils clearly render it no longer necessary that the City Guilds Institute should continue to make grants on results, which, although amounting in the aggregate to a large sum of money, proved to be quite inadequate to properly support the classes. It is, however, to be feared that the grant-earning tendency of the teachers and managers of local schools may cause the distinctly technological subjects of instruction to be neglected for the sake of science subjects by which grants may still be obtained from South Kensington. To prevent this, it is necessary that County Councils should realize the full importance of the work which Parliament has thrown upon them, and should recognize that in future they will be the authorities responsible for the conduct of the technical and, indeed, the secondary education also of the county. In the competition for money grants, technical subjects will be placed at a distinct disadvantage as compared with ordinary science subjects, and it is the more necessary, therefore, that the teaching of these subjects should receive adequate support from local authorities.

In order that the teaching in different localities may be duly adapted to the trades practised in those localities, and may be regulated by these requirements, and not by the grant-earning capacity of the subjects of instruction, it is very desirable that County Councils should organize, independently, or in connection with the City Guilds Institute, a system of inspection of local classes. The value of examinations is immeasurably increased when they are supplemented by inspection by competent experts, and it is to be hoped that some system of inspection of technical schools, which shall include the methods of instruction adopted, will soon be organized.

The Institute's Programme offers to different localities a wide choice of trade subjects, ranging from simple handicrafts to industries involving some of the most difficult applications of physical and chemical science. To the syllabus of each subject is added a valuable list of works of reference, which forms by itself a very complete guide to books in technology. The list of examiners, many of whom have this year been newly appointed, includes well-known experts in each branch of trade, and is a guarantee of the efficiency of the examinations. The future development of technical education is now very largely under the control of County Councils. They possess the funds without which no real progress can be made. But, besides funds, experience and organization are needed, and there can be no doubt that the members of County and Borough Councils will derive much valuable information, and many serviceable suggestions, from the new edition of the City Guilds Institute's Programme of Technological Examinations.

BOTANICAL SURVEY OF INDIA.

THE organization of a Botanical Survey of India, which has been under consideration since 1885, has been finally settled by the following resolution of the Government of India, dated Calcutta, February 26, 1891:—

(1) The scheme for carrying out the botanical survey of India, which has been under consideration for some time, was finally completed a year ago, and His Excellency the Governor-General in Council considers that it is now desirable to publish the details for the general information of local Governments and Administrations.

(2) In February 1885, Mr. Thiselton Dyer, Director of the Royal Gardens at Kew, prepared for the Government of Madras a Memorandum on the constitution of a Botanical Department for the Madras Presidency, one result of which was the eventual establishment of a Botanical Department for that Presidency. In sanctioning the Madras Department, the Secretary of State for India took the opportunity to suggest for the consideration of the Government of India whether, without interfering with the control exercised by the Provincial Governments, it would not be possible to bring into communication the various Botanical Departments of the different Provinces, the desirability of such an association having been prominently noticed by Mr. Thiselton Dyer in his Memorandum of February 1885. The wider scheme thus suggested by the Secretary of State was accordingly considered; and the first step taken for the organization of a Botanical Survey for all India, which was to have its centre in the Royal Botanical Gardens at Seebpur, Calcutta, was the transfer from the control of the Government of the North-Western Provinces and Oudh, to that of the Government of India, of the Superintendent of the Botanical Gardens at Saharanpur. This measure was demanded by the need for botanical survey in the Punjab, Rajputana, Central India, and the Central Provinces, which had hitherto been unrepresented by any

botanical officer, as well as by the necessity for having a botanical officer at the disposal of the Government of India to accompany military expeditions beyond the frontier.

Arrangements were then made, with the concurrence of the local Governments concerned, under which the following territorial division of India was prescribed for the purposes of botanical survey :—

Under the Superintendent, Royal Botanical Gardens, Calcutta.—The Provinces of Bengal, Assam, and Burma, the Andamans and Nicobars, North-East Frontier Expeditions.

Under the Government Botanist, Madras.—The Presidency of Madras, the State of Hyderabad, the State of Mysore.

Under the Principal, College of Science, Poona.—The Presidency of Bombay, including Sind.

Under the Director, Botanical Department, Northern India.—The North-Western Provinces and Oudh, the Punjab, the Central Provinces, Central India, Rajputana, North-West Frontier Expeditions.

The distribution above stated was reported to Her Majesty's Secretary of State, and his Lordship has been pleased to express his satisfaction with these arrangements.

(3) The Government of India now desire to communicate the following observations as to the central position which, in conformity with the suggestions of the Director of the Royal Botanical Gardens at Kew, the officer at Seebpur will occupy in the scheme for the botanical survey of India, and as to the sphere and nature of duties of each botanical officer, so far as they are connected with botanical survey.

It is desirable that the Seebpur Institution—which, as remarked by Mr. Thiselton Dyer, "though technically Provincial, must, at any rate in external estimation, from its age (it has passed its centenary), from its scientific traditions, and from the splendour of its maintenance, rank as Imperial"—should, without any interference with the Provincial control over the Royal Botanical Gardens, be officially recognized as the acknowledged centre of the Botanical Survey of India, and that to it should be referred the solution of all problems rising out of the practical or scientific study of Indian botany. In view of the important position which the Superintendent of the Royal Botanical Gardens, Calcutta, will thus occupy as the central authority in the Botanical Survey of India, the Government of India have, with the concurrence of the Secretary of State, added to Dr. King's present designation the official title of "Director of the Botanical Survey of India," and it is requested that in all correspondence dealing with subjects relating to general botanical exploration the latter title should be employed. The more effective botanical survey of Burma and Assam has also been intrusted to the Director, who will arrange a definite programme each year for the purpose in communication with the Chief Commissioners of those Provinces. He will also submit a separate Annual Report on the botanical exploration and researches effected during the year. The Government of India record with satisfaction that the local Administrations of Burma and Assam have each contributed an annual grant from Provincial revenues as an addition to the Imperial grant for the botanical survey of their provinces.

The investigation of the flora of the Madras Presidency and of the Hyderabad and Mysore States has been intrusted to Mr. M. A. Lawson, the Government Botanist and Director of Cinchona Plantations, who has expressed his opinion that the whole survey of the territories in question might, if diligently prosecuted, be completed in three or four years.

In Bombay, a scheme involving an annual expenditure of Rs. 4500 per annum on botanical work has been sanctioned, and Dr. Cooke, Principal of the College of Science, Poona, is officially recognized as in charge of botanical research in that Presidency. A herbarium exists at the College of Science, and a botanical collection is in course of formation at the Victoria Gardens, Bombay. The former place is to be the head-quarters of botanical research and collections, and the existing herbarium there is to be developed.

By the transfer of the services of the Superintendent of the Government Botanical Gardens, Saharanpur—who now bears the designation of Director of the Botanical Department, Northern India—the services of this officer are, as already explained, available for scientific investigation in all Provinces and States in Northern and Central India, as well as on expeditions beyond the north-west frontier. Mr. Duthie, the officer now holding the appointment, was thus in 1888, by his deputation to accompany the Black Mountain Expedition, enabled to acquire information concerning the flora of a country which had not hitherto been botanically explored. During the last three years, Mr. Duthie has also been deputed to Simla in the hot weather to assist in the preparation of the "Dictionary of the Economic Products of India," and during the same period he has been engaged in the botanical exploration of Rajputana and of the Central Provinces.

M. FAYE'S THEORY OF CYCLONES.

IN his admirable work on "The Principles of Science," the late Prof. Jevons thus sums up the characteristic mental attributes of the great scientific discoverer :—

"He must be fertile in theories and hypotheses, and yet full of facts and precise results of experience. He must entertain the feeblest analogies and the merest guesses at truth, and yet he must hold them as worthless till they are verified in experiment. Where there are any grounds of probability, he must hold tenaciously to an old opinion, and yet he must be prepared at any moment to relinquish it when a single clearly contradictory fact is encountered."

In his theory of cyclones, M. Faye has abundantly proved himself to possess those attributes that are defined in the first phrase of each of these sentences, and particularly the final one. Whether, however, in his treatment of this subject, the manifestation of the remaining and qualifying attributes is equally recognizable; whether he has fairly grasped and duly weighed all the established facts that are relevant and even essential to his hypothesis; and whether, among those that he has overlooked, there are not some that are "clearly contradictory" to the requirements of his theory, and therefore fatal to it—these are the questions that I propose to inquire into in the present article.

A true theory of cyclonic storms has not merely a scientific interest, it has also practical bearings of very high importance. When a ship is involved in the outer circle of a tropical cyclone, the vital problem which the seaman has to solve is, how to escape the fearful squalls of the inner vortex and the tremendous cross-seas of the central calm. In order to do this he must be able to judge of the bearing of the storm-centre from the actual position of his ship, and, to determine this point with even approximate accuracy, his sole guide is the direction of the wind. It may well be, then, that the safety of his ship, his own life and those of his fellow-seamen, are involved in the right answering of this question, "Does the storm-centre bear at right angles to the local direction of the wind, or is it from two to four points in advance of this position?" M. Faye's theory assumes and inculcates the former; the latter is consistent only with the hypothesis of an indraught from all sides, and an ascending current over the storm, the existence of which M. Faye persistently denies.

M. Faye's views on the nature of cyclonic storms are too well known to render necessary any detailed description of them. An account given by Mr. Archibald in vol. xxxviii. of this journal (p. 149) is quoted without disapproval by M. Faye in his latest publication in the *Comptes rendus*, and may therefore be accepted as just. Its essential points are that cyclones are generated as great eddies in the higher regions of the atmosphere, and that there is a downrush of air in the vortex. "Dans ces tourbillons, tout semblables à ceux qui se forment dans les cours d'eau, les spires, d'abord très larges, iront en se rétrécissant par en bas, et leur girations progressivement accélérées, en vertu d'une loi bien connue de mécanique, amènent au contact du sol, et y concentrent sous une aire bien plus étroite que celle de leur embouchure les énergies continuellement renouvellées du fleuve aérien jusqu'à ce que son élargissement croissant aboutisse à la décomposition du cyclone."

Further on, with respect to the descending current in the vortex, he remarks: "L'air envoyé en bas sera en petite quantité mais animé d'une vitesse de rotation énorme."

I leave aside for the present any criticism of the physical and mechanical actions which M. Faye conceives to take place in these unfortunately inaccessible vortices of the higher atmosphere, and which I, for one, am unable to reconcile either with the results of direct observation or with well-established physical laws. For the moment I wish to concentrate attention on the question of fact, whether there is an indraught of air to the cyclone vortex at the earth's surface, and therefore necessarily an ascending current over it, or, on the contrary, an outflow from a descending current. This is the crucial point of the controversy, and by the answer M. Faye's theory must stand or fall. Indeed, M. Faye seems to recognize this, since he says:—

"L'argument le plus solide, celui qu'on m'opposait toujours pour prouver que l'air était ascendant dans les cyclones, à savoir le fait que les isobares étaient partout et toujours coupés sous un angle assez notable par les flèches des vents, de manière à accuser une tendance nettement centripète, &c."

He admits, too, that in certain cases there is really an indraught and ascent of air; only, on his view, these are not cyclones.

In order to forestall any objection on this score, I will take as the subject of inquiry the cyclones of the Bay of Bengal, the typical cyclones to which Mr. Piddington first applied the name, however etymologically incorrect. I trust, by this restriction, to escape ignominious dismissal from court on the plea that my witnesses are impostors—merely "prétendus cyclones"—and that their evidence is consequently irrelevant.

My first experience of a great tropical cyclone was the memorable storm that devastated the port and city of Calcutta on October 5, 1864. Up to that time, my acquaintance with cyclones was, like M. Faye's, "academic"; and under the impression that Reid's and Piddington's description of the winds, as blowing in circles or at right angles to the radius vector of the vortex, was an established scientific fact, on the evening of that day I sketched out, for the information of some friends, the probable course of the storm that was then passing away, having swept the port of its shipping, and left half the houses around us more or less wrecks. Having no other guide at the moment than the changing directions of the hurricane as experienced at Calcutta, on the supposition that the centre lay at right angles to these directions, I inferred that the storm had reached us from the north-east corner of the bay, and had followed a north-west or west-north-west course past Calcutta. What was my surprise, then, when accounts began to come in from other places in Bengal, showing that the course of the storm had been almost due north; and when, further, on plotting down the wind directions reported from other stations according to the hours at which they had been observed, I found that, instead of being at right angles to the radius vector, they were strongly inclined inwards; and such as, after making all allowances for their being only estimated directions and perhaps, therefore, a point or two in error, could be reconciled only with a sharp spiral indraught to and up to the central calm. Later on, when I obtained copies of the logs of ships that had been involved in the storm in its passage up the bay, I found that their wind observations, equally, were compatible only with spiral directions. Unlike M. Faye, I had no theory to support, and I submissively accepted the teaching of the evidence which lay so plainly before me.

This evidence is set forth on Plates I. and II. of the Report drawn up by Colonel Gastrell and myself, which was widely distributed at the time to scientific bodies, so that, in all probability, a copy must exist in the library of the Académie des Sciences.

Since then, many other storms in the Bay of Bengal have been carefully investigated, and their full details embodied in Reports drawn up by Messrs. Wilson, Eliot, Pedler, and myself. Without a single exception, the evidence thus accumulated has been to the same effect as that of the cyclone of 1864, and these gentlemen have all arrived at conclusions similar to mine. Thus, Mr. Wilson says[1]:—"The following rule may be used to determine the approximate bearing of the centre with as much accuracy as it seems to be possible to arrive at: *In the northern hemisphere, with the face to the wind, the direction of the centre is from ten to eleven points to the right-hand side*"; and, to quote only one of Mr. Eliot's numerous references to this subject,[2] "The air is drawn into the centre [of a cyclone], but is not drawn directly to it. The particles move by a kind of spiral path to the centre." And he gives a diagram, followed by charts of the Balasore cyclone of May 1886 and the Madras cyclone of November of the same year, as illustrative examples. And Mr. Pedler, in summing up the evidence of the False Point cyclone of September 1885, says[3]:—

"It is therefore clear, from these autographic records, that there was a very strong indraught towards the storm-centre, and that for a considerable portion of the time, even when the storm-centre was comparatively close to Hazaribagh, the winds were part of a well-defined spiral system. In fact, for a large part of the time they subtended an angle of less than 45° with the radius of the storm. . . . The records of five anemographs within the influence of the storm . . . show that the theory of the circular movement of winds in a cyclone, which was advanced by Reid and Piddington, and has been supported by some later writers, is utterly untenable. At considerable distances from the storm-centre the winds approach more to the radial direction of indraught towards the centre, as advocated by Espy, than to any circular movement. As the centre of the storm is approached, the circulation appears to become more defined; but even just outside the storm-centre there is no evidence to show that the direction is tangential."

The reports here quoted and many others, all leading to the same conclusions, have been communicated officially to a large number of scientific bodies in Europe and elsewhere, and taken together they probably furnish the most copious and complete body of existing evidence relative to the cyclones of a tropical sea. Not long since I examined the whole of the charts given in these reports, in order to verify Mr. Wilson's rule (quoted above) for ascertaining the bearing of the storm-centre when the

1 "Report on the Midnapore and Burdwan Cyclone of October 15 and 16, 1874," p. 86. The italics are as in the original Report.

2 "Hand-book of Cyclonic Storms in the Bay of Bengal," p. 14 (1890).

3 "Indian Meteorological Memoirs," vol. iv., Part 2, p. 127. The barometric reading recorded when the centre of this storm was passing False Point Lighthouse is the lowest that has ever been observed at the sea-level.

local wind direction is the only datum available, and I found that in the north of the Bay of Bengal, as the mean result of 132 measurements, the angle included between the wind arrow and the radius vector of the vortex was 122° (or 32° greater than a right angle), and that of twelve positions within 50 miles of the storm-centre, that is to say, in the inner circle of the hurricane, 123°. In the south of the bay it was 7° greater. Prof. Loomis, taking into account the land as well as the marine observations, and all barometric depressions, whether storms or otherwise, obtained an angle 25° greater, and differing only by 33° from the radial direction. It is hardly necessary to refer to Prof. Loomis's results of his examination of the Manilla cyclone of October 1882, which gave an angle of 118°, or to Mr. Meldrum's work on the cyclones of the South Indian Ocean, which has already been quoted by Mr. Archibald in his article in NATURE, mentioned above. All testify uniformly and in the strongest manner to the sharp spiral indraught of the winds in tropical cyclones, so that, as Prof. Loomis has truly remarked, "we thus see that tropical storms are spouts and not cyclones, and it is unfortunate that the term cyclone should have been ever adopted." In this view I fully agree, and I make M. Faye a present of the admission, that in an etymological sense, if in no other, Mr. Piddington's typical cyclones are not cyclones at all.

With all these results of a quarter of a century's experience present to my mind, when a gentleman holding the high position of M. Faye reiterates the assertion that the winds of tropical cyclones blow in circles, and that if ever they are found to blow spirally inwards such instances are not true cyclones (in the ordinarily accepted, *i.e.* denotative, meaning of the term), the impression I receive is somewhat such as M. Faye would probably experience were some equally eminent scientific authority to assert in his presence that the Ptolemaic system truly represents the relative movements of the sun and planets, and that the heliocentric scheme of Copernicus is a "prétendu systême." If, indeed, M. Faye prefers to avail himself of the admission made above, to relegate Mr. Piddington's typical cyclones to the category of "prétendus cyclones," and therefore to exclude them from his theory, my present argument falls to the ground; but in that case his cyclone becomes the mere abstract definition of a term, and it remains to be shown that there is anything corresponding to it in Nature. That, however, in his latest communication to the *Comptes rendus*, he intended his assertions to apply to these tropical cyclones is abundantly apparent.

Can it be that M. Faye is unacquainted with the mass of original evidence embodied in the Indian cyclone reports, in Mr. Meldrum's writings on the cyclones of the South Indian Ocean, and with Prof. Loomis's work, in which these and many others are discussed? It would indeed seem so, since in none of his writings have I ever seen any reference to any other Indian author than Mr. Piddington, and even in his case it is difficult to believe that M. Faye has done more than simply accept Mr. Piddington's conclusions, without attempting to verify them by an examination of the original data. But if this be really the case—if he has taken so little pains to ascertain the fundamental facts, and to test the soundness of his speculations by an appeal to the evidence of the last twenty-five years—it is indeed strange that he can put forward confident assertions on a matter with which his acquaintance is so imperfect, and that he can disseminate statements that are demonstrably erroneous, and may be fraught with danger to the lives and property of those who accept him as their guide, backed with the high authority that must necessarily attach to his name.

It is a far from edifying spectacle to see such a man, in his latest communications to the *Comptes rendus*, quoting with complacency any isolated passage in the writings of leading meteorologists which seems to promise some support to his tottering theory, and ignoring all that would tell against it. That such cyclones as originate beyond the tropics are, in the first instance, movements of the higher atmosphere, has been rendered very probable by Dr. Hann's demonstration of the temperature relations of cyclones and anticyclones; but nothing that Dr. Hann has ever written has shown that he is in the least inclined to accept M. Faye's strange hypothesis of a descending current as the leading feature of cyclones and tornadoes. That the clearing of the skies in the central calm of a tropical cyclone may be due to the descent of a certain amount of air, although not decisively proved, is yet not improbable; but what would be thought of a man who, standing on a river bank, and seeing an upward current in the back-water immediately below him, should shut his eyes to the broad stream beyond, and assert, on the strength of his observation, that rivers flow from the sea to the mountains? Yet such, and no other, is the relation of this descending current to the great body of the cyclone. All may admit, with Prof. von Bezold, that there is much in the views hitherto prevalent as to the origin of cyclones and anticyclones that requires modification, and it may yet be long before these phenomena are fully and satisfactorily explained. There are many points of difference between the storms of the tropics and those of the temperate zone which seem to show that the forces that are principally active in the former play but a secondary part in the latter. But certainly there is no apparent tendency on the part of the leading meteorologists of Europe and America to accept M. Faye's *idolon specus* as a true theory of cyclones and tornadoes, nor is it in the least likely that such will ever be witnessed.

HENRY F. BLANFORD.

NOTES.

THE arrangements for the meeting of the British Association are now nearly complete. In a former note we referred among other matters to the excursions. We now learn that among them the organization of the pedestrian excursions to the Black Mountains is so far advanced that the detailed programme is now ready, and can be obtained by application to the Local Secretaries.

THE Royal Archæological Institute of Great Britain and Ireland opened their annual meeting in Edinburgh on Tuesday. At noon there was a reception of the members in the National Portrait Gallery by the President and Council of the Society of Antiquaries of Scotland. The inaugural meeting took place in the lecture-hall of the Royal Geographical Society. Sir Herbert Maxwell, on taking the chair, remarked that the closing years of a century naturally suggested the process of stock-taking, and as they had arrived at the last decade of a century which claimed to have witnessed beyond all precedent the accumulation of scientific knowledge, it was not unnatural that they should direct inquiry into the standing obtained by that particular branch of science in which they were all concerned. After a brief summary he stated that one of the problems which was pressing upon antiquaries at the present time was that relating to those mysterious rock sculptures which from time to time were found in increasing numbers all over Scotland. They bore a striking resemblance to similar rock sculptures found not only in Scandinavia and Central Europe, but in such remote parts of the earth as Asia, and Northern, Central, and Southern America. They could hazard no guess even at the race by whom they were made, still less at the object of their authors. All they could do was to record the discovery of them with careful drawings, and wait till perhaps light would flash upon them from the habit of some uncivilized tribe or from a passage in some hitherto unnoticed writer.

In the evening Dr. John Evans opened the Antiquarian Section with an address on the progress of archæology. The address covers the whole ground from Christy and Lartet's researches on the Dordogne to the Assyrian tablets.

BY an Imperial Decree of June 8, the Gold Medal for Art and Science was bestowed by H.I.M. the Emperor of Austria on Dr. R. Bowdler Sharpe, of the British Museum.

AT the graduation ceremony of the University of Edinburgh, held on the 1st inst., the Cameron prize was presented to Dr. Ferrier, F.R.S., by Prof. Fraser. Prof. Fraser said that Dr. Ferrier's researches had gained for him a well-merited fame throughout the whole civilized world. He had contributed to the alleviation of suffering in some of its most distressing and painful manifestations, and therefore the Senatus had thought that they were fully justified in awarding to him the prize, which had been founded for the recognition of important and valuable contributions to practical therapeutics. He had much pleasure in announcing further that Dr. Ferrier would, early next session, communicate to the University a paper describing some portion of his researches into this important subject. Prof. Ferrier, on appearing upon the platform to receive the prize, was received with most enthusiastic cheers.

AT a meeting of the Academy of Medicine of Paris on the 28th ultimo, Sir Joseph Fayrer, of London, and Dr. Bateman, of Norwich, were elected Associates of the Academy. These gentlemen had both been for some years Corresponding Members of the Academy, but they shared the Membership with only six other members of the profession in this country, viz. Sir James Paget, Bart., Sir Richard Owen, Sir Joseph Hooker, Sir Thomas Longmore, Dr. West, and Sir Spencer Wells, Bart.

DR. THORNE THORNE, F.R.S., has been elected a Corresponding Member of the Royal Italian Society of Hygiene.

PROF. DU BOIS-REYMOND has been elected Dean of the Medical Faculty of the Berlin University for this year. He has already more than once filled this post. Prof. Foerster, the astronomer, has been chosen Rector of the University.

HER MAJESTY'S Commissioners for the Exhibition of 1851 have offered nomination to Science Scholarships for the year 1892 to the following Universities and Colleges. The Scholarships are of the value of £150 a year, and are tenable for two years. The scholars are to devote themselves exclusively to study and research in some branch of science the extension of which is important to the industries of the country:—University of Edinburgh, University of Glasgow, University of Aberdeen; Mason College of Science, Birmingham; University College, Bristol; Durham College of Science, Newcastle; Yorkshire College, Leeds; University College, Liverpool; Owens College, Manchester; University College, Nottingham; Firth College, Sheffield; University College of North Wales, Bangor; Queen's College, Cork; Queen's College, Galway; University of Toronto, University of Adelaide, University of New Zealand.

IT has been decided to perpetuate the memory of the connection of Dr. Leidy with the University of Pennsylvania by raising a fund to endow the Chair of Anatomy and to found a memorial museum. Dr. Leidy was Professor of Anatomy for thirty-nine years, and his devoted services will be suitably recognized by connecting his name with the chair which he so long adorned.

THE arrangements for the World's Fair at Chicago seem to be advancing quickly. Seeing that so much benefit to science may be anticipated from the comparison of the best instruments and methods of working in use in different countries, which such exhibitions render possible, it seems a pity that political questions may render them less representative than might be wished. The *New York Nation* refers to the reluctance of French manufacturers to take part in the World's Fair, due to the bad feeling created by the McKinley Bill, and to the belief entertained that any expense incurred in exhibiting goods would be lost by reason of the commercial restrictions which that measure was intended to create and has created. "Nobody cares to spend his money for mere purposes of show. Unless trade follows as a consequence of the exhibition, the money will be sunk. . . . . It does not advance matters, or help on the Fair, to show that both countries are wedded to a false system. It should serve, however, to open the eyes of people on both sides to the absurdity of inviting each other to show their goods, and then creating barriers to prevent each other from buying and selling. Imagine an American McKinleyite meeting his French brother at a World's Fair in Paris or in Chicago, and exhibiting to the latter a choice lot of provisions put up in Mr. Armour's most approved style, while the latter exhibits a fine assortment of woollens, silks, gloves, &c. If they could look in each other's faces without laughing, they must have a gravity exceeding that of two Roman augurs. Ordinary self-respect ought to teach the commercial classes of both countries to keep away from World's Fairs until they learn the A B C's of trade."

E pur si muove. Technical instruction in the provinces is growing apace, small thanks to our statesmen and legislators, for we owe to an accident the possibility of meeting the most crying needs of the time. We may refer to what is going on in Lancashire as an indication of the general awakenment. The total sum available for technical instruction is £40,391, and, after the sums already guaranteed by the County Council and some special amounts now in question are taken into account, there is a balance of about £29,000 to be dealt with, which the committee of the Council recommend should be apportioned between the urban and rural districts of the administrative county on the dual basis of rateable value and population. The committee recommend that a director of technical instruction be appointed at £500 per annum, with travelling expenses; that £3600 be set apart to provide twenty scholarships not exceeding £60 each for a term not exceeding three years, apportioned as follows—eight for science (tenable at Owens College, Liverpool University College, or other approved public institution), two for art, four for commercial subjects, and six for the science of agriculture, including horticulture; that £1200 be set apart for providing eighty exhibitions of £15, tenable for one year at Owens College and Liverpool University College evening classes, or at some approved technical, commercial, or intermediate school, to be apportioned as follows—thirty-two exhibitions for science, eight for art, sixteen for commercial subjects, and twenty-four for agriculture; that £2000 be set apart for founding travelling scholarships and free studentships of £1 to £10 to assist students in attending technical schools; that the various urban and rural sanitary authorities, through or in conjunction with any district committees that may be appointed, be permitted to nominate candidates for the above, two-thirds of whom shall be children of parents whose incomes do not exceed £300 per annum; that all the scholarships and exhibitions be opened to students of both sexes resident in the county; that a sum not exceeding £1000 be granted for the purpose of aiding University Extension lectures; that a sum not exceeding £500 be granted to carry out the arrangements with the council of the Harris Institute in Preston for the promotion of technical instruction in agriculture; and that a sum not exceeding £1000 be granted for staff and office expenses. The migratory dairy school having been much appreciated, arrangements have been made to start a second school at Ulverston on August 11. A scheme for agricultural instruction is also being arranged (estimated to cost £500 per annum), but the details have not yet been finally settled.

THE managers of the New Gallery announce a "Victorian Exhibition," covering the fifty years of Her Majesty's reign from 1837 to 1887. As in the case of the preceding exhibitions, it will contain pictures and other records of events illustrating the history of the Royal Family and of the nation; and it will contain, above all, a series of portraits of the illustrious men and women who, in so many different ways, have made their mark upon the age. We gather from an article in the *Times* that science, in this of all reigns, is not likely to fall behind. We are promised pictures of Charles Darwin, Faraday, and Sir John Herschel, of Lyell and Murchison, of the two Stephensons, of Fox Talbot, one of the inventors of photography, and of Wheatstone, one of the inventors of the telegraph. The article adds that "it would be easy to quadruple this list, supposing the eminent men of science to have had the time and the vanity to sit for their portraits." We agree.

THE *Pall Mall* returns to the charge on the subject of the imagined unpopularity of the British Museum, and states that although the evening openings have so far been a failure, and a very costly failure, the first installation of the electric light costing over £17,000, the problem is being carefully considered. It is also stated that it is an open secret that for some years past the Trustees have been unanimous in favour of Sunday opening, which, as they have more than once pointed out, would entail little or no extra work on the officials, but merely change of work for a few policemen. Among the things that are wanted are certainly continuity in the hours during which the Museum is open on any one day, and the possibility of obtaining some decent refreshment. If in these matters the Trustees will imitate he arrangements at the South Kensington Museum, we believe the attendance will be increased—the attendance of workers certainly will.

WE are requested to state that the designs submitted in competition for the completion of the buildings of the South Kensington Museum are now on view at that Museum from 10 till 6.

DURING the whole month of July little variation in the state of Vesuvius was observable; the lava flowed steadily on, and had at one time extended down the Fossa della Vetrana, nearly opposite the lodge and gate of Messrs. Cook's private road to the Vesuvian railway, but immediately cooled, and again started flowing much nearer its source. At the summit of Vesuvius the vapour appeared to issue almost as in the normal state of the mountain, except for momentary interruptions and occasional ejection of dust and sand. Dr. Johnston-Lavis, who has recently visited the scene, sends us the following details:—"On July 30, I again visited the top of the great cone. The central crater has considerably enlarged, and has now an elliptical plan, with the major axis directed north-west to south-east, but this form has been derived from its original circular shape by the greater destruction of the lips towards the south-east. The edges were in a most unstable state, and attempts at photographing the interior were accompanied by considerable danger, and required many precautions. On the inner walls I was, however, able to make out several dykes besides the hollow one that has supplied the great eastern rift for its several eruptions from 1881-82 to 1890. These may be enumerated as directed north-east; north-north-west, probably the dyke formed at the commencement of this eruption; north-west; south-west, probably the cooled upper extremity of the lava sheet filling the south-west fissure which I have so often mentioned; and lastly, the hollow dyke to the south-south-east, which supplied the lava of May 1885, is again exposed. There may be other dykes, but the large amount of vapour filling the crater, and the danger and impossibility of approaching the edges in most parts, prevent a very detailed examination. So far as I could make out, the situation of the vent is quite to the south-east of the crater bottom, so that this fact, combined with the prolongation of the crater in that direction and the existence of numerous radial fissures, would indicate that the general tendency is for the next lateral disruption to take place towards Pompeii, or Torre Anunziata. On July 30 the lava was flowing very slowly just at the junction of the Atrio del Cavallo and the Fossa Vetrana. To an experienced observer the whole state of the mountain is still very unstable, and a fresh outburst might occur at any moment, although the volcano may gradually quiet down. But a few days before my visit, four strong earthquakes were felt at the lower railway station, showing that important fracturing, injection, or other dynamic disturbances were taking place in the great cone."

WE have received from Mr. C. Mostyn an interesting letter on the well-known appearance of the green ray at sunrise or sunset caused by the refraction of the air. He states:—"This 'green ray' is seen to best advantage at sun-*rise*, owing I imagine to the eye not being wearied with watching the previous glare, as is apt to be the case at sunset. At the same time, I had many very satisfactory observations at sunset, one in particular, when we were running before a very heavy sea in the Southern Ocean, and the 'green ray' was seen no less than three times in as many seconds, as the ship rose and fell on the huge waves causing as it were two sunsets, with a sunrise between them. The best displays took place when the refraction near the horizon was of such a character that the sun assumed a balloon, or vase, shape as he came close to the sea-line. When, on the contrary, the sun appeared flattened out in its horizontal diameter, the 'green ray' was either entirely absent, or was seen only in an indistinct and uncertain manner."

SIR EDWARD WATKIN having now, we presume, cured unpunctuality on the many lines of railway which he is highly paid to manage, is again turning his attention to Snowdon. It will be remembered that he proposed in the first instance to erect an astronomical observatory there. This, of course, was ridiculous. We are now told that the authorities of the Trinity House have expressed warm approval of his more recent proposal to place an electric light on the summit. The Elder Brethren consider that the light should prove an invaluable addition to those already erected round the North Wales coast for the guidance of mariners. Sir Edward hopes to have the light burning before Christmas.

THE Directors of the Crystal Palace, in deference to the wish of the Electrical Trade Section of the London Chamber of Commerce, have decided to postpone the opening of the Electrical Exhibition from November 1891 till January 1, 1892, on which date the Exhibition will be formally opened.

WE learn from the *Photographic News* that the great progress that has been made in the methods by which rapid movements can be analyzed is well seen in a series of photographs lately taken by Anschütz, of Lissa, who has already given to the world some of the best instantaneous pictures ever taken. The subject of the pictures at present under consideration is a dog jumping over a small bush. In the act of making one jump the animal has been photographed twenty-four separate times, and each picture is not a mere silhouette, as was the case with Muybridge's first attempts of this kind, but a little picture showing half-tone and detail. Some of the attitudes are, of course, comic in appearance, for they represent phases of a movement which the eye is unaccustomed to, and cannot possibly appreciate. Notably is this the case in the commencement of the jump, when the dog's hind toes only touch the ground; and again at the finish of the jump, when his legs are gathered together in a heap.

A GERMAN specialist, Dr. Cold, has recently pleaded for giving young people more sleep. A healthy infant sleeps most of the time during the first weeks; and, in the early years, people are disposed to let children sleep as much as they will. But from six or seven, when school begins, there is a complete change. At the age of ten or eleven, the child sleeps only eight or nine hours, when he needs at least ten or eleven, and as he grows older the time of rest is shortened. Dr. Cold believes that, up to twenty, a youth needs nine hours' sleep, and an adult should have eight or nine. With insufficient sleep, the nervous system, and brain especially, not resting enough, and ceasing to work normally, we find exhaustion, excitability, and intellectual disorders gradually taking the place of love of work, general well-being, and the spirit of initiative.

THE *Entomologist's Monthly Magazine*, among much interesting matter, refers to the possibility of the destruction of some of the inclosures in the New Forest which have proved themselves to be among the happiest hunting-grounds of the entomologist.

A RECENT number of the Proceedings of the Academy of Natural Sciences of Philadelphia contains a paper on Echinoderms and Arthropods from Japan, by Mr. J. E. Ives. The specimens described were collected by Mr. Frederick Stearns, of Detroit. The new species of Echinoderms and Crustacea are enumerated. A new Ophurian, a new crab, and a new Pycnogonoid are described, and several species of star-fishes hitherto unfigured are illustrated. The plates are admirable.

BULLETIN No. 10 of the University College of Agriculture at Tokyo contains an account of some manuring experiments with paddy rice (second year) by Dr. O. Kellner, Y. Kozai, Y. Mori, and M. Nagaoka. The principal purpose of the researches carried out in 1889, and reported in Bulletin No. 8, was to ascertain how much nitrogen, phosphoric acid, and potash can be consumed by rice from the stock of nutrients in the unmanured soil, and how much of them is needed in the manure for the production of a maximum crop if the three nutrients are applied in the most assimilable form. On the basis of the results then obtained, the present experiments were tried with the object of getting information on the following questions:—(1) How much nitrogen, phosphoric acid, and potash is taken up from those plots which had not received the respective nutrients in the preceding year? (2) What is the effect of unrecovered phosphatic manure on the succeeding crop? (3) How much nitrogen can be supplied to rice by the preceding cultivation of a leguminous plant (*Astragalus lotoides*, Lam.) for green manuring? (4) What is the effect of various phosphatic fertilizers on rice? (5) What is the effect of various nitrogenous manures on rice? The work seems to have been carefully done, and affords a good instance of the way in which scientific questions are now being treated in Japan.

THE July number of the Proceedings of the Society for Psychical Research has reached us, and contains the following contributions:—"On Alleged Movements of Objects, without Contact, occurring not in the Presence of a Paid Medium," by Mr. F. W. H. Myers; "Experiments in Clairvoyance," by Dr. A. Backman; and "A Case of Double Consciousness," by Mr. R. Hodgson.

AT the Bournemouth meeting of the British Medical Association, a discussion on the subject of alcohol was initiated by a paper by Dr. Samuel Wilks. In the course of his paper he stated that he had no acquaintance with any organic changes attributable to alcohol in the lungs and kidneys, but it seemed that the digestive and nervous systems suffered. Physiologists had failed to demonstrate the chemical changes which it underwent in the body, and consequently it was impossible to say whether t was of the nature of a food or not. No one had yet seen a person who lived on alcohol, although there was evidence of persons taking large quantities of alcohol who yet preserved their weight with a minimum of food; and that supported the theory that, although alcohol was not nutritive in itself, it prevented the wear and tear of the body. The opposite theory also existed, that alcohol acted as a spur to the nervous system and quickly wore it out. He could not disapprove of the use of wine and beer, if taken in moderation, by the masses of the people; but as to spirits or spirits and water, he had not made up his mind that they were in any way useful, and he seldom recommended them. Dr. Bucknill thought that the wise use of wine might cure some cases and be useful in others. Dr. Norman Kerr said that alcohol was a poison, analogous in many respects to other poisons. Sir Risdon Bennett agreed with Dr. Wilk in not approving of spirits as a beverage. He believed it to be useful in fever and in some nervous diseases, but he did not think it desirable at the present time to lay down any broad principles with regard to alcohol with reference to the whole community.

THE Philadelphia *Satellite* states that, during the abortive attempt to cut a canal through the isthmus of Panama, as much as 200,000 ounces of quinine were used annually in combating malarial fever.

ACCORDING to the *Pharmaceutical Journal of Australia*, the practice has been introduced into Victoria, on the recommendation of Baron von Mueller, of placing green branches of eucalyptus in sick rooms as a disinfectant. Dr. Curgenven states, after twelve months' trial, that in cases of scarlet fever, if the branches be placed under the bed, the bedding undergoes thorough disinfection, the volatile vapour penetrating and saturating the mattress and every other article in the room. Its vapour is also said to have a beneficial effect upon phthisical patients, acting not only as an antiseptic, but as a sedative and to some extent as a hypnotic.

THE Bulletin of the (American) Essex Institute just received contains an account of the annual meeting held last May, and a retrospect of the year, from which we learn that Mr. Perley, in a lecture on "Old-time Winters in Essex County," gave interesting particulars on many subjects, including weather. We give the following extract:—"The lecturer spoke of the watch, church services, dress, food, and schools of the early winter seasons; how the people spent their evenings, the winter employment of the people in cutting off the forests, sledding timber and wood, making pipe staves and barrel hoops, and, most interesting of all, the institution of the old-fashioned shoemakers' shops, of which nearly every farm had one a century ago. Women in those days engaged in spinning and weaving. The holidays were referred to—Thanksgiving, Christmas, and New Year's; and the winter pleasures, such as sleigh-rides, dancing, spinning and quilting parties, and games, shuffle-board, coasting, skating, trapping, gunning, fishing, singing-schools, and girls' samplers. He also spoke of the old modes of travel, snow-shoes, &c. Nearly all the heavy teaming was done on sleds, and he mentioned the winter of 1768-69, when the travelling was so bad that the farmers in the western part of the State could not get their grain and provisions to the coast to market. Snow remained on the roads as it fell until about a century ago. Mr. Perley then spoke of particular winters: that of 1641-42, when the Indians said they had not seen the ocean so much frozen for forty years; of 1646-47, when there was no snow to lay; of 1696-97, said to be the coldest winter since the first settlement of New England; of 1701-2, which was 'turned into summer'; of 1717-18, when the snow was from ten to fifteen feet deep and the drifts twenty-five feet, many one-story houses being buried; of 1740-41, said to be the severest winter known by the settlers, Salem Harbour being frozen over as early as October; of 1774-75, a wonderfully mild winter; of 1779-80, when for forty days, including March, there was no perceptible thaw, and the snow was so hard and deep that loaded teams passed over the fences in any direction, arches being dug under the snow so that men on horseback could ride under them, and which was long remembered as *the* hard winter; of 1784-85, when, as late as April 15, snow was 2 feet deep, and frozen hard enough to bear cattle; of 1785-86, when in the remarkable storm of November 25, the snow blew into balls, one of which had rolled 76 feet, measuring 17½ by 22 inches; of 1794-95, when the *Betsey* was launched in Salem on Christmas Day, the thermometer indicating 80° above zero at noon, and men and boys went in swimming; of 1801-2, when the *Ulysses*, *Brutus*, and *Volutia*, three Salem vessels, which sailed out of the harbour on a summer-like morning in February, were all cast away at night on Cape Cod, in a terrible snow-storm, which continued a week. He also referred to more recent seasons, and of the cold winter of 1856-57, when in one week in January was the coldest day by the thermometer ever recorded of late years, mercury in Salem 20° below zero; travel on the railroad between Boston and Salem entirely suspended from Tuesday morning to Thursday afternoon. The recent mild winters were also alluded to."

In the volume of Bavarian meteorological observations for 1890, Dr. C. Lang (the Director of the Service) contributes an article on the "Secular Variations of Damage by Lightning and Hail." He points out that in almost all recent investigations the conclusions come to are that during the last 50 years damage by lightning has much increased, but this is not borne out by his inquiry, but is probably owing to more attention having been paid to the subject recently. The numerous impurities introduced into the air of towns from fire-places, &c., would make it probable that they would be more liable to damage than country places, but exactly the opposite is the case, the ratio of damage to buildings in towns to that in the country being 1 : 2. This result is possibly to some extent due to the more numerous lightning-conductors, and to railway lines in the towns. He finds that the damage from hail shows a very probable connection with the period of sun-spot frequency, but the secular range of the former points more particularly to the influence of temperature, so that the curve of hail-frequency shows, not only a minimum occurring with the 11-year sun-spot maximum, but also a period of about 35 years. The damage from lightning, on the other hand, does not show any connection with a secular range of temperature, but the minimum occurs with the maximum of sun-spot frequency. In other words, damage from hail seems to be more decidedly connected with terrestrial, and damage from lightning more with cosmical influence.

The application of science in the direction of domestic comfort seems to be advancing with great strides in the United States. The *Nation*, in reference to the announcements that the inhabitants of Kansas City are about to be supplied with cool air in summer and warm air in winter through a system of pipes laid in the streets; and that the people of Framingham, Mass., are to be furnished with gas for heating purposes at the price of 50 cents a thousand feet, thus writes:—"Thus the ends of the land are advancing in the art of living while the metropolis remains tationary, and is kept from falling behind only by incessant grumbling. And yet the possibilities of comfort, of health, and ven of cheapness revealed in these schemes are wonderfully alluring, and their realization would be prevented by no physical obstacles. If we consider that wonderful work of human hands, the kitchen range, under the management of the regular cook, who knows how to put on all the draught at once and keep it on, what a devourer of fuel it is! We need a cup of tea or a chop in summer, and a fire is kindled that would generate steam enough to drive an ocean racer a mile upon her course, the kitchen is turned into a Tophet, the miserable servants swelter in the apartments which their own stupidity and that of mankind have rendered uninhabitable, and their employers are rendered uncomfortable above. The extravagance of the Chinese, who, as related by Charles Lamb, at first thought it necessary to burn down a house whenever they wanted to roast a pig, is nothing to ours." Has anybody ever calculated the annual waste caused by the above described "use" of the ordinary "kitchen range"?

An interesting paper upon the slow combustion of explosive gas mixtures is contributed to the current number of *Liebig's Annalen* by Dr. Krause and Prof. Victor Meyer. The experiments described were made with electrolytic mixtures of hydrogen and oxygen, and detonating mixtures of carbon monoxide and oxygen. The first experiment consisted in heating in a bath of vapour of diphenylamine (305°) a detonating mixture of hydrogen and oxygen contained in a U-shaped tube closed by mercury. The heating was continued without intermission for a fortnight, at the end of which time very little gas remained, almost the whole having slowly combined to form water. The experiment was then repeated in an apparatus constructed entirely of glass, and in which the use of mercury was avoided, except in a small manometer used to indicate the pressure. It was then found that no trace of water was formed at the temperature of diphenylamine vapour (305° C.); at the temperature of boiling sulphur (448°) the amount of combination was exceedingly small; while at 518°, the boiling-point of phosphorus pentasulphide, a considerable amount of combination occurred, but no quantitative rule could be deduced. In all these experiments the gases employed were moist, and no particular care had been taken to remove the last traces of admixed air. Now Bunsen and Roscoe, in their celebrated work on detonating mixtures of hydrogen and chlorine, showed that regular results were only obtained when the film of air condensed upon the surfaces of the glass vessels employed was removed by allowing the gas to stream through the apparatus for several days previous to the experiment. A fresh series of experiments were therefore made, in which these precautions were most rigidly observed; most complicated pieces of apparatus were constructed of glass throughout, which admitted of the drying of the gases prepared (in case of hydrogen and oxygen) by the electrolysis of hot water, so as to exclude ozone and hydrogen peroxide; and the pure gases thus obtained were allowed to stream through the series of bulbs united by capillary tubes for a fortnight, night and day, before the bulbs were sealed off at the capillaries. It was found that, with pure dry gases, scarcely a trace of combination occurred by the fusion of the very fine capillaries. As regards the temperature of ignition of electrolytic hydrogen and oxygen, or detonating carbon monoxide and oxygen, it was found that bulbs containing them do not explode when placed in boiling pentasulphide of phosphorus (518°), but do explode in vapour of stannous chloride (606°). The temperature of ignition lies, therefore, between 518° and 606° C. The mode of explosion differs considerably under different circumstances. In case of explosion in vapour of stannous chloride, the bulb was never shattered, but a sudden appearance of flame within the bulb occurred, accompanied by a slight detonation, and in some cases the point of the capillary was blown off. It is also astonishing how long one requires to hold such a bulb in a Bunsen flame before explosion occurs; it never occurs until the flame becomes coloured yellow, and the glass begins to soften, and frequently only causes a swelling out of the glass at the heated spot. Thin-walled bulbs, however, are sometimes shattered. In two cases it was noticed that the glass at the softened part was violently forced in, owing to the previous heating having caused a large percentage of combination, and hence the production of a partial vacuum. Even after taking the rigid precautions to insure purity above described, no definite quantitative rule connecting the time and percentage of combination has been discovered, experiments performed simultaneously upon similarly treated mixtures yielding widely different results; showing that the irregularities of glass surfaces, even after removal of their air-films, are quite sufficient to modify very sensibly the conditions under which combination occurs.

THE additions to the Zoological Society's Gardens during the past week include an Egyptian Gazelle (*Gazella dorcas*) from North Africa, presented by Mr. S. C. Saunders; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. Edward J. Brown; two Herring Gulls (*Larus argentatus*), British, presented by Mr. T. A. Cotton; two White-bellied Sea Eagles (*Haliaëtus leucogaster*) from Australia, presented by Mr. Hugh Nevill, F.Z.S.; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by Miss Partridge; three Barbary Turtle Doves (*Turtur risorius*) from North Africa, presented by Miss D. Bason; an Indian Cobra (*Naia tripudians*) from India, presented by Mr. H. E. Lindsay; two Harnessed Antelopes (*Tragelaphus scriptus* ♂ ♀) from Gambia, a —— Paradoxure (*Paradoxurus aureus*) from Ceylon, two Grey Ichneumon (*Herpestes griseus*) from India, four grey Parrots (*Psittacus erithacus*) from West Africa, deposited.

OUR ASTRONOMICAL COLUMN.

THE SPECTRUM OF β LYRÆ.—A study of twenty-nine photographs of the spectrum of β Lyræ has led to some interesting results, noted by Prof. E. C. Pickering in *Astronomische Nachrichten*, No. 3051. The spectrum of this star contains, in addition to the absorption lines, several bright lines, the most conspicuous of which are about $\lambda\lambda$ 486, 443, 434, 410, 403, and 389, to use a three-figure reference. The lines near λ 443 and λ 403, are two of the most prominent lines in the spectra of the Orion stars, and the remaining four coincide with the hydrogen lines F, G, *h*, and *α*. From the investigation it appears that these bright lines change their positions, so that sometimes they have a greater wave-length than the corresponding dark lines, whilst at other times the reverse is the case. In some of the photographs several bright lines are double, and the dark lines are also not free from changes. This naturally led to the inquiry as to whether the changes were connected with the variations of the star's brightness. Starting from a minimum of brightness there is a maximum at 3d. 5h., a secondary minimum at 6d. 11h., another maximum at 9d. 16h., and then the principal minimum is again reached after a total period of 12d. 22h. The point of interest is that the fourteen plates in which the wave-length of the bright lines was increased were taken during the first half of this period of variation—that is, before the secondary minimum; whilst on the eleven plates taken during the second half of the period the displacement was towards the blue end of the spectrum. And since the photographs extend over more than four years, there can be little doubt that the displacements are intimately connected with the variations of the star's brightness. One of the explanations suggested by Prof. Pickering to account for the observed phenomena is that the bright lines are emitted by an object revolving in a circular orbit round the principal star, with a maximum velocity of about 300 miles per second, and completing its circuit in a period of 12d. 22h. The corresponding periastron distance is about 50,000,000 miles. If this be so, β Lyræ is a binary of the β Aurigæ type, but differing from it in the fact that the component stars have unlike spectra. The phenomena could also be produced by a meteor stream, or by an object like the sun, rotating in 12d. 22h., and having a large protuberance on it extending over more than 180° of longitude. The study of the additional photographs which are being taken will doubtless elucidate the matter.

THE POLARIZATION THEORY OF THE SOLAR CORONA.—In the Publications of the Astronomical Society of the Pacific, vol. iii. No. 16, 1891, Prof. Frank H. Bigelow gives some further results of his investigations of coronal forms, and arrives at some new results. It can be shown that in the case of repulsion of matter in a spherical rotating body like the sun, two poles of repulsion are formed, and the body is polarized about an axis. Within the body the lines of force are parallel to the axis of polarization, and their curvature outside the surface may be calculated. Applying these considerations to the similar coronal forms exhibited in the eclipse photographs of July 1878 and January and December 1889, Prof. Bigelow finds that the axis of polarization is at the surface of the sun about $4\frac{1}{2}°$ from the axis of rotation, and taking the radius of the sun as 866,500 miles, the length of the axis to which the lines of force are parallel is 1,729,700 miles. Its direction is fixed, and in 1878 the north and south coronal poles had the positions, north pole = 201°·2, south pole = 301°·6, when referred to the ascending-node of the sun's equator on the plane of the ecliptic. If 138 + 349°·85, 151 + 311°·40, and 12 + 312°·55 be taken as the number of revolutions and the angular excess during the three intervals between the dates of the above eclipses, the mean daily motion in longitude at the latitude of the coronal pole, 85°·5, is found to be 13°·13307. From this the following periods of the sun's rotation in latitude 85°·5 is deduced—

Sidereal period 27·41171d. = 27d. 9h. 52m. 52s.
Synodic period 29·63580d. = 29d. 15h. 15m. 33s.

The formula proposed to express the rotation-period in different solar latitudes is $X = 862' - 76' \sin l$, where X is the mean daily motion in minutes, and l the latitude. With these elements it is possible to predict the positions of the coronal poles at any epoch, and in consequence the relative form of the corona at the time, as seen from the earth. A comparison of the calculated results and photographs, obtained during some recent eclipses, displays a striking concordance. The investigation "also serves to strengthen the conviction that the sun-spots are probably formed by the descent of material from the extremities of the coronal streamers, in a vertical direction upon the sun."

OBSERVATIONS OF THE MOTION OF SIRIUS.—At the Berlin Academy of Sciences on June 4, Prof. Vogel communicated some observations of the motion of Sirius in the line of sight. Using the iron spectrum as the term of comparison with the spectrum of the star, it was found that the velocity of approach on March 22 was 1·96 geographical miles per second with respect to the sun. With hydrogen comparison lines the velocity found was 1·73 miles per second.

RETURN OF ENCKE'S COMET.—A telegram from the Lick Observatory to Prof. Krüger, announces that Encke's periodic comet has been observed on its return by Mr. Barnard on August 1·9958 G.M.T., in the position R.A. 3h. 55m. 20·6s., Decl. 29° 59'·1 N.

ON SOME TEST CASES FOR THE MAXWELL-BOLTZMANN DOCTRINE REGARDING DISTRIBUTION OF ENERGY.[1]

(1) MAXWELL, in his article (*Phil. Mag.*, 1860) "On the Collision of Elastic Spheres," enunciates a very remarkable theorem, of primary importance in the kinetic theory of gases, to the effect that, in an assemblage of large numbers of mutually-colliding spheres of two or of several different magnitudes, the mean kinetic energy is the same for equal numbers of the spheres irrespectively of their masses and diameters; or, in other words, the time-averages of the squares of the velocities of individual spheres are inversely as their masses. The mathematical investigation given as a proof of this theorem in that first article on the subject is quite unsatisfactory; but the mere enunciation of it, even if without proof, was a very valuable contribution to science. In a subsequent paper ("Dynamical Theory of Gases," Phil. Trans. for May 1866) Maxwell finds in his equation (34) ("Collected Works," p. 47), as a result of a thorough mathematical investigation, the same theorem extended to include collisions between Boscovich points with mutual forces according to any law of distance, provided only that not more than two points are in collision (that is to say, within the distances of their mutual influence) simultaneously. Tait confirms Maxwell's original theorem for colliding spheres of different

[1] Paper read at the Royal Society by Sir William Thomson, D.C.L., P.R.S., on June 11, 1891.

magnitudes in an interesting and important examination of the subject in §§ 19, 20, 21 of his paper "On the Foundations of the Kinetic Theory of Gases" (Trans. R.S.E. for May 1866).

(2) Boltzmann, in his "Studien über das Gleichgewicht der lebendigen Kraft zwischen bewegten materiellen Punkten" (*Sitzb. K. Akad. Wien*, October 8, 1868), enunciated a large extension of this theorem, and Maxwell a still wider generalization in his paper "On Boltzmann's Theorem on the Average Distribution of Energy in a System of Material Points" (Cambridge Phil. Soc. Trans., May 6, 1878, republished in vol. ii. of Maxwell's "Scientific Papers," pp. 713–41), to the following effect (p. 716):—

"In the ultimate state of the system, the average kinetic energy of two given portions of the system must be in the ratio of the number of degrees of freedom of those portions."

Much disbelief and doubt has been felt as to the complete truth, or the extent of cases for which there is truth, of this proposition.

(3) For a test case, differing as little as possible from Maxwell's original case of solid elastic spheres, consider a hollow spherical shell and a solid sphere—globule we shall call it for brevity—within the shell. I must first digress to remark that what has hitherto by Maxwell and Clausius and others before and after them been called for brevity an "elastic sphere," is not an elastic solid, capable of rotation and of elastic deformation; and therefore capable of an infinite number of modes of steady vibration, into which, of finer and finer degrees of nodal subdivision and shorter and shorter periods, all translational energy would, if the Boltzmann-Maxwell generalized proposition were true, be ultimately transformed by collisions. The "smooth elastic spheres" are really Boscovich point-atoms, with their translational inertia, and with, for law of force, zero force at every distance between two points exceeding the sum of the radii of the two balls, and infinite repulsion at exactly this distance. We may use Boscovich similarly for the hollow shell with globule in its interior, and so do away with all question as to vibrations due to elasticity of material, whether of the shell or of the globule. Let us simply suppose the mutual action between the shell and the globule to be nothing except at an instant of collision, and then to be such that their relative component velocity along the radius through the point of contact is reversed by the collision, while the motion of their centre of inertia remains unchanged.

(4) For brevity, we shall call the shell and interior globule of § 3, a double molecule, or sometimes, for more brevity, a doublet. The "smooth elastic sphere" of § 3 will be called simply an atom, or a single atom; and the radius or diameter or surface of the atom will mean the radius or diameter or surface of the corresponding sphere. (This explanation is necessary to avoid an ambiguity which might occur with reference to the common expression "sphere of action" of a Boscovich atom.)

(5) Consider now a vast number of atoms and doublets, inclosed in a perfectly rigid fixed surface, having the property of reversing the normal component velocity of approach of any atom or shell or doublet at the instant of contact of surfaces, while leaving unchanged the absolute velocity of the centre of inertia of the two. Let any velocity or velocities in any direction or directions be given to any one or more of the atoms or of the shells or globules constituting the doublets. According to the Boltzmann-Maxwell doctrine, the motion will become distributed through the system, so that ultimately the time-average kinetic energy of each atom, each shell, and each globule shall be equal; and therefore that of each doublet double that of each atom. This is certainly a very marvellous conclusion; but I see no reason to doubt it on that account. After all, it is not obviously more marvellous than the seemingly well-proved conclusion that in a mixed assemblage of colliding single atoms, some of which have a million million times the mass of others, the smaller masses will ultimately average a million times the velocity of the larger. But it is not included in Maxwell's proof for single atoms of different masses [(34) of his "Dynamical Theory of Gases" referred to above]; and the condition that the globules inclosed in the shells are prevented by the shells from collisions with one another violates Tait's condition [(C) of § 18 of "Foundations of K.T. Gases"], "that there is perfectly free access for collision between each pair of particles whether of the same or of different systems." An independent investigation of such a simple and definite case as that of the atoms and doublets defined in §§ 3–5 is desirable as a test, or would be interesting as an illustration were test not needed, for the exceedingly wide generalization set forth in the Boltzmann-Maxwell doctrine.

(6) Next, instead of only a single globule within the shell of § 4, let there be a vast number. To fix ideas let the mass of the shell be equal to a hundred times the sum of the masses of the globules, and let the number of the globules be a hundred million million. Let two such shells be connected by a push-and-pull massless spring. Let all be given at rest, with the spring stretched to any extent; and then left free. According to the Boltzmann-Maxwell doctrine, the motion produced initially by the spring will become distributed through the system, so that ultimately the sum of the kinetic energies of the globules within each shell will be a hundred million million times the average kinetic energy of the shell. The average velocity[1] of the shell will ultimately be a hundred-millionth of the average velocity of the globules. A corresponding proposition in the kinetic theory of gases is that, if two rigid shells, each weighing 1 gram, and containing a centigram of monatomic gas, be attached to the two prongs of a massless perfectly elastic tuning-fork, and set to vibrate, the gas will become heated in virtue of its viscous resistance to the vibration excited in it by the vibration of the shell, until nearly all the initial energy of the tuning-fork is thus spent.

(7) Going back to the double molecules of § 5, suppose the internal globule to be so connected by massless springs with the shell that the globule is urged towards the centre of the shell with a force simply proportional to the distance between the centres of the two. This arrangement, which I gave in my Baltimore Lectures, in 1884, as an illustration for vibratory molecules embedded in ether, would be equivalent to two masses connected by a massless spring, if we had only motions in one line to consider; but it has the advantage of being perfectly isotropic, and giving for all motions parallel to any fixed line exactly the same result as if there were no motion perpendicular to it. When a pair of masses connected by a spring strikes a fixed obstacle or a movable body, with the line of their centres not exactly perpendicular to the tangent plane of contact, it is caused to rotate. No such complication affects our isotropic doublet. An assemblage of such doublets being given moving about within a rigid inclosing surface, will the ultimate statistics be, for each doublet,[2] equal average kinetic energies of motion of centre of inertia, and of relative motion of the two constituents?

(8) If we try to answer this question synthetically, we find a complex and troublesome problem in the details of all but the very simplest case of collision which can occur, which is direct collision between two not previously vibrating doublets, or any collision of one not previously vibrating doublet against a fixed plane. In this case, if the masses of globule and shell are equal, a complete collision consists of two impacts at an interval of time equal to half the period of free vibration of the doublet, and after the second impact there is separation without vibration, just as if we had had single spheres instead of the doublets.

[1] The "average velocity of a particle," irrespectively of direction, is (in the kinetic theory of gases) a convenient expression for the square root of the time-average of the square of its velocity.

[2] This implies equal average kinetic energies of the two constituents; and, conversely, equal average kinetic energies of the two constituents, except in the case of their masses being equal, implies the equality stated in the text. Let u, u' be absolute component velocities of two masses, m, m', perpendicular to a fixed plane; U the corresponding component velocity of their centre of inertia; and r that of their mutual relative motion. We have

$$u = U - \frac{m'r}{m+m'}, \qquad u' = U + \frac{mr}{m+m'}; \quad \ldots \ldots (1)$$

whence

$$mu^2 - m'u'^2 = (m - m')\left[U^2 - \frac{mm'r^2}{(m+m')^2}\right] - 4\frac{mm'}{m+m'}Ur. \quad . . (2)$$

Now suppose the time-average of Ur to be zero. In every case in which this is so, we have, by (2),

$$\text{Time-av.}\{mu^2 - m'u'^2\} = (m - m') \times \text{Time-av.}\left\{U^2 - \frac{mm'r^2}{(m+m')^2}\right\}. \quad (3)$$

Hence in any case in which

$$\text{Time-av. } mu^2 = \text{Time-av. } m'u'^2 \quad \ldots \ldots \ldots (4)$$

we have

$$(m - m') \times \text{Time-av.}\left\{U^2 - \frac{mm'r^2}{(m+m')^2}\right\} = 0, \quad \ldots \ldots (5)$$

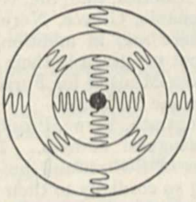
and therefore, except when $m = m'$, we must have

$$\text{Time-av. } (m + m')U^2 = \text{Time-av.} \frac{mm'r^2}{m+m'} \quad \ldots \ldots (6)$$

which proves the proposition, because, as we readily see from (1), $\frac{1}{2}mm'r^2/(m+m')$ is, in every case, the kinetic energy of the relative motions, $u - U$, and $U - u'$.

But in oblique collision between two not previously vibrating doublets, even if the masses of shell and globule are equal, we have a somewhat troublesome problem to find the interval between the two impacts, *when there are two*, and to find the final resulting vibration. When the component relative motion parallel to the tangent plane of the first impact exceeds a certain value depending on the radius of the outer surface of the shell, the period of free vibration of the doublets, and the relative velocity of approach; there is no second impact, and the doublets separate with no relative velocity perpendicular to the tangent plane, but each with the energy of that component of its previous motion converted into vibrational energy. When the mass of the shell is much smaller than the mass of the interior globule, almost every collision will consist of a large number of impacts. It seems exceedingly difficult to find how to calculate true statistics of these chattering collisions, and arrive at sound conclusions as to the ultimate distribution of energy in any of the very simplest cases other than Maxwell's original case of 1860; but, if the Boltzmann-Maxwell generalized doctrine is true, we ought to be able to see its truth as essential, with special clearness in the simplest cases, even without going through the full problem presented by the details. I can find nothing in Maxwell's latest article on the subject (Camb. Phil. Trans., May 6, 1878), or in any of his previous papers, proving an affirmative answer to the question of § 7.

(9) Going back to § 6, let the globules be initially distributed as nearly as may be homogeneously through the hollow; let each globule be connected with neighbours by massless springs; and let all the globules which are near the inner surface of the shell be connected with it also by massless springs. Or let any number of smaller shells be inclosed within our outer shell, and connected by massless springs, as represented by the accompanying diagram, taken from a reprint of my Baltimore Lectures now in progress. Let two such outer shells,



given at rest with their systems of globules in equilibrium within them, be connected by massless springs, and be started in motion, as were the shells of § 6. There will not now be the great loss of energy from the vibration of the shells which there was in § 6. On the contrary, the ultimate average kinetic energy of the whole two hundred million million globules will be certainly small in comparison with the ultimate average kinetic energy of the single shell. It may be because each globule of § 6 is free to wander that the energy is lost from the shell in that case, and distributed among them. There is nothing vague in their motion allowing them to take more and more energy, now when they are connected by the massless springs. If we suppose the motions infinitesimal, or if, whatever their ranges may be, all forces are in simple proportion to displacements, the elementary dynamical theorem of *fundamental modes* shows how to find determinately each of the 600 million million and six simple harmonic vibrations, of which the motion resulting from the prescribed initial circumstances is constituted. It tells us that the sum of the potential and kinetic energies of each mode remains always of constant value, and that the time-average of the changing kinetic energy during its period is half of this constant value. Without fully solving the problem for the 600 million million and six co-ordinates, it is easy to see that the gravest fundamental mode of the motion actually produced in the prescribed circumstances differs but little in period and energy from the single simple harmonic vibration which the two shells would take if the globules were rigidly connected to them, or were removed from within them, and the other initial circumstances were those of § 6. But this conclusion depends on the forces being *rigorously* in simple proportion to displacements.

(10)[1] In no real case could they be so, and if there is any deviation from the simple proportionality of force to displacement, the independent superposition of motions does not hold good. We have still a theorem of fundamental modes, although, so far as I know, this theory has not yet been investigated. For any stable system moving with a given sum, E, of potential and kinetic energies, there must in general be *at least as many fundamental modes of rigorously periodic motion as there are freedoms* (or independent variables). But the configuration of each fundamental mode is now not *generally* similar for different values of E; and superposition of different fundamental modes, whether with the same or with different values of E, *has now no meaning.* It seems to me probable that every fundamental mode is essentially unstable. It is so if Maxwell's fundamental assumption[1] "that the system, if left to itself in its actual state of motion, will, sooner or later, pass through every phase which is consistent with the equation of energy" is true. It seems to me quite probable that this assumption *is* true, provided the "actual state of motion" is not exactly, as to position and velocity, a configuration of some one of the fundamental modes of rigorously periodic motion, and provided also that the "system" has not any exceptional character, such as those indicated by Maxwell for cases in which he warns[2] us that his assumption does not hold good.

(11) But, conceding Maxwell's fundamental assumption, I do not see in the mathematical workings of his paper[3] any proof of his conclusion "that the average kinetic energy corresponding to any one of the variables is the same for every one of the variables of the system." Indeed, as a general proposition its meaning is not explained, and seems to me inexplicable. The reduction of the kinetic energy to a sum of squares[4] leaves the several parts of the whole with no correspondence to any defined or definable set of independent variables. What, for example, can the meaning of the conclusion[5] be for the case of a jointed pendulum? (a system of two rigid bodies, one supported on a fixed horizontal axis and the other on a parallel axis fixed relatively to the first body, and both acted on only by gravity). The conclusion is quite intelligible, however (but is it true?), when the kinetic energy is expressible as a sum of squares of rates of change of single co-ordinates each multiplied by a function of all, or of some, of the co-ordinates.[6] Consider, for example, the still easier case of these coefficients constant.

(12) Consider more particularly the easiest case of all, motion of a single particle in a plane; that is, the case of just two independent variables, say x, y; and kinetic energy equal to $\frac{1}{2}(\dot{x}^2 + \dot{y}^2)$. The equations of motion are

$$\frac{d^2x}{dt^2} = -\frac{dV}{dx}, \qquad \frac{d^2y}{dt^2} = -\frac{dV}{dy},$$

where V is the potential energy, which may be any function of x, y, subject only to the condition (required for stability) that it is essentially positive (its least value being, for brevity, taken as zero). It is easily proved that, with any given value, E, for the sum of kinetic and potential energies, there are two determinate modes of periodic motion; that is to say, there are two finite closed curves such that, if m be projected from any point of either with velocity equal to $\sqrt{[2(E-V)]}$ in the direction, either-wards, of the tangent to the curve, its path will be exactly that curve. In a very special class of cases there are only two such periodic motions, but it is obvious that there are more than two in other cases.

(13) Take, for example,

$$V = \tfrac{1}{2}(a^2x^2 + \beta^2y^2 + cx^2y^2).$$

For all values of E we have

$$\left.\begin{array}{l} x = a\cos(\alpha t - e) \\ y = 0 \end{array}\right\} \text{ and } \left.\begin{array}{l} y = 0 \\ x = b\cos(\beta t - f) \end{array}\right\}$$

as two fundamental modes. When E is infinitely small we have only these two; but for any finite value of E we have clearly an infinite number of fundamental modes, and *every mode* differs infinitely little from being a fundamental mode. To see this, let m be projected from any point N in OX, in a direction perpendicular to OX, with a velocity equal to $\sqrt{(2E - a^2ON^2)}$.

[1] Sections 10 to 17 added July 10, 1891.

[1] "Scientific Papers," vol. ii. p. 714.

[2] *Ibid.*, pp. 714, 715.

[3] *Ibid.*, pp. 716–726.

[4] *Ibid.*, p. 722.

[5] Or of Maxwell's "b," in p. 723.

[6] [It may be untrue for one set of co-ordinates, though true for others. Consider, for example, uniform motion in a circle. For all systems of rectilineal rectangular co-ordinates (x, y), time-av. $\dot{x}^2$ = time-av. $\dot{y}^2$; but for polar co-ordinates (r, θ) we have *not* time-av. $\dot{r}^2$ equal to time-av. $r^2\dot{\theta}^2$.—W. T., July 21, 1891.]

After a sufficiently great number of crossings and re-crossings across the line X'OX, the particle will cross this line very nearly at right angles, at some point, N'. Vary the position of N very slightly in one direction or other, and re-project *m* from it perpendicularly and with proper velocity; till (by proper "trial and error" method) a path is found, which, after still the same number of crossings and re-crossings, crosses exactly at right angles at a point N'', very near the point N'. Let *m* continue its journey along this path, and, after just as many more crossings and re-crossings, it will return *exactly* to N, and cross OX there, *exactly* at right angles. Thus the path from N to N'' is exactly half an orbit, and from N'' to N the remaining half.

(14) When $c\mathrm{E}/(\alpha^2\beta^2)$ is a small numeric, the part of the kinetic energy expressed by $\frac{1}{2}cx^2y^2$ is very small in comparison with the total energy, E. Hence the path is at every time very nearly the resultant of the two primary fundamental modes formulated in § 13; and an interesting problem is presented, to find (by the method of the "variation of parameters") *a, e, b, f*, slowly varying functions of *t*, such that

$$x = a \sin(\alpha t - e), \qquad y = b \sin(\beta t - f),$$
$$\dot{x} = a\alpha \cos(\alpha t - e), \qquad \dot{y} = b\beta \cos(\beta t - f),$$

shall be the rigorous solution, or a practical approximation to it. Careful consideration of possibilities in respect to this case [$c\mathrm{E}/(\alpha^2\beta^2)$ very small] seems thoroughly to confirm Maxwell's fundamental assumption quoted in § 11; and that it is correct whether $c\mathrm{E}/(\alpha^2\beta^2)$ be small or large seems exceedingly probable, or quite certain.

(15) But it seems also probable that Maxwell's *conclusion*, which for the case of a material point moving in a plane is

$$\text{Time-av. } \dot{x}^2 = \text{Time-av. } \dot{y}^2, \quad . \ . \ . \ . \ . \ . \ (1)$$

is not true when α^2 differs from β^2. It is certainly not proved. No dynamical principle except the equation of energy,

$$\tfrac{1}{2}(\dot{x}^2 + \dot{y}^2) = \mathrm{E} - \mathrm{V}, \quad . \ . \ . \ . \ . \ . \ (2)$$

is brought into the mathematical work of pp. 722-25, which is given by Maxwell as proof for it. Hence any arbitrarily drawn curve might be assumed for the path without violating the dynamics which enters into Maxwell's investigation; and we may draw curves for the path such as to satisfy (1), and curves not satisfying (1), but all traversing the whole space within the bounding curve

$$\tfrac{1}{2}(\alpha^2x^2 + \beta^2y^2 + cx^2y^2) = \mathrm{E}, \quad . \ . \ . \ . \ . \ (3)$$

and all satisfying Maxwell's fundamental assumption (§ 11).

(16) The meaning of the question is illustrated by reducing it to a purely geometrical question regarding the path, thus:—Calling θ the inclination to x of the tangent to the path at any point xy, and q the velocity in the path, we have

$$\dot{x} = q\cos\theta, \qquad \dot{y} = q\sin\theta, \quad . \ . \ . \ . \ . \ (4)$$

and therefore, by (2),

$$q = \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}. \quad . \ . \ . \ . \ . \ . \ . \ (5)$$

Hence, if we call s the total length of curve travelled,

$$\int \dot{x}^2 dt = \int q\cos^2\theta\, q dt = \int \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\cos^2\theta\, ds; \quad . \ (6)$$

and the question of § 15 becomes, Is or is not

$$\frac{1}{\mathrm{S}}\int_0^{\mathrm{S}} ds \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\cos^2\theta = \frac{1}{\mathrm{S}}\int_0^{\mathrm{S}} ds \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\sin^2\theta \,? \quad . \ . \ . \ (7)$$

where S denotes so great a length of path that it has passed a great number of times very near to every point within the boundary (3), very nearly in every direction.

(17) Consider now separately the parts of the two members of (7) derived from portions of the path which cross an infinitesimal area $d\sigma$ having its centre at (x, y). They are respectively

$$\left.\begin{array}{l} \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma \int_0^{\pi} \mathrm{N}d\theta\cos^2\theta \\ \text{and} \\ \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}\, d\sigma \int_0^{\pi} \mathrm{N}d\theta\sin^2\theta \end{array}\right\}, \quad . \ . \ . \ . \ (8)$$

where $\mathrm{N}d\theta$ denotes the number of portions of the path, per unit distance in the direction inclined $\frac{1}{2}\pi + \theta$ to x, which pass eitherwards across the area in directions inclined to x at angles between the values $\theta - \frac{1}{2}d\theta$ and $\theta + \frac{1}{2}d\theta$. The most general possible expression for N is, according to Fourier,

$$\left.\begin{array}{l} \mathrm{N} = \mathrm{A}_0 + \mathrm{A}_1\cos 2\theta + \mathrm{A}_2\cos 4\theta + \&c. \\ \qquad + \mathrm{B}_1\sin 2\theta + \mathrm{B}_2\sin 4\theta + \&c. \end{array}\right\} \quad . \ . \ . \ (9)$$

Hence the two members of (8) become respectively

$$\left.\begin{array}{l} \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma\tfrac{1}{2}\pi(\mathrm{A}_0 + \tfrac{1}{2}\mathrm{A}_1) \\ \text{and} \\ \sqrt{\{2(\mathrm{E} - \mathrm{V})\}}d\sigma\tfrac{1}{2}\pi(\mathrm{A}_0 - \tfrac{1}{2}\mathrm{A}_1) \end{array}\right\} \quad . \ . \ . \ . \ (10)$$

Remarking that A_0 and A_1 are functions of x, y, and taking $d\sigma = dxdy$, we find, from (10), for the two totals of (7) respectively

$$\left.\begin{array}{l} \tfrac{1}{2}\pi\iint dxdy(\mathrm{A}_0 + \tfrac{1}{2}\mathrm{A}_1)\sqrt{[2(\mathrm{E} - \mathrm{V})]} \\ \text{and} \\ \tfrac{1}{2}\pi\iint dxdy(\mathrm{A}_0 - \tfrac{1}{2}\mathrm{A}_1)\sqrt{[2(\mathrm{E} - \mathrm{V})]} \end{array}\right\}, \quad . \ . \ . \ (11)$$

where $\iint dxdy$ denotes integration over the whole space inclosed by (3). These quantities are equal if and only if $\iint dxdy\mathrm{A}_1$ vanishes; it does so, clearly, if $\alpha = \beta$; but it seems improbable that, except when $\alpha = \beta$, it can vanish generally; and unless it does so, our present test case would disprove the Boltzmann-Maxwell general doctrine.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT BERNE.

THIS Congress began its proceedings on Monday. Fourteen countries and forty-six Geographical Societies are officially represented. France has sent 73 delegates, Germany 33, Austria-Hungary 21, Switzerland 87, Italy 21, Russia 13, Great Britain 8, and Spain, America, and the Netherlands two each. Egypt, Portugal, Roumania, Greece, Norway, and Sweden are also represented. There are, in addition, 150 Members and Associates who have not yet given in their names.

M. Numa Droz, Swiss Minister for Foreign Affairs, bade the delegates heartily welcome to Berne.

Dr. Gobat, Regierungsrath, Berne, President of the Congress, then delivered his inaugural address. In the name of the Geographical Societies of Switzerland he thanked the *savants* present for responding so cordially to their invitation.

Among the good work already done, Prof. Penck, of Vienna, has proposed the following resolution:—"This Congress on the geographical sciences, held at Berne, resolves to take the initiative in the preparation of a large map of the earth on a scale of one to a million, of which the various sections shall be delimited by latitudes and longitudes; and, with this object, it appoints an international committee to determine the principles upon which the preparation of such map shall proceed. The members of this committee shall arrange that the various States engaged in preparing maps, the societies and periodicals publishing original maps, and all private geographical establishments working in this field shall prepare detached sections of the said map, the sale of which shall also be regulated and arranged for by the committee."

In the course of his address on the subject Prof. Penck paid a high tribute to the services rendered by Mr. Stanley to the cause of geographical science, directing special attention to the fact that each of the explorer's expeditions across Africa had led to the preparation of from 20 to 30 maps.

The proposal was referred to a committee of the Congress, which will report upon it.

The subjects of an initial meridian and universal time, geographical education, orthography of geographical names, lakes and glaciers, cartography, bibliography, meteorology, commercial geography, and voyages and travels are all to be touched upon in the deliberations.

SCIENTIFIC SERIALS.

Journal of the Russian Chemical and Physical Society, vol. xxiii., No. 1.—The chief papers are:—On the molecular weight of albumen, by A. Sabanéeff and N. Alexandroff. Several determinations were made on the method of Raoult, and gave an average of 14,276, the molecular weight thus appearing to be nearly three times as great as that deduced from the formula of

Harnack (4730), and nearly nine times as high as that given in Lieberkühn's formula (1612). The molecule contains nine atoms of sulphur, of which two are easily separated. Submitted to a temperature of 40°, the solution of albumen changes its properties, and its temperature of freezing is lowered.—On the measurement of density of sea-water, by Vice-Admiral Makaroff. This elaborate work gives the results of measurements made on board the corvette *Vityaz*. The value of various instruments used during the cruise is discussed in detail, and the following formulæ are given as expressing the results of the observations between the temperatures of 0° and 30°. For distilled water, the density is—

$$S_o = 0{\cdot}9998795$$
$$= S_t(1 - 0{\cdot}000061398t + 0{\cdot}0000080021t^2 - 0{\cdot}0000000045 86t^3),$$

maximum density at 3°·972. For sea-water, the density of which at 15° compared with that of distilled water at 4° is = 1·019, the formula is—

$$S_o = 1{\cdot}0207769$$
$$= S_t(1 + 0{\cdot}000022268t + 0{\cdot}0000069801t^2 - 0{\cdot}0000000047 61t^3),$$

maximum density at − 1°·570. For sea-water, the density of which, also at 15°, is = 1·026, the formula is—

$$S_o = 1{\cdot}0280936$$
$$= S_t(1 + 0{\cdot}000050453t + 0{\cdot}0000062833t^2 - 0{\cdot}0000000038 52t^3),$$

maximum density at − 3°·876. The last two formulæ gave excellent results for temperatures down to − 5°. A comparison between the figures obtained by the *Vityaz* and those obtained by the *Challenger* proved very satisfactory. Finally, the author gives six most valuable tables of corrections. Tables I. and II. contain the corrections to be applied to $S\frac{15}{4}$ for obtaining $S\frac{t}{4}$, and *vice versâ*, from − 5° to + 36°, for both distilled and sea-water. Detailed interpolation tables are also given. Table III. contains the corrections due to the coefficient of dilatation of glass of the areometer being not equal to the normal coefficient 0·000028. The three other tables are for transferring densities $S\frac{17{\cdot}5}{17{\cdot}5}$ into densities $S\frac{15}{4}$.

Bulletin de la Société des Naturalistes de Moscou, 1890, No. 3.—On the *Protopirata centrodon*, Trd., by H. Trautschold (in German). The two Ichthyodornlithes from the Carboniferous of North America, described in J. S. Newberry's capital work upon the "Palæozoic Fishes of North America," Table xxxix., are very much like the Moscow fossils described by the author in the above periodical (1884 and 1886) under the names of *Edectus protopirata*, and later on, of *Protopirata centrodon*.—Geo-botanical notes about the flora of European Russia, by D. I. Litvinoff (in Russian). The common Scotch fir (*Pinus sylvestris*) grows, as known, chiefly on a sandy soil. However, it also appears in the hilly tracts of Europe and Asia, and there it grows upon a rocky soil, chiefly limestone. In the lowlands of Germany and Russia, the appearance of fir upon a rocky ground is extremely rare; but there are some exceptions to this rule—namely, on the chalk hills of the Donets, the Volga mountains, the Middle Russian plateau, and the Silurian limestones of the Baltic provinces; in all those places the fir appears in company with a number of sub-Alpine and Alpine plants which are not met with elsewhere in the Russian plains, and with a number of endemic plants very rare in Russia as a whole. The author considers these rocky islands of fir-growths as survivals from the pre-Glacial period. The paper is full of most interesting botanical data and valuable remarks upon the connection of the glaciation of Russia with its present flora.—The influence of friction upon the rotatory motion of celestial bodies, by Th. Sloudsky (in French). The auxiliary theorems, upon which the principal theorem relative to the effects of friction is based, are demonstrated, the sun being taken as an illustration.—On the origin of endosperm in the embryo-pouch of certain Gymnosperms, by Miss C. Sokolowa (in French, with three plates). Strassburger's researches have proved the similarity between the formation of endosperm and of multicellular albumen, and the partition of cells, especially as regards the Angiosperms. The same researches are pursued by Miss Sokolowa as regards the Gymnosperms, attention being paid to the part played by the nucleus in the formation of partition walls.—Contribution to the morphology and classification of the Chlamydomonads, by Prof. Goroschankin (in German, with two plates).—Preliminary note upon inter-glacial layers about Moscow, by N. Krichtafovitch.

No. 4.—Traces of an inter-glacial period in Central Russia, by N. Krichtafovitch (in German; already analyzed in NATURE).—Remarks upon the function of the nucleus in cells, by J. Gerassimoff (in German), being observations upon cells without a nucleus in *Spirogyra* and *Sirogonium*.—On the molecular weight of the albumen of the egg, by N. Alexandroff (Russian).—Why the relative masses of the brain decrease in proportion to the increase of the weight of the body, in the same type of Vertebrata, by Fernand Lataste (in French).—*Tarentula* (*Lycosa*) *opiphex*, new species, by W. A. Wagner (French, with a plate). This trap-spider inhabits Middle Russia, and is especially numerous in the fields of Orel. Its thin trap, made of one sheet of web with some mould, is even more ingenious, for its shape, than that of the *Ctemiza*.

THE *Nuovo Giornale Botanico Italiano* for July contains two articles of interest to lichenologists: an account of the lichens of Brisbane gathered by Mr. F. M. Bailey, by Herr J. Mueller; and contributions to the lichen-flora of Tuscany, by Signor E. Baroni. Signor E. Tanfani has an important paper on the morphology and histology of the fruit of the Apiaceæ (Umbelliferæ), and Prof. C. Massalongo an account of the galls made by Acari on 45 species of trees, shrubs, and herbaceous plants, as well as of the insects which produce them.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, August 5.—Mr. Frederick Du Cane Godman, F.R.S., President, in the chair.—The President announced the death of Mr. Ferdinand Grut, the Hon. Librarian of the Society, and commented on the valuable services which the deceased gentleman had rendered the Society for many years past.—Dr. D. Sharp, F.R.S., exhibited *Japyx solifugus*, from the Eastern Pyrenees, and stated that in his opinion it was a connecting link between the *Thysanura* and *Dermaptera*. He also exhibited pupæ of *Dytiscus marginalis*; one of these was perfectly developed, with the exception that it retained the larval head: this was owing to the larva having received a slight injury to the head. Dr. Sharp also exhibited specimens of *Ophonus puncticollis* and allied species, and said that Thomson's characters of the three Swedish species, *O. puncticollis*, *O. brevicollis*, and *O. rectangulus*, applied well to our British examples, and separated them in a satisfactory manner. Thomson's nomenclature, however, would, he thought, prove untenable, as the distinguished Swede described our common *puncticollis* as a new species under the name of *rectangulus*.—Mr. F. W. Frohawk exhibited a bleached specimen of *Epinephele janira*, having the right fore-wing of a creamy white, blending into pale smoky brown at the base; also a long and varied series of *E. hyperanthus*, from the New Forest and Dorking. The specimens from the former locality were considerably darker and more strongly marked than those from the chalk. Amongst the specimens was a variety of the female with large lanceolate markings on the under side, taken in the New Forest, and a female from Dorking with large, clearly defined white-pupilled spots on the upper side. Mr. Frohawk further exhibited drawings of varieties of the pupæ of *E. hyperanthus*, and also a large specimen of a variety of the female of *Euchloë cardamines*, bred from ova obtained in South Cork, with the hind wings of an ochreous-yellow colour. Coloured drawings illustrating the life-history of the specimen in all its stages were also exhibited.—M. Sergé Alphéraky communicated a paper entitled "On some cases of Dimorphism and Polymorphism among Palæarctic Lepidoptera."

EDINBURGH.

Royal Society, July 15.—Sir Douglas Maclagan, President, in the chair.—The Prince of Monaco gave an account of the new yacht which he has had fitted out for the study of the sea. He also described the investigations which he has conducted since 1886, first in the Bay of Gascony, and then around the Azores and off Newfoundland. The latter investigations extended over three years, and had as their object the investigation of the direction and speed of the surface currents in the North

Atlantic. Special floats were thrown into the sea in three different places, and their progress was traced from place to place. As a preliminary trial 160 floats were thrown into the sea between the Azores and the Canary Islands. Some of these arrived at the Bermudas eighteen months later. In all 1700 floats were despatched, and the result was that the great ocean currents of the North Atlantic were now fairly well known. The Prince's new yacht is provided with an electric search-light of 10,000 candle-power for illuminating the surface of the sea when investigations are being carried on at night. Soundings can be made to a depth of 8000 metres without much difficulty. —M. le Baron Jules de Guerne, President of the Zoological Society of France, read a paper on the zoological results of the voyages of the *Hirondelle* (the Prince of Monaco's former yacht). He described the work of exploration among the Oceanic Islands, and alluded specially to the new species which had been found.—Mr. J. Y. Buchanan described a cartographic device which is of great use in the treatment of some geographical and telluric problems.—Mr. W. E. Hoyle described a deep-sea tow-net, which, by means of an electrical device, can be opened and closed at definite (arbitrary) instants.—Dr. H. R. Mill exhibited an improved form of his self-locking water-bottle.

July 20.—The Hon. Lord McLaren in the chair.—Some additional observations, by Prof. McIntosh, on the development and life-histories of the marine food-fishes and the distribution of their ova, were communicated. By means of various kinds of tow-nets, an endeavour has been made to ascertain the distribution of the eggs of the food-fishes on our shores. They are found at all depths, at the surface, and at the bottom. The floating eggs of the pilchard and mackerel are chiefly found on the south and south-west shores. On the east coast of Scotland the ova of the cod, whiting, and haddock are abundant. On the west coast, those of the sole, &c., abound.—The Astronomer-Royal for Scotland read a paper on the bright streaks on the moon. When the moon is half full its brilliancy is not nearly one-half so great as its brilliancy when it is quite full. Now at full moon the surface is observed to be covered by bright streaks which originate at the craters. The author believes that the great brightness of the full moon is due to these streaks. He considers them to be convex or concave, and so to be largely invisible under cross light, while they are brilliantly illuminated when the sun shines full upon them. The paper was illustrated by a model in plaster of Paris, with glass beads attached to its surface.—A paper, by Prof. C. G. Knott, on the effect of longitudinal magnetization on the interior volume of iron and nickel tubes, was communicated.—Dr. H. R. Mill read an obituary notice of Prof. C. I. Burton.

PARIS.

Academy of Sciences, August 3.—M. Duchartre in the chair.—Experimental researches on the probable *rôle* of gases at high temperatures and pressures, and in rapid movement, in various geological phenomena, by M. Daubrée. The experiments show how gases at high pressure, and contained in a closed reservoir, may, by a sort of latent action, violently push out rocks into conical or bell-shaped formations without any noise or escape of gas occurring to indicate their gaseous nature. —Heats of combustion and formation of nitrobenzenes, by MM. Berthelot and Matignon. The heats of combustion of ortho-, meta-, and para-dinitrobenzenes are found to be respectively 704·6, 698·1, and 696·5 calories; and the heats of formation 0·5, 6·8, and 8·4 calories. The heats of combustion of the two isomeric trinitrobenzenes examined are 665·9 and 680·6 calories; and the heats of formation +5·5 and −9·2 calories.—On the oldest European Dicotyledons observed in strata at Cercal, Portugal, by M. G. de Saporta.—On some improvements carried out in the manufacture of artificial Seltzer water: the siphon arrangement, by M. de Pietra Santa.—On a new and improved construction of the thermo-cautery of 1876, by M. Paquelin.—Periodic variations of the latitudes of solar prominences, by M. A. Riccò. The author's observations demonstrate that solar prominences, like spots, approach the equator up to the minimum period of activity, and afterwards begin again to appear more numerous in high latitudes.—On induction inclination needles, by M. Ernest Schéring. This is a brief description of a new magnetic inclination needle constructed by the author, and with which it is said to be possible to determine inclination with a probable error of 4″·2.—On the expansion of phosphorus, and its change of volume at the melting-point, by M. A. Leduc. The coefficient of expansion for solid phosphorus between 0° and 44°·1 is found to be 0·000372, whilst for liquid phosphorus between 26° and 50° the coefficient is 0·000560. The expansion is regular up to the melting-point, but an abrupt change of volume then occurs. The relation between the volume of phosphorus in the liquid and solid state is 1·0345.—Study of the chemical neutralization of acids and bases, by means of their electric conductivities, by M. Daniel Berthelot. From the investigation it appears that, when potash is acted on by hydrochloric acid, acetic acid, and phenic acid, compounds are formed having approximately equal electric conductivities. Ammonia, with the first two acids, gives similar stable salts, but with the last acid an unstable compound having a less electric conductivity is produced. Aniline forms with hydrochloric acid a stable compound having good electrical conductivity; and with acetic acid, an unstable body whose conductivity is said to be mediocre.—Action of phenylhydrazine on phenols, by M. Alphonse Seyewetz.—On the development of sponges (*Spongilla fluviatilis*), by M. Yves Delage.—On *Isaria densa*, Link, a parasite of the white worm, by M. Alfred Giard.—The parasite of the cockchafer, by M. Le Moult.—Action of poisons on the germination of the seeds of the plants which furnish them, by M. Ch. Cornevin.—On the resistance of the rabic virus to the action of prolonged cold, by M. Jobert.—Chromoscopic analysis of white light, by M. A. Charpentier.

Erratum.—On line 36, p. 336, instead of 0·1050 and 4·9720, read 1·1050 and 0·9720.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Elementary Science Lessons, Standard III.: W. Hewitt (Longmans).—Elementary Geometry of Conics, 7th edition: Dr. C. Taylor (Bell).—Instructions Météorologiques, 3me édition: A. Angot (Paris, Gauthier-Villars).—Bush Friends in Tasmania: L. A. Meredith (Macmillan).—Illustrations of the C.G.S. System of Units: J. D. Everett (Macmillan).—Elements of the Differential and Integral Calculus: A. Harnack; translation (Williams and Norgate).—Denmark: its Medical Organization, Hygiene, and Demography (Churchill).—Statistical Investigations concerning the Imbeciles in Denmark, 1888-1889 (Churchill).

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