THURSDAY, JUNE 14, 1894.

MINING BOOKS.

Economic Geology of the United States, with briefer mention of Foreign Mineral Products. By Ralph S. Tarr, B.S., F.G.S.A., Assistant Professor of Geology at Cornell University. (London: Macmillan and Co., 1894.)

The Ore Deposits of the United States. By James F. Kemp, A.B., E.M., Professor of Geology in the School of Mines, Columbia College. (New York: Scientific Publishing Company, 1893.)

Mining; an Elementary Treatise on the Getting of Minerals. By Arnold Lupton, M.I.C.E., F.G.S., &c. (London: Longmans, 1893.)

The Miner's Handbook. Compiled by John Milne, F.R.S., Professor of Mining in the Imperial University of Japan. (London: Lockwood, 1893.)

THE mining student of to-day has no reason to complain that his interests are being neglected, for text-books relating to his art are being showered upon him. Prof. Tarr states in his preface that there is no recent text-book on economic geology of any value. Surely the well-known library of his University must possess the big treatise of Fuchs and De Launay, published last year. The first part of Prof. Tarr's work, which deals with the mineralogical aspect of the question, might well have been omitted, for the student gains nothing in the end by being taught mineralogy in a loose and vague fashion. Objection must be taken to the word "mineralizer," which is used throughout the book to denote a non-metallic element, such as sulphur or chlorine, combined with a metal. In mining and metallurgy the author perpetrates a series of blunders, for which even junior students would be upbraided by an examiner. In speaking of the extraction of metals, he says there are three methods of treating ores: "Amalgamation, smelting (the dry way), and metallurgy (the wet way)." A treatise upon metallurgy would be strangely imperfect if Prof. Tarr's definition of the term were adopted. On the next page is the remarkable statement: "Before smelting some ores it is necessary to either calcine them—that is, to allow them to decompose in the air at ordinary temperatures—or to roast them." A moment's reflection upon the derivation of the word "calcine" would have prevented the mistake. It is evident that the author has not even turned over the pages of "De re Metallicâ," for otherwise we should not have the curious piece of historical information: "During the reign of Agricola, Portugal produced stream tin." Though sadly marred by careless writing of this description, the book contains much useful information compiled from various sources; but it is singularly deficient in figures.

Prof. Kemp in his introduction gives a valuable *résumé* of various schemes for classifying ore-deposits, a subject upon which there is much difference of opinion, for mining geologists are not yet agreed whether the basis of the classification should be form or origin. The author casts his vote in favour of the latter, and brings forward an elaborate scheme of his own, which will be of service to teachers and to students in reminding them of the very various causes which may have contributed to the production of ore-deposits. But is it not a mistake for a Professor to limit his classification to deposits worked for metals? Surely it is better to make the student take a wider view of the subject, and adopt some scheme which includes all kinds of mineral deposits. In the second part of the work will be found concise and useful descriptions of the modes of occurrence of the various metallic ores, with references to numerous original memoirs. The illustrations are far too few to do justice to the importance of the subject, and many of them are valueless. Reproductions of photographs of mining buildings and mining camps serve no useful purpose in a work of this description. There is a strange lack of geological feeling in the section of the Eureka Mine; judging by the illustration, the surrounding strata are horizontal, whilst Mr. Curtis' original plates show that they are highly inclined. Several of the woodcuts are rendered useless from the absence of any explanatory legend.

Prof. Lupton has brought into comparatively small compass the results of a long experience among mines; but it is not good taste in an author to blow his own trumpet so loudly in his preface. The arrangement of the book is not all that one would desire, for it shows a decided want of method. Like many of his predecessors, the author devotes one of the early chapters to "sinking," with the result of confusing the student, who is introduced suddenly to processes of excavation, supporting, winding, pumping and ventilation, all of which are described at length in other parts of the book. The gases found in mines are dealt with in the chapter upon ventilation; it would have been more logical to have discussed the nature of the polluting agents before describing the means of getting rid of them. Due importance is very rightly given to the dangers arising from coal dust; but why separate this chapter by 200 pages from the part of the book treating of accidents generally? The student will be grateful to the author for the lavish manner in which he inserts woodcuts, though some are far from satisfactory, and a few utterly useless. Reduction by photography may be carried too far, and the figure of the Rio Tinto drill is practically incomprehensible.

In the remarks about coal-cutters the author is not up to date, for he says "electrical coal-cutters have made but small progress," and supposes that no Winstanley machines are in use at the present time.

Mistakes are more frequent than they should be in the case of an author who has travelled much at home and abroad. It might almost be supposed that he had never looked inside a smith's shop at a mine, when one reads that the edge of a drill cannot be sharpened sufficiently by hammering. It will be news to most miners that lead ore is jigged upon a bed of *felspar*, and that gold quartz, after a preliminary crushing, is passed through rolls before going to the stamps. The description of the concentration of gold ores by endless belts is strangely confused. The author is weak in physics, for he seems to consider the density and the specific gravity of a gas to be two different things. The passage of gases through porous diaphragms is spoken of as "Eudiometry," and the repetition of the word in the index proves that it is not a mere slip of the pen.

The same inexactness pervades his mineralogy and geology; he looks upon tungsten ore and wolfram as two different minerals, and he puts down cadmium and phosphorus in his list as if they occurred native. If he had taken the trouble to consult the details of the official statistics, which he quotes, he would have been spared the erroneous statements that all the British tin comes from Cornwall, and that only small quantities of zinc ore are obtained in Great Britain.

When dealing with coal-mining Prof. Lupton is standing upon firmer ground, and he has brought together much general information and many useful details, which will render the book acceptable to students. Considering the amount of matter and the number of illustrations, the treatise is remarkably cheap.

During his long stay in Japan, Prof. Milne seems to have acquired the deftness of a native in packing, for it is difficult to conceive how more information could have been crammed into a book no bigger than a cigar-case, and weighing only six and a half ounces. It is a veritable miniature compendium of mining, which is likely to find a place not only on the shelves, but also in the luggage of most mining engineers.

A NEW STANDARD DICTIONARY.

A Standard Dictionary of the English Language. Vol. i. (New York: Funk and Wagnall's Company, 1893).

IT has been said that "a dictionary of language should contain all the words which may be reasonably looked for in it, so arranged as to be readily and surely found, and so explained as to make their meaning, and if possible their use, clear to those who have a competent knowledge of the language or languages in which the explanations are given." In other words, a dictionary should be an "inventory of language," and this being so, it constitutes an index to the state of knowledge at any epoch. Not so very many years ago it was held that words belonging to sciences and the arts should be omitted from dictionaries. The French Academy at first went so far as to reject all technical terms from their dictionary, though they afterwards decided to admit them, and, when the Philological Society projected their dictionary in 1856, they resolved to accept all English words except "such as are devoted to purely scientific subjects, as treatises on electricity, mathematics, &c." But time has changed all that. No man is now considered well-informed if he is not familiar with common scientific words, and therefore no work in which such a sin of omission is committed deserves the name of a dictionary.

In the dictionary before us, special attention has been paid to science, and words have in all cases been submitted to specialists. As a guarantee of the trustworthy character of the definitions, it is sufficient to mention the names of some of the eminent scientific men upon the editorial staff. Among those responsible for words pertaining to astronomy, physics, and mathematics, are Prof. Simon Newcomb, Prof. Frank H. Bigelow, Dr. A. E. Bostwick, and Prof. A. J. Kimball. Meteorological definitions have been edited by Prof. Mark W. Harrington, and zoological ones have been controlled by Prof. T. N. Gill, Mr. L. O. Howard, and Mr. Ernest Ingersoll. Special biological terms have been referred to Prof. F. Starr and C. S. Dolley. The editors of botanical definitions are Prof. Frank H. Knowlton, with Mr. E. F. Smith (mycology), Mr. David White and Mr. W. T. Swingle (Palæozoic flora), and Mr. A. A. Crozier (pomological terms). Anatomy was under the editorship of Prof. Frank Baker; bacteriology, of Dr. T. M. Prudden; medicine, of Dr. F. P. Foster; chemistry, of Prof. R. O. Doremus and Dr. M. Benjamin. Dr. W. Hallock and Mr. R. Gordon are responsible for the formulæ of colours; Prof. N. S. Shaler and W. R. Dwight for geological words; Dr. G. H. Williams and Dr. W. G. Brown for mineralogy and crystallography; and Mr. G. F. Kunz for gems and precious stones. Dr. G. P. Merrill has been the referee for words relating to building-stones; Mr. R. W. Pope for words used in electricity; Prof. W. H. Pettee for those belonging to metallurgy; Prof. Huxley has had evolution under his care; Dr. P. T. Mason, anthropology, and Mr. E. Muybridge, animal locomotion. These are only a few of the names of men of science who have helped in the production of the dictionary. One has only to read through the complete list to come to the conclusion that the projectors of the dictionary have done everything possible to render the work authoritative and uniformly accurate.

It is for us to point out the special features of the dictionary as regards science. Beginning with chemistry, we find that the rules adopted for the spelling and pronunciation of chemical terms are those recommended in a resolution passed by the Chemical Section of the American Association for the Advancement of Science, at the Rochester meeting, in 1892. The following changes have, therefore, been introduced. In the case of terminations in *ide* the final *e* has been dropped, thus giving chlorid, iodid, hydrid, oxid, hydroxid, sulfid, amid, &c. In names of chemical elements and compounds terminating in *ine* (except doubly unsaturated hydrocarbons) the final *e* is also dropped, and the syllable pronounced *in*, as, for instance, chlorin, bromin, &c.; amin, anilin, morphin, quinin, vanillin, emulsin, caffein, and cocain. The termination *ine* is retained, however, in the case of the hydrocarbons referred to. Preference is given to the use of *f* in the place of *ph* in sulphur and all of its derivatives, as sulfate, sulfite, sulfuric, &c. But though this system of spelling has been accepted by most American chemists, there is little possibility of its being generally adopted in our own chemical literature.

Handicraft terms are given with great completeness and grouped under the different trades. By a new system of grouping applied to the names of fruits, flowers, coins, weights, measures, stars, &c., the facts concerning this class of words are very fully given. Thus, in *constellation* Prof. Newcomb gives the names of all the constellations; under *apple* are found the names of 368 varieties, under *dog* the names and characteristics of all the different kinds of dogs, under *coin* a complete list of coins, under *element* a list of chemical elements, with their atomic weight, specific gravity, melting points, valency, date of discovery, name of discoverer, and condition of occurrence in nature.

The volume under review is full of illustrations, and the fine plates in it are marvellous specimens of colour-printing. Among the full-page coloured plates is one of gems and precious stones, and another of birds. A third plate of special interest is a splendid monochrome in which a number of ancient coins are grouped. When the work is completed it will contain nearly five thousand illustrations, all especially drawn for it. Each picture has been drawn so as to help to define a word, and the object of the plates is to facilitate comparison.

Whether the dictionary will, in course of time, "be accepted as the standard by all who use the English language," may be doubted. Many years will pass before we spell honour without the *u*, and sulphur has evolved into sulfur. But, putting these differences of spelling aside, we have no hesitation in saying that, in point of accuracy, the dictionary will compare favourably with any similar compilation extant, while for comprehensiveness combined with handiness, it is as good a work as could be desired. Everything has been done to facilitate the finding of words and to make the definitions trustworthy when found. It passes the wit of man to suggest anything which ought to have been done that has not been done to make the dictionary a success.

OUR BOOK SHELF.

An Introduction to the Study of Metallurgy. By Prof. W. C. Roberts-Austen, C.B., F.R.S. Third edition. (London: Charles Griffin and Co., 1894.)

THE part metallurgy has played in the industrial progress and material prosperity of our country is so great, that we hail with pleasure the appearance of this enlarged edition of Prof. Roberts-Austen's book, in which all that is important for a sound knowledge of the principles on which metallurgy is based is set forth with remarkable lucidity and ability.

The issue of this edition marks, in fact, an epoch in metallurgical teaching.

Its especial value lies, not in mere descriptions of the processes and appliances of metallurgy, but in the admirable systematic course of study laid down for the student in the fundamental scientific principles on which the appliances used in metallurgy are constructed, its processes based, and the character of their products determined. Without a clear understanding of these principles, it is needless to say, no knowledge of mere practical details, however extensive, can be of any value in enabling the metallurgist to cope successfully with the difficult problems which often confront him both in furnace and laboratory operations.

The elaborate researches of the author in the "thermal treatment of metals" and "thermal measurements" is a sufficient guarantee that these subjects will be treated in a manner worthy of their importance. (Chaps. iv. and v.)

Chapter ix., a special feature of this edition of the book, is a masterly compendium of the facts, principles, theories and laws of thermo-chemistry, and the importance of a correct application of these to the practical work of metallurgy is wisely insisted on. In other text-books and treatises the laws of stoichiometry have been chiefly relied on for the guidance of the metallurgist in interpreting and controlling the reactions which take place under the complex conditions which present themselves in furnace operations, and it has long been felt that the results of many of these operations could only be imperfectly explained or predicted by these laws. In this chapter metallurgists are clearly shown that they "have no longer merely to deal with atoms and molecules, but with the influence of mass," and that if they are to advance their industrial practice "they must think in calorics, and not merely employ the ordinary atomic tools of thought." They will then be able to suggest what reactions can take place under given conditions, to indicate those which will be completed, and to avoid those which are impracticable.

Thus far we have mainly considered those chapters of the book which deal with the fundamental principles of scientific metallurgy, but the whole work is of the greatest interest, and deserves the careful and earnest study of all who are interested in the scientific advances which have been made in metallurgy during recent times. It is, in fact, indispensable not only to students, but to all metallurgists. W. GOWLAND.

Structural Botany (Flowering Plants). By Dukinfield Henry Scott, M.A., Ph.D., F.L.S., F.G.S. With 113 Figures. (London: A. and C. Black, 1894.)

AN introduction to the study of structural botany has long been a desideratum in this country, where we have hitherto been compelled to refer the beginner either to works in foreign languages, or to such help as he may glean from lecture courses. Dr. Scott's little book supplies this need in a most admirable manner, and he has thoroughly earned the gratitude both of teacher and student alike for the freshness and clearness with which he has presented his subject. We notice with satisfaction that, amongst many other good points, there is an intelligible account given of the transition of the structure of the root to that of the stem, a matter concerning which there exists a great deal of needless ignorance and misapprehension in the minds of many students. Another excellent character of the work lies in the large number of new figures which it contains, an example which might with advantage be followed by other writers, for it is really not easy to see why the older illustrations should be regarded with such superstitious (or is it indolent ?) veneration, especially when this practice leads to the exclusion of new figures, as is not unfrequently the case.

We can only hope that Dr. Scott will speedily fulfil the promise hinted at in his preface, and provide, before long, a second volume dealing with the cryptogams.

The Lowell Lectures on the Ascent of Man. By Henry Drummond. (London: Hodder and Stoughton, 1894.)

MR. DRUMMOND is well known as a brilliant and enthusiastic writer, and his latest book will be welcomed by a wide circle of admirers. He approaches the study of nature and evolution with the sympathetic eye of a moral teacher who is possessed by a praiseworthy desire to find wholesome and ennobling lessons therein. In this he is successful. He has, however, a further purpose, that of setting biologists right in matters of biology. In this he is scarcely so successful. "Evolution," he tells us in his preface, "was given to the modern world out of focus, was first seen by it out of focus, and has remained out of focus to the present hour." The focus is adjusted in "The Ascent of Man." We must, however, leave those of our readers who can spare an hour or two for the perusal of the well-printed volume, to see how far Mr. Drummond aids them in acquiring a more definite and accurate conception of evolution. They will, we feel sure, be impressed with his eloquence and earnestness.

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.*]

Tribute to Hertz.

[We have received the following two communications. In accordance with the wish expressed in the first letter, the writer's name is not given.—ED.] :—

ON page 133 of this week's number of NATURE, Prof. Oliver J. Lodge suggests "an act of tribute" to the memory of Hertz, "useful to students in this country," to which I desire to contribute *anonymously*; and I enclose my cheque for £200.

To this distinguished man the world is more indebted than has, as yet, been made known. His broad mind enabled him to conform to what Herbert Spencer has said to be the first condition of success in scientific research, viz. "an honest receptivity, and willingness to abandon all preconceived notions, however cherished, if they be found to contradict the truth."

When invited, in 1889, to witness demonstrations, declared by men of science to "demonstrate the discovery of a force previously unknown to them," he did not excuse himself on the ground of his own occupations, nor yet because he believed the man to be a charlatan. He gave over five hours to the examination of photographs of the discoverer's researching instruments; at the end of which he said that were he to go to America to witness the production of the energy, he could render no assistance; that the man must work out his system alone; and that, in order to work it out, he should not attempt to apply it to mechanics until he had obtained full knowledge of the laws of nature governing its operation.

This advice, within a period of four years, followed faithfully as it was (after nearly twenty years of work on engines), has now led to the completion of a system of vibrating physics, with entire mechanical success (it is for the assistance thus rendered that I give my tribute of gratitude); and will, in the not distant future, give to the world "the crowning achievement of an age of scientific progress," opening "the unseen highways of the air" to ships of thousands of tons burden, by the neutralising of gravity.

June 9.

SINCE writing my letter Prof. Dewar has been here, and some remarks made by him have caused me to think I can better serve the end that I have in view by another appropriation of the £200 which I offered to you for the publication of Hertz's works, although he made no suggestions, nor does he know that I have sent it.

Will you kindly hold the cheque until I gain further information, or return it to me, as you may think best?

June 10.

[The cheque has been returned to the writer.—ED.]

Bullet-Proof Shields.

I AM induced by the sight of the letter from Mr. Frederick J. Smith, in NATURE for June 7, to suggest an idea for armour-plating which occurred to me a few weeks ago, and which seems to me to offer certain advantages over Mr. Smith's proposal.

If a space were filled closely with balls of approximately the same size as the expected missile, would not the resistance be greater than that offered by either a solid plate or by Mr. Smith's cylinders, while there would be a considerable diminution of weight as compared with either?

Each ball, except those at the surface of the receptacle, would be surrounded by twelve balls, to the three of which furthest from the missile the force of the impact would pass, radiating from the ball struck at an angle of 180°. The direction thus deflected would be passed on, again at an angle of 180°, to 3×3 balls, each of which would again forward it to its three hindermost balls.

These balls, of which there should perhaps be six layers, should be of the hardest metal available; perhaps of aluminium steel or aluminium bronze. Possibly they should be set in some soft and elastic medium that would prevent their leaking out at the hole made by the missile in the rigid covering; and, if this be not done, then a sheet of india-rubber of sufficient thickness to close after the entry of a bullet should be placed outside the frame holding the balls.

This method seems to me to have 50 per cent. more deflecting power than that of Mr. Smith, as the cylinders would only divide the direction of the missile into two, while the spheres would divide it into three.

Whether the missile would behave like Achilles when he so unwarrantably passed the tortoise, or whether its initial line would be curled round hexagonally in every direction, as it theoretically should be, might, I think, be very simply proved by experiment. EMMA HUBBARD.

Kew, June 10.

The Teeth and Civilisation.

IN reply to Mr. Arthur Ebbels, I can state some facts about several thousand people in the north isles of Scotland. We find here side by side old people with strong teeth free from decay, though possibly worn down like those of an old horse, and several later generations among whom dental caries is quite general, and including many girls in their teens who are almost edentulous.

No increased wear and tear of the nervous system, nor overstrain of the fifth nerve, nor increased privation can explain this extraordinary contrast. Work is if anything less arduous, clothing and other comforts more.

The habits of the older and younger generations form an equally striking contrast. The former, even as children, were thinly dressed, and did well on three meals daily. Both men and women gathered seaweed for kelp in all weathers, and worked until the tough bere bannock in their pockets became a tempting meal. It was then torn and masticated with incisors and molars doing their proper work. A drink of milk at the nearest farm completed the repast. Oatcake or oatmeal as brose or porridge served for breakfast and dinner, and home-brewed ale was a frequent beverage. Four distinctive facts can be pointed out. (1) They did not eat till they were hungry and at long intervals; (2) plenty of exercise for teeth and jaws; (3) no hot drinks; (4) they could eat without drinking. In all these points the younger generation differs. White bread is preferred, washed down with tea at 150° to 160° F. (tested with thermometer). The eat-and-swill method of eating is universal, the bolus being swept into the œsophagus without even the pretence of mastication. It is considered that not even a child can eat without a hot drink ready to its hand, and children of eighteen months may be seen drinking strong concoctions of theine and tannic acid, and refusing other food. And this usually for every meal. As school children they exist but do not thrive on this diet, but at twenty commences a divergence in the habits of the sexes. The woman, unless engaged in outdoor work, eats and swills more; the hungry ploughboy eats and masticates more, and swills less. As regards the teeth, two results are observed.

Either decay and disintegration takes place, or else the alveoli shorten until the teeth hang loose by their exposed fangs and drop out. This pseudo-senile change may happen before thirty. The incisors hardly ever suffer so much from inertia; biting is essential, but on the other hand the first impact of the semi-boiling tea is borne by them, and they often share the general ruin. Neuralgias of the fifth nerve and stomachic catarrh are exceedingly common. Oatmeal is of course almost banished from the diet of the people.

The only fallacy seems to be this: May not the old people in question be the exceptionally hardy survivors of a race equally prone to dental decay? Others must judge; but the old folk say, "I never heard much of toothache when I was young."

Sanday, May 26. ED. JAS. WENYON.

IT may be mentioned, in reply to a letter on the "Teeth and Civilisation," that this agent probably affects the health of the human teeth by the injurious nature of the food and diet she introduces in her wake. The worn-down crowns of the molar teeth of the native will correspond with the use of *grain food* and vegetable diet, mostly cold, when the silex in their constituents triturates the teeth down by degrees. But the use of *meat diets* by the civilised peoples will not affect the crown of the teeth, but tend to induce rheumatic or gouty disorders and affections of their periosteum. The most likely medium of *teeth caries*, however, being induced is the use of hot drinks, soups, tea and coffee, which primarily may cause a fissure in the enamel by unequal contraction and expansion of the structures of the teeth. Into this fissure, on it cooling down, will be kneaded by mastication articles of irritating food and drink, which will lead to caries round it. The progress of this may *erode* a segment of the tooth, or at last penetrate into the cavity and the pulp, and lead to inflammation and abscess; and none is a more virulent agent in doing this than hot tea. The simmering kettle may be seen on the hobs of the kitchen fires in the houses of the working classes in Yorkshire and Lancashire, who are much subject to caries of the teeth and dyspepsia, in consequence of the frequent imbibition of its hot contents all day. W. G. BLACK.

Edinburgh, May 17.

The Lowell Observatory, Arizona.

I LEARN—although I have not myself yet seen the note—that NATURE has been unwittingly led into the error of stating that Lowell Observatory, at Flagstaff, Arizona, is a branch of Harvard College Observatory. This impression had its origin in a press dispatch, and I am, with the approval of Mr. Lowell, correcting these wrong impressions when possible.

Mr. Percival Lowell—whose father is trustee of the Lowell Fund from which the cost of the Lowell Institute Lectures is defrayed—is himself an author ("Japanese Art and Customs") and a man of scientific training. He has himself worked out the plan for his observatory work, and will personally supervise and direct the investigations. His institution is one of magnitude, having 18 in. and 12 in. telescopes, and he is justly entitled to the credit. The misunderstanding seems to have arisen from the fact that he has employed two of the Harvard College Observatory assistants for the season, they having been granted leave of absence. I enclose Mr. Lowell's own statement, published yesterday, being his paper before the Boston Scientific Society, and really the first public official statement.

May 26. JOHN RITCHIE, JUN.

[The following description is from the enclosure referred to by Mr. Ritchie. We are glad to render Mr. Lowell the credit due to him.—ED.]

The Lowell Observatory, the construction of which is now almost completed, is situated in the territory of Arizona, near the town of Flagstaff, in longitude 112° west, latitude 35° north, at an elevation of 7300 feet above the sea. Its site is thus the highest of any large observatory in the northern hemisphere, the next in point of elevation being the observatory at Denver, 5400 feet. In latitude it is furthermore the most southerly of those north of the equator. But the chief advantage hoped for from its position is in the way of atmospheric conditions, the singularly dry and clear climate of Arizona commending itself to astronomical purposes.

The observatory buildings stand upon the eastern end of a spur of high land, which rises just to the west of the town and is connected at the back some fifteen miles away with the San Francisco Mountains that reach to a height of 12,500 feet. The buildings are thus protected from the north. To the east and south they overlook the town and the plain beyond, being about 300 feet above Flagstaff and a mile away from it in an air line. The hill and the surrounding country are covered in part by a sparse growth of timber. Trees about an observatory are usually considered an advantage, as such vegetation reduces the radiation from the ground and tends to equalise the daily extremes of temperature, thus giving steadier seeing. The land for the site has very generously been given by the town, and a road to the observatory is being built by the town at its own expense.

The buildings consist of the equatorial building and of the study, placed at a short distance away from it to leeward of the prevailing winds. This disposition of the buildings is in order to minimise the risk from fire, a serious matter in so isolated a situation.

The dome of the equatorial building is constructed on a system of parallel arches, after a design by Prof. W. H. Pickering, who has made a study of domes here and abroad. It is built of a framework upon which rests a cage of wire-netting, and over this is stretched a covering of canvas. One of the chief features of the dome is its lightness. Although it is thirty-four feet in diameter, the whole revolving hemisphere weighs but two tons. Some idea of its lightness and of the ease of moving it in consequence may be got by comparing it with the dome of the large equatorial at Harvard, which, though four feet smaller, weighs fourteen tons, or seven times as much. The whole revolves on the wheels of a live-ring. The dome was built here and, together with the pier, shipped out in pieces to Arizona. The study building will contain a general or reception room, two sleeping rooms, a photographic room and a tool-room.

The telescopic equipment consists of three telescopes of 18 inches, 12 inches and 6 inches aperture, respectively. The 18-inch glass is by Brashear, and is the largest objective Mr. Brashear has yet finished. Its focal length is 26 feet 4 inches, This is an unusually long focus, and length of focus is an advantage in an objective. It and the 12-inch one of Clark's are mounted in twin. The 18-inch will be used for usual and spectroscopic purposes, while the 12-inch will be chiefly employed photographically. The third glass, the 6-inch, is also by Clark, and is a fine objective. It has already done good work at Flagstaff by being the first of those in the northern hemisphere to catch the Gale comet the other day. Incidentally, it is a far travelled telescope, having been safely half round the world and back again before ever it started for Arizona. It is of the same size and quality as the one with which Burnham made himself the first of double-star observers. By the ingenuity of Mr. Clark it is mounted portably in equatorial, being thus rendered the largest of small telescopes, or the smallest of large ones, at pleasure.

The 18-inch has been carefully fitted by Mr. Brashear with various ingenious contrivances by Prof. Pickering for photometric and spectroscopic work. For micrometrical purposes, in addition to the micrometer proper, he has also had prepared plates minutely ruled, dotted and designed and then diminished by photography, to be introduced beside the image in the telescope, for direct comparison with the canals and lakes of Mars and other similar purposes, thus furnishing a second method for micrometrical measurement of such detail.

The Berthollet-Proust Controversy and the Law of Definite Proportions.

IN his able address at the annual meeting of the Chemical Society, the President spoke of chemical text-books somewhat scornfully. While I confess that I am not prepared to regard these books as "soul-destroying," one and all, I have long felt at least that the dogmatic exposition of the elementary laws of chemistry to which they have accustomed us is most unsatisfactory, and that a critical re-statement of first principles is much needed. To deal with the subject fully, would carry me far beyond the limits of a letter to NATURE; but it is proposed in the following communication to draw attention to certain serious misconceptions which have crept into modern text-books with regard to the Berthollet-Proust controversy and the Law of Definite Proportions, and to attempt to re-define somewhat more accurately the points which were at issue.

Berthollet, it is said in the text-books, held that the composition of a compound was not rigidly constant, while Proust showed that "the same chemical compound always consists of the same elements combined in the same proportions by weight," (a statement to be referred to later, as statement A); and this statement is regarded as an enunciation of the Law of Definite Proportions, against the acceptance of which Berthollet strove so hard. As a matter of fact it seems unlikely that Berthollet would have felt in the least inclined to contradict the statement quoted. He did not suppose for a moment that it *was* possible for two substances to exist which should be sufficiently alike in properties for them to be called the same chemical compound, and yet for these to differ sensibly in their quantitative chemical composition; yet this is what a denial of statement A amounts to. On the contrary, Berthollet, like Proust, held the opposite view, namely, that the physical properties of substances are necessarily correlated with their chemical composition, and therefore that two substances differing in their chemical composition have in general different properties and are not called by the same name. We find Berthollet making use of this view, for instance, in the course of an argument given in the "Essai de Statique Chimique," vol. i. p. 346. For he says in effect that if in certain cases we only find compounds of which the constituents are united in ratios, such as $x:y$ or $x:y_1$, among the infinite number of compounds of these constituents capable of existing, it is just because these combination-ratios correspond precisely to some physical property (*e.g.* insolubility) which renders the resulting substance easy of isolation, and takes it (to use the terminology of the time) beyond the reach of the chemical forces which caused its formation.

We see then that statement A in no wise discriminates between the views of Proust and Berthollet, and cannot be regarded as an enunciation of the Law of Definite Proportions. That such misrepresentation should have arisen, shows how hard it is to find in Proust's writings any sufficiently clear account of his views. I think the following may perhaps be accepted as a correct statement of his position :—

"If two substances unite chemically, they will do so either in a single ratio or in a series of ratios which are separated by intervals of finite magnitude." Berthollet thought, on the contrary, that in most cases two substances could combine chemically in an infinite number of ratios varying continuously between certain limits.

As Berthollet himself pointed out, the whole question turns on our definition of the term *chemical union*, and of *compound*, which latter we may regard as a substance formed by the chemical union of its constituents.

The joint efforts—or rather the divided efforts—of Berthollet and Proust made clear what neither chemist was willing to recognise frankly, namely, that there exist two distinct classes of homogeneous chemical substances which might fairly have been called compounds :—

Class I.—The substances belonging to this class are formed by the union of their constituents either in a single ratio or in a series of ratios separated by a definite interval. By the addition of a small quantity of any one of its constituents to a portion of a substance of this class we shall in general obtain a heterogeneous body.

Class II.—The substances belonging to this class are formed by the union of their constituents in an infinite number of ratios which vary continuously between certain limits. By the addition of a small quantity of any one of its constituents to a portion of a substance belonging to this class, we shall in general be able to obtain a new homogeneous substance.

Berthollet, on the one hand, regarded the substances belonging to Class I. as exceptions to the normal rule; Proust, on the other, wished to restrict the name of compound entirely to these. But for such a restriction Proust had certainly no sufficient reason to give. His point, however, as is well known, was carried by the weight of Dalton's discoveries of the Law of Equivalents and the Law of Multiple Proportions, which only applied to Class I. and therefore drew special attention to it, and by the weight of Dalton's atomic hypothesis, which allowed a sharp theoretical distinction to be drawn between the constitution of substances belonging to Class I. and that of substances belonging to Class II.[1]

To enter into a more complete discussion of this distinction as understood by Dalton, and of the modifications of the theory necessitated by our modern ideas on dissociation, would be beyond the scope of the present letter; but it should be pointed out that the controversy at present raging on the theory of solutions is, after a long interval, the continuation and development of the controversy between Berthollet and Proust.

With the facts clearly set before us, we may now inquire into the origin of the error of the text-books, an error which seems to me to be not a merely verbal one, but one due to a misunderstanding of the real points at issue.

I have not found this error in any book before Davy's "Elements of Chemical Philosophy," first published in 1812,[2] and it appeared but in comparatively few text-books until attention had been re-directed to the Law of Definite Proportions by Marignac and Stas in the "sixties."[3] It has since that time been reproduced in most of the books under one form or another. It is often stated, for instance, that Stas showed that "however we prepare ammonium chloride, it always has the same composition." The real problem attacked by that great chemist was this :—"Is what we have called 'chloride of ammonium' a single chloride of ammonium or a series of chlorides of ammonium resembling one another closely, and of which the combination-ratios only vary between certain narrow limits?" Or, to state the matter more generally, "Ought the substances which we have supposed to be members of Class I. (*supra*) to be really considered as members of Class II., with the reservation that the limits of the combination-ratios are in these cases close together?"

Stas's own language is, it must be admitted, not perfectly unambiguous on this point.

If Davy's treatise be possibly the historical source of the error, to trace its intellectual origin, or at any rate to offer some plausible explanation of this origin, we must go back further, and consider a time when a nomenclature founded on the exact chemical composition of substances, and the accurate measurement of their properties, was not so much impossible as uncontemplated.

In those days a common name was given to specimens of homogeneous substances, which might (excluding the case of the elements) prove to be either

(1) As in the case of liver of sulphur, a *series* of substances belonging to Class II.; or

(2) As in the case of water, a *single* substance belonging to Class I.; or

(3) As in the case of, say, some *particular* gun-metal, a *single* substance belonging to Class II.

I have chosen the order of these alternatives in this somewhat arbitrary manner in order to bring out more clearly the point where I believe misconception to have arisen. For I think that what the writers have done is to have considered only alternatives (1) and (2), and to have neglected (3).

After the rise of modern chemistry a closer examination of specimens of "liver of sulphur" and of "water" enabled chemists to say:

(B) The specimens labelled "liver of sulphur" do not always contain the same elements united in the same proportion. (C) The specimens labelled "water" do always contain the same elements united in the same proportion.

And these statements were contracted very naturally into the following :—

(D) "Liver of sulphur" does not always contain the same elements united in the same proportion; (E) "water" does always contain the same elements united in the same proportion.

Now the contracted statement (D) has misled the writers into forgetting that "liver of sulphur" is a collective noun, and that the contrast of the two statements is not a contrast between *a* mixture[1] and *a* compound, to which it is of course inapplicable; but a contrast between a *series* of mixtures and a *single* compound.[2]

They then proceed to substitute for "liver of sulphur" the general term, *a mixture*, and for water the general term, *a compound*, and so we obtain statement (F): *A mixture* does not always contain the same elements united in the same proportion; which is absurd; and our old friend (A): A *compound* does always contain the same elements united in the same proportion; which bears a very different meaning to that which its authors intend to convey by it, and which will be further considered immediately.

With statements F and A before them it appeared quite natural to the writers to suggest that "ammonium chloride" prepared in different ways might vary in composition, without their realising that they had returned to the careless days when "liver of sulphur" appeared an eminently satisfactory term.[3]

Perhaps from their error it may be possible to extract some good after all. For would it not be well to state more clearly in our books the postulate to which enunciation A reduces itself when interpreted rationally, viz. "Two portions of matter in other respects alike possess the same quantitative composition."[4] This postulate has been tacitly accepted by chemists, and it is made use of every day in the laboratory.

In conclusion I may be allowed to reply to a criticism which I foresee, namely, that no serious misunderstanding has followed from the errors to which I have drawn attention. That may be so, but accuracy of expression has a value of its own, and my object will have been attained, at any rate partially, if I have succeeded in removing (what should have been) a serious stumbling-block from the path of the student.

PHILIP J. HARTOG.

Owens College, Manchester, June 4.

[1] Kopp in his contribution to the much transformed Lehrbuch of "Graham Otto," and Mendeléef in his treatise, depart very wisely from usual custom in calling both these classes of homogeneous bodies compounds.

[2] See "Davy's Collected Works," vol. iv., p. 379 (1840). This reference I owe to my friend Dr. Harden.

[3] It must be noted that the Law of Multiple Proportions includes the Law of Definite Proportions, and the latter has on that account often been omitted entirely from text-books.

[1] I use the word "mixture" for "homogeneous mixture," or "solution" in the sense of Van't Hoff.

[2] They have neglected alternative (3), which would have reminded them that E applies quite as well to any *single* homogeneous mixture as to any single compound.

[3] The accurate statement of the problem dealt with by Stas has been given previously.

[4] This interpretation may seem to some of my readers to need a fuller explanation, for which I have not space here.

THE OXFORD MEETING OF THE BRITISH ASSOCIATION.

THERE are already signs that the meeting of the British Association, to be held this year at Oxford, will be a success. It is unfortunate, perhaps, that the city of Oxford is this year destitute of municipal buildings, the old buildings having been pulled down, while the new have scarcely their walls raised to the level of the first floor. But this deficiency is amply compensated by the numerous University and College buildings which have been placed at the disposal of the Local Executive Committee. The reception room will be in the entrance hall of the new Examination Schools in High Street, and the rooms for the meetings of Council, of the General Committee, and of Sections E and F will be held in the same building, the large south and east writing schools lending themselves particularly well for the departments of Geography and Economics and Statistics. The meeting rooms of the remaining sections will be distributed among the University Museum and among Colleges which are on the direct road between the Schools and the Museum. Section A (Mathematical and Physical Science) will meet in the Lecture Theatre of the Clarendon Laboratory, and the allied Section G (Mechanical Science) will meet in close contiguity in Keble College Hall. Section B (Chemistry) will meet in the Chemical Theatre, and for larger meetings will have the use of the large Lecture Theatre in the Museum. Section C (Geology) will meet in Hertford College Hall; Section D (Biology) in the Anatomical Theatre. Section H (Anthropology) will be accommodated in Prof. Arthur Thomson's new Hall of Anatomy, and will have the advantage of being in close proximity to the Pitt-Rivers Museum. The new Section I (Physiology) will perhaps be better off than any, as the whole of the new Physiological Laboratories will be at its disposal.

The proceedings will begin on the evening of Wednesday, August 8, when Prof. Burdon Sanderson will resign the presidency, and the new President, the Most Hon. the Marquis of Salisbury, K.G., Chancellor of the University, will deliver the opening address. On the Thursday evening there will be a conversazione in the University Museum. On the Friday evening Mr. W. H. White, C.B., will give an evening lecture in the Sheldonian Theatre, on "Steam Navigation at High Speeds." The Saturday evening lecture to working men will be given by Prof. Sollas. On Monday evening Prof. J. Shields Nicholson will lecture in the Sheldonian Theatre, on "Historical Progress and Ideal Socialism," and the Tuesday evening will be occupied by a conversazione, which will probably be given in the new Examination Schools. Invitations to foreign investigators have been issued by the Local Executive Committee, and nearly eighty have already signified their intention to attend the meeting, amongst them being Prof. Quincke, Prof. Oskar Schlömilch, Prof. Moritz Cantor, Prof. Kohlrausch, Prof. Strasburger, Prince Roland Bonaparte, Prof. Anoutchine, M. Cartailhac, Dr. Mojsisovics von Mojsvar, Prof. Maxime Kovalevskij, Prof. Victor Carus, Prof. E. van Beneden, Prof. Dames, Prof. F. von Sandberger, Prof. F. Schmidt, Prof. Taussig, Prof. Ostwald, Prof. Beilstein, and many other notabilities in every branch of science. Nearly every prominent English man of science has already expressed his intention of being present, and there can be little doubt that the Oxford meeting of 1894 will equal in interest the last Oxford meeting of 1860, which was made celebrated by Prof. Huxley's spirited defence of the then novel doctrine of Darwinism.

The Local Secretaries for the Oxford meeting are Messrs. G. C. Bourne, G. Claridge Druce, and D. H. Nagel, and any communications respecting the meeting should be addressed to them at the University Museum, Oxford.

EXHIBITIONS OF PHYSICAL APPARATUS.

IN the days when *a priori* reasoning reigned supreme, when all observations which were not found in the works of early writers were regarded with suspicion, and all facts had to stand or fall according to their relation to metaphysics, there was no demand for scientific instruments and apparatus. A cause or a principle was then stated like a proposition in mathematics, and the effects which follow upon it were deduced; nowadays the scientific method is to observe the effects, and afterwards formulate a law which embraces them. To carry out this method of experiment and induction, apparatus is needed, and hence the state of physical science at any epoch can be estimated by the character of the instruments at the disposal of investigators. Judged by this criterion, physics and astronomy must have attained a marvellous degree of accuracy. The intricate nature of some physical instruments, and the complicated accessories with which all large astronomical telescopes are now equipped, not only testify to the skill of the instrument-maker, but also represent engines of research whereby new fields are explored. These instruments thus afford tangible evidence of advance, and it is for this reason that their exhibition is to be commended. Such an exhibition of physical instruments was lately held at Paris by the Société Française de Physique, and it is well worthy of imitation on this side of the Channel.

The apparatus of physics falls naturally into two classes—that used for lectures, and that belonging more especially to the laboratory. The apparatus employed in teaching elementary science cannot be too simple and the experiments performed with it should be so clearly shown that the facts they exemplify become evident to the most obtuse student. In many cases this tenet of experimental philosophy is disregarded, the lecturer aiming at producing brilliant effects—stage fireworks, as they have been appropriately called—rather than the illustration of a physical law. In fact, there is a tendency to push lecture-room experimentation too far, to use the lecture-assistant's skill as a make-up for lack of eloquence. The popular mind looks in awe upon the abundance of instruments arranged for this end, but it may be doubted whether, under such circumstances, the points of the discourse are not often obscured.

As to laboratory experiments for students, each should constitute a little investigation in itself. An experiment consists in changing the conditions and arrangements of natural bodies in order to examine their behaviour. The student should, therefore, be given the apparatus required to demonstrate a principle, and should be told what to do with it, but the inference to be drawn from his observations should be left entirely to him. If it is necessary to tell him what the experiment proves, then the object of his work has not been attained. By following this method, and properly grading the experiments, the student not only derives considerable educational benefit in learning to think for himself, but the instinct for research is also stimulated. In many colleges and institutions where the aim is to rush the student through as much experimental work as possible in a short time, the apparatus is all arranged for the student, who merely presses a knob and sees a galvanometer needle wriggle, or something of the kind. There can be no independent thinking in such cases, and, except for examinational purposes, the experiments might just as well be left undone. Most physicists agree with these opinions, and, by arranging an exhibition of apparatus, the Physical Society would help to impress their importance upon teachers. Sets of apparatus suitable for lectures and for practical work in various branches of physics might be arranged for exhibition by a committee, and these, with the instruments of precision, would make an extremely interesting, as well as useful, collection.

The exhibition of physical apparatus at Paris comprised numerous ingenious instruments, but there was no attempt at arranging educational sets. Lord Kelvin's voltmeters and ammeters were shown, and various instruments for measuring electric energy and resistance. A binocular photometer attracted some attention, and also a new kind of ophthalometer and a monochromatoscope. M. V. Chabaud showed a form of electrometer devised by M. Lippmann, several pieces of apparatus made from dielectrine, tolueine thermometers for the measurement of low temperatures, Villard manometers, Varenne's apparatus for fractional distillation, and Bichat's hygrometers. M. J. Carpentier's exhibit included mica condensors, and an instrument invented by General Sebert for determining the rapidity of photographic plates. M. J. Richard showed a meteorograph constructed for the observatory on Mont Blanc, an electric anemometer, Favé sounding-line, and numerous recording voltmeters and ammeters. His exhibit also comprised, among other things, several of Bonetti's electrical machines, Berlemont's mercury pump, and various sterilisers. The photographs of interference fringes obtained by M. Meslin call for special mention, and also a pendulum devised by Captain Colson for measuring short exposures in photography, and a theodolite adapted to photographic work by M. Echassoux. The French Photographic Society exhibited sets of photographic apparatus, and M. G. Raymond some fine cloud photographs. The apparatus used by M. Marey for photographing objects in motion, naturally found a place in the exhibition. Photographs in colours, obtained by the Lippmann method, were seen by projection, and were greatly admired. Many other results of scientific research were shown, together with the instruments by means of which they were obtained, but no useful purpose would be served by enumerating them. It is proposed to hold a similar exhibition next year, and if instrument-makers co-operate with investigators as they did in the one just closed, there can be no doubt as to its value to workers in all branches of physics.

There should be little difficulty in arranging an annual exhibition of a similar kind in London. Scientific instrument-makers would compete with one another in showing work of a high quality; and if the exhibits were organised by a competent committee, the venture would be successful from every point of view. R. A. G.

AUGUST KUNDT.

PHYSICAL science, which within the lapse of six years has witnessed the death of Kirchhoff, Clausius, and Hertz, has suffered another severe loss; on May 21, August Kundt, who was but fifty-four years of age, suddenly died at his country place near Lübeck.

Kundt was born at Schwerin, on November 18, 1839, and began his studies at Leipzig in 1860, under Hankel, Neumann, Bruhns, and others. Thence he went to Berlin, where Encke, Förster, Dove, and Kummer were his principal teachers. He began by giving special attention to astronomy, and indeed intended to devote himself to that branch of science. While yet undecided, however, he entered the private physical laboratory that Gustav Magnus had fitted out in the Prussian capital, and in which students with a decided taste for experimental investigation were allowed to work. From the beginning he displayed extraordinary experimental ability, combined with rare energy in the pursuit of the work he had once taken in hand, qualities which were characteristic of him during his whole scientific career. He also attended the physical "colloquia" which Magnus had introduced, and under the influence of the latter was definitely enrolled in the lists of experimental physicists.

He graduated at Berlin in April 1864, with an investigation on the depolarisation of light. The first and last of the theses appended to his dissertation (dedicated to Magnus) are characteristic of the state of his mind at that time. They run as follows:—

(1) Vires animæ non minus metiri possumus, quam vires physicas. . . .

(4) Theoriam a Cl. Fresnel de torsione planitiei polarisationis promulgatam si adoptamus, omnia ea corpora quæ planitiem polarisationis torquent, sub aptis conditionibus birefractionem demonstratura esse, negare non possumus.

He never himself followed up the psychological lines of research hinted at in the first thesis; the last proposition is known to be entirely borne out by modern research on circular double refraction.

In 1867 he became "Privatdocent" in the University of Berlin, but was appointed to a professorship in the Swiss federal polytechnic school at Zurich, in the following year. There he remained but two years, removing to Würzburg in 1870, where his stay was of no longer duration, the then newly organised University of Strasburg having called him to represent his science on a brilliant staff of young and enterprising men, who within a few years brought their "alma mater" to a high level of excellence. In this work of organisation Kundt was one of the most actively engaged, holding the office of rector in the year 1877, when but 38 years of age. Quite apart from his purely scientific reputation, this alone is sufficient to mark his name with golden letters in the annals of Strasburg University, for which he also erected an imperishable monument, the Physical Institute, well known throughout the scientific world as one of the best laboratories existing.

In 1888, when Prof. von Helmholtz became president of the "Reichsanstalt," Kundt succeeded him as professor of experimental physics, and director of the Berlin Physical Institute. A prolonged period of scientific activity from a man of but fifty years of age with a world-wide reputation might still have been expected; but these hopes have proved vain. A few years ago the symptoms of a disease began to appear, which could not be subdued. Kundt fought for life to the last; and notwithstanding the slow but unceasing strides his ailment made, which would have entirely prostrated most other men, he continued his lectures and other pressing duties during the whole of last winter, thus setting an example of sacrifice to the cause of science even in the face of death. When, at the urgent instance of his medical advisers and friends, he stopped work and left Berlin, it proved of no avail; in fact, he may be said to have died as he had lived, in the midst of scientific work.

As an investigator Kundt was many-sided; his discoveries are so generally known, that it is hardly necessary to describe them in detail. He first turned his attention to acoustics; his start in scientific life being the invention of the well-known "Kundt's sound tubes," or "Kundt's dust figures," which he himself and others turned to account in many different ways. The application of that purely acoustic method led to the determination of the ratio of specific heats of mercury vapour. In collaboration with Warburg (1884), Kundt found this to be 5/3, as predicted by the kinetic theory for a monatomic gas. He also conducted researches on thermal conductivity and inter-diffusion of gases or vapours and on the influence of pressure on the surface tension of liquids; and developed his well-known red and yellow dust-spray method for investigating the pyro-electric and piezo-electric properties of crystals.

But in glancing over his life-work as it now lies before us, it appears as if the palm ought to be assigned to his optical and magneto-optic discoveries. He began with a brilliant series of papers on anomalous dispersion, which placed this important subject on a sound footing. He described the doubly refractive properties of vibrating solids, of metallic films obtained by disintegration of cathodes and of certain liquids in motion, and investigated the optical properties of electrified quartz. With Röntgen he was able to show a slight magneto-optic rotation in several vapours and compressed gases, which even Faraday had not been able to detect, and, on the other hand, its enormous value in iron, cobalt, and nickel. The latter will be known to coming generations as "Kundt's phenomenon." Last, but not least, he succeeded in determining the refractive indices of metals, which he was able to obtain in the shape of extremely thin prisms.

His experimental work, of which the above gives but an incomplete summary, is throughout characterised by the greatest ingenuity in the selection of means to attain definite ends, by the rare quality of ever-watchful self-criticism, which prevented his running away with himself. He possessed that instinctive and immediate power of discriminating the broad way of progress into the unknown from the stray paths leading into tangled wilderness, a faculty which he used to call the pioneering scent of the experimenter.

Space forbids an adequate account of what Kundt personally was to his family, his friends, and his pupils. The latter, a great number of whom are scattered throughout the civilised world, were attached to him by the strongest ties of a scientific and private character, and lost no chance of showing the high esteem they felt for him. They owe a life-long debt of gratitude to the great experimenter, who to most of them was not only a teacher but also a personal friend, ever ready to render help and advice based on his varied experience of scientific life.

H. DU BOIS.

NOTES.

THE annual meeting for the election of Fellows into the Royal Society was held on Thursday last, when the following gentlemen were elected:—Mr. William Bateson, Mr. G. A. Boulenger, Dr. J. R. Bradford, Prof. H. L. Callendar, Prof. W. W. Cheyne, Mr. R. E. Froude, Prof. M. J. M. Hill, Prof. J. V. Jones, Mr. E. H. Love, Mr. Richard Lydekker, Mr. F. C. Penrose, Mr. D. H. Scott, Rev. F. J. Smith, Mr. J. W. Swan, Mr. V. H. Veley.

PROF. PERCY FRANKLAND, F.R.S., has been elected to the chair of chemistry and metallurgy in Mason's College, Birmingham, rendered vacant by the resignation of Dr. Tilden.

WE regret to announce the death, at the age of sixty-seven, of Prof. W. D. Whitney, well known for his philological researches.

WE are requested to state that a British Committee, of which Sir Douglas Galton, K.C.B., F.R.S., is the chairman, and Prof. W. H. Corfield is the treasurer, has been formed to further the interests in this country of the Eighth International Congress of Hygiene and Demography, which is to be held in Budapest, from September 1 to 8 of this year. Any information may be obtained about the Congress from the Hon. Secretary, Dr. Paul F. Moline, 42 Walton Street, Chelsea, S.W.

THE University of Halle will celebrate its second centenary on August 2nd, 3rd, and 4th of this year.

SIR SPENCER WELLS has been elected a Fellow of the Hungarian Academy of Sciences.

M. D'ARSONVAL has been elected a member of the Section de Médecine et Chirurgie of the Paris Academy of Sciences, in succession to the late Dr. Brown-Sequard.

THE death is announced of Dr. E. Sperk, Director of the Imperial Institute of Experimental Medicine, St. Petersburg, and of Prof. Fischer, Chief of the Royal Prussian Geodetic Institute.

DR. H. MOLISCH has been appointed Director of the Institute of Vegetable Physiology at Prague, in the place of the late Prof. G. A. Weiss.

M. P. SINTEINS has just started on a journey of botanical exploration in Eastern Armenia.

DR. C. V. RILEY has resigned the post of entomologist to the U.S. Department of Agriculture, on account of failing health.

IT is reported by the Eastern Extension, Australasia and China Telegraph Company, that a plague has broken out at Hong Kong. No particulars as to the epidemic have been received, but its serious nature may be gathered from the report that fifteen hundred deaths have already occurred, and that this list is increased by nearly one hundred every day. It is said that half the native population, numbering about one hundred thousand, have left the colony, and thousands are following them daily.

A VIOLENT hailstorm visited Vienna on Thursday last, shortly before seven o'clock in the morning. The hail was preceded by a heavy fall of rain, and accompanied by slight displays of sheet lightning. In the course of a few minutes the streets were covered with a thickness of several inches of hailstones. It is said that upwards of one hundred thousand windows were smashed by the hail; numerous trees were entirely stripped of their foliage, and most outdoor plants within the area of fall were destroyed. The hailstones were, on the average, about the size of hazel-nuts. During the storm the temperature dropped to 10° Réaumur (54° Fahr.), but shortly afterwards the thermometer rose a few degrees. Similar storms are reported from various districts in Hungary and Croatia.

THE New York members of the London Society of Chemical Industry have drawn up a petition requesting permission from the Council to form a local section. This is a step towards the realisation of the scheme suggested by Dr. Armstrong in his recent address to the Chemical Society.

THE Iron and Steel Institute has issued its provisional programme for the Brussels meeting, which is to be held August 20 to 24. There will be a reception by the Local Committee on the 20th, reading and discussion of papers on the mornings of 21st and 22nd, a visit to the Antwerp International Exhibition on the afternoon of 21st, a visit to the Mariemont Collieries and Couillet Steel-works at Charleroi on the 23rd, and a visit to the works of the Cockerill Company, at Seraing, and the Angleur Steel-works, at Liége, on the 24th.

IN connection with the recent foundation of a Research Fellowship in Chemical Pharmacology by the Court of the Salters' Company, the Research Committee of the Pharmaceutical Society announces that the selection of the Salters' Company's Research Fellow will take place on July 3 next. Written applications for the Fellowship must be received by the Director of the Research Laboratory, 17, Bloomsbury Square, before June 30.

AT the meeting of the American Academy, on May 8, the following officers were elected to serve during the coming year: President, Prof. Josiah P. Cooke; Vice-President, Mr. Augustus Lowell; Corresponding Secretary, Prof. Charles L. Jackson; Recording Secretary, Mr. William Watson; Treasurer, Mr. Eliot C. Clarke; Librarian, Mr. Henry W. Haynes; Councillors, Messrs. William R. Livermore, Benjamin O. Peirce, Benjamin A. Gould, Henry P. Walcott, Benjamin L. Robinson, Henry W. Williams, J. R. Thayer, T. W. Higginson, and Andrew M. Davis.

THE preliminary programme of the forty-third meeting of the American Association for the Advancement of Science, to be held in Brooklyn, from August 15 to 24, under the presidency of Dr. D. G. Brinton, has been issued. The officers of the various sections are as follows:—Section A (Mathematics and Astronomy): Vice-President, Prof. George C. Comstock; Secretary, Prof. Wooster C. Beman. Section B (Physics): Vice-President, Mr. William A. Rogers; Secretary, Mr. Benj. W. Snow. Section C (Chemistry): Vice-President, Mr. Thomas H. Norton; Secretary, Prof. S. M. Babcock. Section D (Mechanical Science and Engineering): Vice-President, Mr. Mansfield Merriam; Secretary, Mr. John H. Kinelay. Section E (Geology and Geography) Vice-President, Mr. Samuel Calvin; Secretary (vacancy to be filled). Section F (Zoology): Vice-President (vacancy to be filled); Secretary, Prof. William Libbey. Section G (Botany): Vice-President, Mr. Lucien M. Underwood; Secretary, Prof. Charles R. Barnes. Section H (Anthropology): Vice-President, Mr. Franz Boaz; Secretary, Mr. Alex. F. Chamberlain. Section I (Economic Science and Statistics): Vice-President, Mr. Henry Farquhar; Secretary, Mr. Manly Miles. The following subjects of addresses by the Vice-Presidents are announced:—Physics: "Obscure Heat as an Agent in producing Expansion and Contraction in Metals." Anthropology: "Human Faculty as determined by Race." Geology and Geography: "Some Points in Geological History illustrated in North-Eastern Iowa." Economic Science and Statistics: "A Stable Monetary Standard." Mathematics and Astronomy: "Binary Stars." Botany: "The Evolution of the Hepaticæ." Chemistry: "The Battle with Fire." Mechanical Science and Engineering: "Paradoxes in the Resistance of Materials."

THE affiliated societies holding meetings during the meeting of the Association are:—The Geological Society of America (President, Prof. T. C. Chamberlain; Secretary, Prof. H. L. Fairchild); Society for Promotion of Agricultural Science (President, Mr. L. O. Howard; Secretary, Mr. William Frear); Association of Economic Entomologists (President, Mr. L. O. Howard; Secretary, Mr. C. P. Gillette); Association of State Weather Service (Secretary, Mr. Robert E. Kerkham); Society for Promoting Engineering Education (President, Prof. De Volson Wood; Secretary, Prof. J. B. Johnson); American Microscopical Society (President, Dr. Lester Curtis; Secretary, Dr. W. H. Seaman); American Chemical Society (President, Prof. H. W. Wiley; Secretary, Prof. Albert C. Hale); American Forestry Association (President, Prof. B. E. Fernow; Secretary, Mr. J. D. W. French); the Botanical Club (President, Prof. William P. Wilson; Secretary, Mr. Thomas H. McBride); the Entomological Club (President, Mr. C. J. S. Bethune; Secretary, Mr. C. L. Marlett). Geological, mineralogical, botanical, zoological, and engineering excursions have been organised, and arrangements are being made by the American Forestry Association to enable members to proceed from Brooklyn at the close of the session to the White Mountains to attend a Forestry Congress. Special invitations have been extended to distinguished European men of science, and it is announced that properly-accredited members of all National Associations for the Advancement of Science attending a meeting of the American Association are entitled to register without fee as members for the coming meeting. There is every prospect that the meeting will be a very successful one. Information relating to membership and papers can be obtained from Mr. F. W. Putnam, Permanent Secretary, Salem, Mass. All matters relating to local arrangements are managed by Prof. George W. Plympton, Local Secretary, 502 Fulton Street, Brooklyn, N.Y.

THE revival of exploration by Frenchmen has led to the establishment of a series of lectures on scientific subjects to intending travellers at the Natural History Museum in Paris, of which the most recent, a discourse on comparative anatomy, by M. H. Beauregard, appears in the current number of the *Revue Scientifique*. This lecture was originally undertaken by Prof. Georges Pouchet, whose untimely death deprives the French scientific world of one of their most laborious and successful travelling naturalists. The lecturer attributed the lack of attention to comparative anatomy on the part of most travellers to the fact that in making collections they aimed rather to supply museums with attractive specimens than to provide specialists with the material for study and research.

A PLAN of Timbuktu, sent by an officer of the French expedition, was presented to a recent meeting of the Paris Geographical Society, and is reproduced in the last number of the *Comptes Rendus* of that Society. The town has about 12,000 inhabitants, but its commercial prosperity has been destroyed by recent Tuareg raids, many of the buildings being in ruins, although from a distance its large pyramidal mosques give it an imposing appearance. The town is surrounded outside the walls by mounds of dried filth and putrefying animal remains. The desert lies all round, but on the west side there is an extensive pond gradually undergoing desiccation, and several small pools whence the water-supply is obtained.

THE Ethnological Museum at Berlin has just published the second part of Mr. Hrolf Vaughan Stevens' great study of the people of the Malay Peninsula, under the title "Materialen zur Kenntniss der wilden Stämme auf der Halbinsel Malaka," edited by Albert Grünwedel. This part contains a short account of the Negritoes of the Malay peninsula, and a full discussion of the mythology and religion of the Orang Panggang, illustrated by numerous drawings of ceremonial accessories, and particularly the curiously inscribed bamboo-rods called *penitah*, which are buried with the dead to serve as passports in the other world. A long glossary of the Orang-hutan dialects is given in conclusion, being compiled from the records of all travellers who have studied the Malay languages. The value of this glossary is enhanced by the actual renderings of the various authorities being preserved in the different European languages in which they wrote.

THE Weather Bureau of the United States has published its first volume of results of meteorological observations for the years 1891 and 1892, continuing the series formerly published by the Signal Service, together with other climatological tables and special reports of general interest. The work contains 528 large quarto pages, with illustrations and plates, and includes hourly means for 28 stations, with comprehensive and plainly printed monthly and annual summaries at about 170 stations. Prof. C. F. Marvin gives a very full description of the various instruments in use, and Prof. C. Abbe contributes a paper on instrumental corrections and methods of reduction. Both these reports supply much valuable information which will be found very useful to the general public. The work will be widely distributed, as we see that no less than 9000 copies have been printed.

WE believe it is generally known that the Central Observatory of Moncalieri has for many years published a *Bollettino Mensuale*, which is the recognised organ of the Italian Meteorological Society. The bulletin contains the monthly results of a large number of meteorological stations in the Alps, the Appennines, and other parts of Italy, summaries of the proceedings of the Italian and other meteorological societies, and bibliographical notices. In addition to the above, there are articles by members of the Italian Meteorological Society and others on various subjects of scientific interest. The number for May contains a note by Prof. G. Buti on Dr. von Bezold's thermodynamics of the atmosphere, and attention is drawn to two phenomena which up to the present time have been but little studied, viz. the supersaturation and the over-cooling of the air in relation to the formation of thunderstorms and variations of barometric pressure; also a note, by Prof. L. Descroix, on the diurnal oscillations of the barometer at Paris, based on twenty years' observations. Prof. Descroix is of opinion that the differences in the variations of the maxima and minima from day to night, in passing from the warm to the cold season, are explained by the changes of conditions of dryness in the lower strata of the atmosphere, in so far as it is due to their expansion and contraction.

THOUGH the destruction of books by insects is not so great here as in India, it is sufficient to give general interest in the result of an inquiry into the means of preservation adopted in Indian museums (*Indian Museum Notes*, vol. iii. No. 3). In the library of the Revenue and Agricultural Department of the Government of India the books are disinfected by pouring a few teaspoonfuls of refined mineral naphtha, or what is known as benzine collas, into the crevices of the binding, and then shutting up the volume for a few days in a close-fitting box to prevent the escape of the fumes. Books so treated have to be afterwards sponged over lightly with a very little of the finest kerosine oil, which should be rubbed off with a cloth before it has time to penetrate into the binding. Dr. George King reports very favourably upon a system adopted for preserving books in the Royal Botanical Gardens, Sibpore. It consists in brushing the books over with a saturated solution of corrosive sublimate made by constantly keeping a few lumps of the poison at the bottom of a jar of alcohol, so that the maximum amount may be absorbed. In the Indian Museum Library the books are kept in close-fitting glass cases with a few ounces of naphthaline upon each shelf, with the result that little or no damage is caused by insects. It appears that the paste used in binding the Indian Museum books is poisoned by adding about half an ounce of sulphate of copper to each pound of paste, while books already infested are disinfected by shutting them up for four or five days in a close-fitting box of loose naphthaline with as much of this substance as possible between the leaves.

ANOTHER new method for determining the pitches of high tuning-forks is described by Herr F. Melde in the current number of *Wiedemann's Annalen*. It is. like the vibroscopic method previously described, independent of the ear, and is based upon the resonance of a rod clamped at one end and vibrating transversely. The laws of vibration of such clamped rods have already been so carefully studied that calculations of pitch, based upon their dimensions and the properties of the material of which they are made, are very reliable. The rods used consisted of hard brass, cast steel, or iron. They were 32 cm. long, 1 cm. broad, and 1·5 or 2 mm. thick. They were firmly clamped in an iron clamp let into a piece of sandstone, care being taken that the jaws of the clamp were strictly in the same plane at right angles to the length of the rod. The tuning-fork tested was mounted in a wooden block, and placed with one prong lightly touching the end of the rod, so that a vibration of the tuning-fork when bowed produced a transverse vibration of the rod. Fine sand was dusted on to the rod. If on bowing the tuning-fork the sand did not arrange itself in straight lines at right angles to the length of the rod, the clamp was shifted until it did. The mode of vibration, and consequently the pitch, was then calculated from the number of such nodal lines produced. An interesting application of the method was the testing of Appunn's tuning-fork apparatus for the determination of the upper limit of audibility. One fork marked 16,384, as determined by the method of beats, gave really only 11,717 vibrations per second. On the other hand, a standard fork by Dr. König, of Paris, of pitch 16,383, was found to give 16,480 by the new method—a good testimony to the accuracy of both determinations. In each case, the results were confirmed by the vibroscopic method.

THE current number of *L'Elettricista* (Rome) contains an interesting description, by Signor Riccardo Arnò, of a new experiment he has performed. As is well known, Prof. Crookes has shown that when an electric discharge is passed through an exhausted tube, and a small windmill is suitably placed in the path of the discharge, a continuous rotation is obtained. This phenomenon suggested to the author to try if he could obtain a similar rotation by placing an exhausted bulb containing a small windmill in a rotating electrostatic field. The rotating electrostatic field was obtained by connecting four upright brass plates to fixed points in the secondary of a large Ruhmkorff coil, through the primary of which an alternating current was passed. In order to try the experiment it was impossible to use an ordinary radiometer with mica vanes, since the author in a previous series of experiments had shown that when a dialectric is placed in a rotating electrostatic field it experiences a force tending to rotate it, in the same sense as the direction of rotation of the field. Hence the author had a special radiometer constructed with thin brass vanes, since it was only by using a windmill made entirely of a metal that he could be sure he had entirely eliminated the direct action of the rotating field on the vanes, and be sure the effect observed was due to the gas remaining in the tube. When the electrostatic field was sufficiently strong, and the surface of the glass vessel containing the vanes well dried, a rotation was obtained in the same direction as that of the field. In order to show that the rotation is not due to direct action on the vanes, the author suspended a similar set of brass vanes, by means of a long silk fibre, in air at the ordinary pressure in the same rotating field, and found that no rotation was produced. When the radiometer is under the influence of the rotating electrostatic field the bulb is uniformly lighted up, so that the number of turns of the vanes could be counted in the dark. The author considers the effect must be due to some action of the rotating field on the molecules of the gas, which tends to increase their velocity in the direction of rotation of the field, and thus in the case when the gas is much rarefied, so that the free path of the molecules is relatively long, the impact of the molecules on the metallic vanes cause the latter to rotate in the same sense as the field.

THE current number of the *Annali dell Istituto d'Igiene di Roma* contains a paper by Dr. Palermo, on the action of sunshine on the virulence of the cholera bacillus suspended in broth and water respectively. The pathogenic property of all the infected solutions was in each case determined by inoculation into guinea-pigs, so that the difference in the toxic character of the contents of the insolated and darkened tubes could be compared with that possessed by the cholera-infected broth or water solutions treated in the ordinary manner. In order to ascertain what was the effect of sunshine on the *number* of cholera bacilli present, agar dish cultures were made of the insolated and darkened tubes respectively; in no single instance, however, could any numerical difference be detected in either set of experiments. That the sunshine had modified the biological character of the bacilli, was shown very strikingly in drop-cultures, for when examined from insolated broth tubes they were found to have been deprived of all power of motility, whilst the characteristic activity was still apparent in such cultures prepared from the darkened tubes. As regards the degree of virulence possessed by the broth cultures, those exposed to sunshine for *less* than three hours invariably killed the animals, whilst when insolation was prolonged for three and a half, four, and four and a half hours respectively, not a single guinea-pig succumbed. The interesting discovery was, moreover, made that those animals which had survived inoculation with the insolated cholera cultures were protected from cholera, for when eight days later they were inoculated with virulent cholera cultures they did not succumb to this disease. The pathogenic properties of the cholera bacillus were removed more quickly by insolation when immersed in water than in broth. It will be remembered that Arloing stated, as far back as 1885, that he had succeeded in reducing virulent anthrax cultures to the condition of vaccine by insolation; but so far as we are aware, Dr. Palermo is the only other investigator who has been able to render animals immune to a disease by the inoculation of insolated pathogenic cultures.

A PAMPHLET on "Dry Methods of Sanitation," by Mr. G. V. Poore, the author of "Essays on Rural Hygiene," has been published by Mr. Edward Stanford.

IN connection with an exhibition of beautiful and curious British and foreign species of butterflies and moths, at his Piccadilly establishment, Mr. William Watkins has issued a descriptive guide to the specimens on view.

THE address on "The Rise of the Mammalia in North America," delivered by Prof. H. F. Osborn at the last meeting of the American Association for the Advancement of Science, and partly reprinted in these columns (vol. xlix. pp. 235, 257, 1893), has been published separately, and can be obtained from Messrs. W. Wesley and Son.

A PRELIMINARY list of the vertebrate animals of Kentucky is contributed by Mr. H. Garman to the *Bulletin* of the Essex Institute, Massachusetts (vol. xxvi. Nos. 1-3). The list is based upon collections and observations made in various parts of Kentucky from points near the eastern limits of the State to Hickman on the Mississippi River.

A VOLUME by Prof. Dwelshauvers-Dery, entitled "Étude Expérimentale Dynamique d'une Machine a Vapeur," has lately been added to the Aide-Mémoire series published at Paris by Gauthier-Villars and by Masson. Two other volumes recently received are "Électricité Appliquée a la Marine," by M. P. Minel, and "La Rectification de L'Alcool," by M. Ernest Sorel.

THE Agent-General for New South Wales has sent us the report of the Department of Public Works for the year 1892. A considerable amount of work was carried out during the year in connection with harbours and rivers and water supply, water conservation and irrigation, roads and bridges and sewerage. The report contains twenty-seven plates illustrating the state of the work in hand and the machinery employed.

THE difficult genera *Rosa* and *Rubus* are the subject of careful study by French botanists. A Rhodological Society has been founded for the purpose of publishing a herbarium of the Roses of France, named by the Belgian rhodologist M. Crépin. Those intending to subscribe are invited to correspond with Dr. Pons, Ille-sur-Têt, Pyrénées Orientales. A publication is also announced with the title *Rubi præsertim Gallici exsiccati*, under the editorship of Prof. Bourlay, Rue de Toul, Lille, and M. Bouly de Lesdain, 16, Rue Emmery, Dunkerque. We note also the publication of the first fascicle of Messrs. E. F. and W. R. Linton's "Set of British Willows."

FOUR new volumes of the series of reprints published by Engelmann, of Leipzig, viz. Ostwald's "Klassiker der Exakten Wissenschaften," have just appeared. Nos. 46 and 47 deal with the calculus of variation, and contain papers by Joh Bernoulli (1696), Jac Bernoulli (1697), Euler (1744), Lagrange (1762, 1770), Legendre (1786), and Jacobi (1837). Electricians will be interested in No. 52, which contains Galvani's observations on the action of electricity on the muscles of frogs. The twenty-one quaint figures in the text give this volume additional value. Gauss' researches on the intensity of terrestrial magnetism, communicated to the Göttingen Gesellschaft der Wissenschaften in 1832, are reprinted in No. 53 of this very useful series.

AMONG numerous papers recently distributed by the Smithsonian Institution are Prof. S. P. Langley's memoir on "The Internal Work of the Wind" (see NATURE, vol. xlix. p. 273, 1893), and several contributions by Prof. H. F. Osborn to the *Bulletin* of the American Museum of Natural History. One of these is concerned with the fossil mammals of the Upper Cretaceous beds of America, and the conclusions arrived at from a discussion of the upper and lower dentition are the reverse of those expressed by Prof. Marsh on the same fauna. Other recently-issued excerpts from the *Bulletin* referred to are "Artionyx, a new Genus of Ancylopoda," by Prof. Osborn and Dr. J. L. Wortman; "On the Divisions of the White River or Lower Miocene of Dakota," by Dr. Wortman; and "Ancestors of the Tapir from the Lower Miocene of Dakota," by Dr. Wortman and Mr. C. Earle.

MM. J. B. BAILLIÈRE ET FILS, Paris, have published a "Flore de France," by M. A. Acloque, containing the description of all the indigenous species, and illustrated by 2165 small figures representing the characteristic types of genera and sub-genera. The book has been designed to assist in the identification of plants. It appeals, therefore, to those who, when they see a plant, want to know its place in the flora of France. By means of it, local botanists will be able to determine easily the species of plants in their districts, and thus a large amount of useful material with regard to geographical distribution may be got together. Another flora lately published is that of "Nordwestdeutchen Tiefebene" (Engelmann, Leipzig), by Prof. F. Buchenau. This, however, is not so much a work to assist amateur botanists as a work of reference in which all the plants in the region covered are systematically arranged and described.

THREE iodo-sulphides of phosphorus have been prepared by M. Ouvrard, and are described in the June issue of the *Annales de Chimie et de Physique*. The iodide of phosphorus P_2I_4 is not attacked by sulphuretted hydrogen at the ordinary temperature, but at a temperature slightly higher than the melting point of the iodide, about 115°, hydriodic acid is slowly produced, and after a couple of days' heating at this temperature the reaction is usually complete. The product is readily soluble in carbon bisulphide, and the solution deposits crystals of an iodosulphide of the composition $P_4S_3I_2$. The reaction proceeds in accordance with the equation, $2P_2I_4 + 3H_2S = P_4S_3I_2 + 6HI$. This new substance forms very well-developed yellow crystals of high refractive power. They are permanent in dry air, but slowly attacked by moisture with elimination of sulphuretted hydrogen. They melt about 106° to a viscous liquid, and about 300° they inflame with evolution of iodine vapour and white fumes of phosphoric anhydride. Cold water only slowly attacks them, but they are rapidly decomposed by hot water. Fuming nitric acid at once induces an explosion accompanied by incandescence. The compound may more easily be prepared by dissolving the constituents in the correct proportions in carbon bisulphide, evaporating and heating to 120° in a current of inert gas, and again dissolving in carbon bisulphide; the solution deposits crystals of the new substance upon evaporation. It may also be at once obtained by dissolving iodine in a solution of sesquisulphide of phosphorus in carbon bisulphide and evaporating. The second iodo-sulphide of phosphorus has the composition PSI or $P_2S_2I_2$, and was obtained by the action of sulphuretted hydrogen upon the tri-iodide of phosphorus, PI_3. A lower temperature than that required for the formation of the compound just described is advisable at first; it should not be much higher than 55°, the melting point of the tri-iodide; before the conclusion of the reaction, however, it may safely be raised to 120°. The solution of the product in carbon bisulphide deposits red crystals of the new compound PSI. These crystals are much more rapidly attacked by moist air than those of the first iodo-sulphide, and the reaction is accompanied by the liberation of fumes of hydriodic acid. They take fire upon warming in the air, disseminating the odour of sulphur dioxide and the violet vapour of iodine. Water dissolves them rapidly, producing trisulphide of phosphorus and hydriodic and phosphorous acids, and sulphuretted hydrogen is subsequently evolved owing to the decomposition of the trisulsphide. The third iodo-sulphide was obtained by reacting with excess of tri-iodide of phosphorus upon the trisulphide. It is deposited from carbon bisulphide in deep red crystals, very rapidly decomposed by moist air, and its composition is P_2SI_4. It thus appears that iodine is capable of replacing more or less of the sulphur contained in the sulphides of phosphorus, although it does not succeed in totally eliminating sulphur from its combination with phosphorus. M. Ouvrard has also obtained several new halogen derivatives of the sulphides of arsenic and antimony. English readers of the original paper cannot but be sorry, however, that M. Ouvrard employs the old notation, which renders it difficult at first sight to follow the equations representing the reactions. The formulæ above given are translated into the modern notation now universally employed in this country and Germany.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*, ♀) from India, a White-throated Capuchin (*Cebus hypoleucus*) from Central America, presented by Mr. F. Erskine Paton; a Grey Ichneumon (*Herpestes griseus*) from India, presented by Miss Florence Marryat; two Common Peafowl (*Pavo cristatus*, ♂ ♀) from India, presented by Mr. A. Tannenbaum; a Puff Adder (*Vipera arietans*) from South Africa, presented by Mr. J. E. Matcham; four Common Snakes (*Tropidonotus natrix*), a Common Viper (*Vipera berus*), British, presented by Mr. Harold Attewell; a Smooth Snake (*Coronella lævis*) British, presented by Mr. Harry Furniss; a Natterjack Toad (*Bufo calamita*), British, presented by Mr. F. Wallace; a Raven (*Corvus corax*), British, presented by Mr. Robert O. Callaghan; two Cape Crowned Cranes (*Balearica chrysopelargus*) from South Africa, four Yellow-bellied Liothrix (*Liothrix luteus*), two Hamadryads (*Ophiophagus elaps*) from India, deposited; an Ashy-black Macaque (*Macacus ocreatus*, ♂) from the East Indies, a Beech Marten (*Mustela foina*) from Russia, a Red and Yellow Macaw (*Ara chloroptera*) from South America, a Yellow-headed Vulture (*Cathartes urubitinga*) from Brazil, a Turkey Vulture (*Cathartes aura*) from America, a Guianan Crested Eagle (*Morphnus guianensis*) from the Amazons, purchased; an English Wild Cow (*Bos taurus*, var.), three Varied Rats (*Isomys variegatus*), a Bennetts Wallaby (*Halmaturus bennetti*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

REPORT OF THE ASTRONOMER-ROYAL FOR SCOTLAND.—The fourth annual report of Prof. Copeland on the Royal Observatory, Edinburgh, informs us that great progress has been made in the construction of the new Observatory. The masonry of all the buildings is complete, and some parts are ready for the internal fittings.

A comparison of the earlier Edinburgh star places with the catalogue of the *Astronomische Gesellschaft* has shown the necessity of a complete new reduction of the observations, in order to bring them into line with modern practice in this kind of work. For this purpose considerable progress has been made in an investigation of the errors of the transit instrument.

At the request of M. d'Abbadie, of the Paris Academy of Sciences, a bifilar pendulum was temporarily erected on the rock at Calton Hill on March 24. This extremely sensitive instrument, constructed by Mr. Horace Darwin on a principle suggested by Lord Kelvin, indicates the minutest change of level in the foundation to which it is attached. Prof. Copeland hopes shortly to commence a series of systematic observations in conjunction with allied observations made by M. d'Abbadie nearly on the same meridian in the south of France. These investigations will probably show if any considerable tilt takes place at the same time at both stations. It is thought that the bifilar pendulum may serve to detect the occurrence of sudden displacements in the foundations of observatories.

AWARD OF THE WATSON MEDAL.—At Washington a few weeks ago Mr. S. C. Chandler was awarded the Watson medal by the National Academy of Sciences. A description of the founding of the award and the work of previous recipients, given by Mr. John Ritchie, jun., in the *Boston Commonwealth*, recalls a few facts of interest. Prof. J. C. Watson, the founder of the award, was for many years professor of astronomy and physics in the Universities of Michigan and Wisconsin, and for some time previous to his decease was director of the Washburn Observatory at Madison. His treatise on theoretical astronomy is known to every computing astronomer. During the later years of his life he devoted his attention to the minor planets, of which he discovered twelve. It is common knowledge that, at the eclipse of July 29, 1878, he and Dr. Swift reported observations of an intra-mercurial planet, and he believed in the existence of such a body up to his death in 1880. At his death he left his estate, some family legacies excepted, in trust to the National Academy of Sciences, the fund having since been designated the Watson Fund. The amount of money realised was in all some twenty or thirty thousand dollars. The income of this is to be expended for the promotion of astronomical science, specific provision being made for the presentation of a gold medal and a gratuity of one hundred dollars in gold coin, from time to time, to an astronomer who shall have accomplished work of high merit. He nominated as trustees of his fund his friends Hilgard, Coffin and Newcomb, with provision for the appointment of their successors. The high quality of the trust has been continued by the selection of Dr. B. A. Gould and Prof. Asaph Hall as successors to Hilgard and Coffin, who passed away some three years ago. Four medals only have been given: the first to Dr. B. A. Gould in 1887; the second to Prof. Edward Schönfeld, Director of the University of Bonn, in 1888; the third to Dr. Arthur Auwers, of Berlin, in 1891; and the fourth to Mr. Chandler. It need hardly be said that the award was chiefly given to Mr. Chandler for his brilliant investigations on the variations of latitude.

TWO NEW CATALOGUES.—*Astronomische Nachrichten* No. 3232 contains a long list of stars with remarkable spectra, observed by the Rev. T. E. Espin. The catalogue comprises 167 stars, most of which have not had their spectra previously recorded, 206 stars found to have spectra belonging to Type III., and a list of 136 stars, of which it is doubtful whether they belong to Type II. or III. Nos. 3233-34 of the same publication contain a catalogue of 187 new double stars discovered with the 18¼ inch refractor of the Deerhorn Observatory, U.S.A., and measures of 152 double stars, by Prof. G. W. Hough.

THE DENSITY OF NITROGEN GAS.[1]

IN a former communication[2] I have described how nitrogen, prepared by Lupton's method, proved to be lighter by about 1/1000 part than that derived from air in the usual manner.

[1] "On an Anomaly encountered in Determinations of the Density of Nitrogen Gas." A paper read before the Royal Society on April 19, by Lord Rayleigh, Sec. R.S.

[2] "On the Densities of the Principal Gases," *Roy. Soc. Proc.* vol. liii. p. 146, 1893.

In both cases a red hot tube containing copper is employed, but with this difference. In the latter method the atmospheric oxygen is removed by oxidation of the copper itself, while in Lupton's method it combines with the hydrogen of ammonia, through which the air is caused to pass on its way to the furnace, the copper remaining unaltered. In order to exaggerate the effect, the air was subsequently replaced by oxygen. Under these conditions the whole, instead of only about one-seventh part of the nitrogen is derived from ammonia, and the discrepancy was found to be exalted to about one half per cent.

Upon the assumption that similar gas should be obtained by both methods, we may explain the discrepancy by supposing either that the atmospheric nitrogen was too heavy on account of imperfect removal of oxygen, or that the ammonia nitrogen was too light on account of contamination with gases lighter than pure nitrogen. Independently of the fact that the action of the copper in the first case was pushed to great lengths, there are two arguments which appeared to exclude the supposition that oxygen was still present in the prepared gas. One of these depends upon the large quantity of oxygen that would be required in view of the small difference between the weights of the two gases. As much as 1/30th part of oxygen would be necessary to raise the density by 1/200, or about one-sixth of all the oxygen originally present. This seemed to be out of the question. But even if so high a degree of imperfection in the action of the copper could be admitted, the large alteration caused by the substitution of oxygen for air in Lupton's process would remain unexplained. Moreover, as has been described in the former paper, the introduction of hydrogen into the gas made no difference, such hydrogen being removed by the hot oxide of copper subsequently traversed. It is surely impossible that the supposed residual oxygen could have survived such treatment.

Another argument may be founded upon more recent results, presently to be given, from which it appears that almost exactly the same density is found when the oxygen of air is removed by hot iron reduced with hydrogen, instead of by copper, or in the cold by ferrous hydrate.

But the difficulties in the way of accepting the second alternative are hardly less formidable. For the question at once arises, of what gas, lighter than nitrogen, does the contamination consist? In order that the reader may the better judge, it may be well to specify more fully what were the arrangements adopted. The gas, whether air or oxygen, after passing through potash was charged with ammonia as it traversed a small wash-bottle, and thence proceeded to the furnace. The first passage through the furnace was in a tube packed with metallic copper, in the form of fine wire. Then followed a wash-bottle of sulphuric acid by which the greater part of the excess of ammonia would be arrested, and a second passage through the furnace in a tube containing copper oxide. The gas then traversed a long length of pumice charged with sulphuric acid, and a small wash-bottle containing Nessler solution. On the other side of the regulating tap the arrangements were always as formerly described, and included tubes of finely divided potash and of phosphoric anhydride. The rate of passage was usually about half a litre per hour.

Of the possible impurities, lighter than nitrogen, those most demanding consideration are hydrogen, ammonia, and water vapour. The last may be dismissed at once, and the absence of ammonia is almost equally certain. The question of hydrogen appears the most important. But this gas, and hydrocarbons, such as CH_4, could they be present, should be burnt by the copper oxide; and the experiments already referred to, in which hydrogen was purposely introduced into atmospheric nitrogen, seem to prove conclusively that the burning would really take place. Some further experiments of the same kind will presently be given.

The gas from ammonia and oxygen was sometimes odourless, but at other times smelt strongly of nitrous fumes, and, after mixture with moist air, reddened litmus paper. On one occasion the oxidation of the nitrogen went so far that the gas showed colour in the blow-off tube of the Töppler, although the thickness of the layer was only about half an inch. But the presence of nitric oxide is, of course, no explanation of the abnormal lightness. The conditions under which the oxidation takes place proved to be difficult of control, and it was thought desirable to examine nitrogen derived by *reduction* from nitric and nitrous oxides.

The former source was the first experimented upon. The gas was evolved from copper and diluted nitric acid in the usual way, and, after passing through potash, was reduced by *iron*, copper not being sufficiently active, at least without a very high temperature. The iron was prepared from blacksmith's scale. In order to get quit of carbon, it was first treated with a current of oxygen at a red heat, and afterwards reduced by hydrogen, the reduction being repeated after each employment. The greater part of the work of reducing the gas was performed outside the furnace in a tube heated locally with a Bunsen flame. In the passage through the furnace in a tube containing similar iron, the work would be completed, if necessary. Next followed washing with sulphuric acid (as required in the ammonia process), a second passage through the furnace over copper oxide, and further washing with sulphuric acid. In order to obtain an indication of any unreduced nitric oxide, a wash-bottle containing ferrous sulphate was introduced, after which followed the Nessler test and drying tubes, as already described. As thus arranged, the apparatus could be employed without alteration, whether the nitrogen to be collected was derived from air, from ammonia, from nitric oxide, from nitrous oxide, or from ammonium nitrite.

The numbers which follow are the weights of the gas contained by the globe at zero, at the pressure defined by the manometer when the temperature is 15°. They are corrected for the errors in the weights, but not for the shrinkage of the globe when exhausted, and thus correspond to the number 2·31026, as formerly given for nitrogen.

Nitrogen from NO by Hot Iron.

November 29, 1893	...	2·30143	Mean, 2·30008
December 2, 1893	...	2·29890	
December 5, 1893	...	2·29816	
December 6, 1893	...	2·30182	

Nitrogen from N_2O by Hot Iron.[1]

December 26, 1893	...	2·29869	Mean, 2·29904
December 28, 1893	...	2·29940	

Nitrogen from Ammonium Nitrite passed over Hot Iron.

January 9, 1894 ...	...	2·29849	Mean, 2·29869
January 13, 1894...	...	2·29889	

With these are to be compared the weights of nitrogen derived from the atmosphere.

Nitrogen from Air by Hot Iron.

December 12, 1893 ...		2·31017	Mean, 2·31003
December 14, 1893 ...		2·30986 (H)	
December 19, 1893 ...		2·31003 (H)	
December 22, 1893 ...		2·31007	

Nitrogen from Air by Ferrous Hydrate.

January 27, 1894 ...	...	2·31024	Mean, 2·31020
January 30, 1894 ...	...	2·31010	
February 1, 1894 ...	...	2·31028	

In the last case a large volume of air was confined for several hours in a glass reservoir with a mixture of slaked lime and ferrous sulphate. The gas was displaced by deoxygenated water, and further purified by passage through a tube packed with a similar mixture. The hot tubes were not used.

If we bring together the means for atmospheric nitrogen obtained by various methods, the agreement is seen to be good, and may be regarded as inconsistent with the supposition of residual oxygen in quantity sufficient to influence the weights.

Atmospheric Nitrogen.

By hot copper, 1892	2·31026
By hot iron, 1893	2·31003
By ferrous hydrate, 1894	2·31020

Two of the results relating to hot iron, those of December 14 and December 19, were obtained from nitrogen, into which hydrogen had been purposely introduced. An electrolytic generator was inserted between the two tubes containing hot iron, as formerly described. The generator worked under its own electromotive force, and the current was measured by a tangent galvanometer. Thus, on December 19, the deflection throughout the time of filling was 3°, representing about 1/15

[1] The N_2O was prepared from zinc and very dilute nitric acid.

ampère. In two hours and a half the hydrogen introduced into the gas would be about 70 c.c., sufficient, if retained, to reduce the weight by about 4 per cent. The fact that there was no sensible reduction proves that the hydrogen was effectively removed by the copper oxide.

The nitrogen, obtained altogether in four ways from chemical compounds, is materially lighter than the above, the difference amounting to about 11 mg., or about 1/200 part of the whole. It is also to be observed that the agreement of individual results is less close in the case of chemical nitrogen than of atmospheric nitrogen.

I have made some experiments to try whether the densities were influenced by exposing the gas to the silent electric discharge. A Siemens tube, as used for generating ozone, was inserted in the path of the gas after desiccation with phosphoric anhydride. The following were the results:—

Nitrogen from Air by Hot Iron, Electrified.

January 1, 1894	2·31163	Mean, 2·31059
January 4, 1894	2·30956	

Nitrogen from N_2O by Hot Iron, Electrified.

January 2, 1894	2·30074	Mean, 2·30064
January 5, 1894	2·30054	

The somewhat anomalous result of January 1 is partly explained by the failure to obtain a subsequent weighing of the globe empty, and there is no indication that any effect was produced by the electrification.

One more observation I will bring forward in conclusion. Nitrogen prepared from oxygen and ammonia, and about one-half per cent. lighter than ordinary atmospheric nitrogen, was stored in the globe for eight months. The globe was then connected to the apparatus, and the pressure was readjusted in the usual manner to the standard conditions. On reweighing no change was observed, so that the abnormally light nitrogen did not become dense by keeping.

DR. ARMSTRONG ON THE PUBLICATION OF SCIENTIFIC LITERATURE.

THE presidential address delivered by Dr. Armstrong at the last annual meeting of the Chemical Society, and published in the May number of the Society's *Journal*, contains numerous suggestive remarks on questions affecting all branches of science. A subject that has lately been attracting some attention is the publication of the proceedings of societies. On this Dr. Armstrong has much to say, and as he has had abundant opportunity of proving the value of the system followed by the Chemical Society, and comparing it with those of other societies, his opinions carry weight. Our space will not permit us to reprint the address, but the following extracts will suffice to show its character.

"Chemical literature is fast becoming unmanageable and uncontrollable from its very vastness. Not only is the number of papers increasing from year to year, but new journals are constantly being established. Something must be done in order to assist chemists to remain in touch with their subject and to retain their hold on the literature generally. This object would be best attained if chemists could agree to publish everything in one journal; but for many reasons, and until the world has recognised one language, such an idea must remain but a dream. This being the case, we must endeavour to have as few journals as possible, which is desirable even from the point of view of our pockets and of the dimensions of our book-shelves and houses, none of which are infinitely elastic. It is clear that in the British Isles but one journal is necessary; a large majority of the papers by workers in British laboratories, containing matter new to chemical science, are at present communicated to us, and I see no reason why all should not be. I do not mean that all should be read before the Chemical Society, because the mere reading is frequently but a formal proceeding, or, in some cases, may take place with advantage elsewhere. The Society of Chemical Industry has set us a good example in this respect by publishing in one journal the papers read at various places in the country; it matters little that the papers are read before affiliated sections of the Society, as these sections are practically independent organisations. . . .

"It seems to me, that eventually one of two courses must be adopted in this country—either the societies engaged in doing simiiar work must become affiliated, or our Society must return to the practice of early days and publish lengthy abstracts of papers communicated to societies such as the Royal Societies of London and Edinburgh, in order to bring these papers properly under the notice of chemists generally. The former course would involve an agreement amongst us to print in some uniform manner, less expensive, magnificent and stately than that adopted by the Royal Societies; a somewhat larger octavo than that of our present journal would probably suffice, such as is adopted for the *Annals of Botany*. If such an agreement were arrived at, a paper read and discussed before the Royal Society of London or Edinburgh, for example, might be printed off, and the necessary number of copies supplied to the society; while, if the paper interested chemists, we might at the same time take an appropriate number, and issue the paper as part of our Transactions. . . .

"The policy thus advocated with reference to English chemical papers is already being elsewhere adopted. The *Monatshefte für Chemie*, for example, is advisedly a collection of the papers of Austrian chemists, although, unfortunately, this does not yet include the whole of the work done in Austria-Hungary. The *Gazzetta chimica italiana* appears to contain very nearly all the Italian work. All that is done in Holland is brought together in the *Recueil des travaux chimique des Pays-Bas*. France and Germany, however, each have a variety of journals. In France the prestige of the Academy is such that for some time to come it will probably be difficult to consolidate the interests of French chemists. In Germany, however, the *Deutsche chemische Gesellschaft* is no longer hampered by the words *zu Berlin*, which it has boldly dropped, while we still remain the Chemical Society *of London* in name; it is to be hoped that in the interests of the scientific world it will ere long acquire and quash the private interests by which other journals are supported. I see no good reason even why journals devoted to special branches of our subject should exist, and I regard the appearance, for example, of a special journal of inorganic chemistry as an unmitigated evil. Political colouring and a tendency to adopt methods akin to those of the newspaper editor, of which we have had evidence in one of these journals, are most undesirable features in science. Moreover, we cannot afford to buy everything; and no effort should be spared to prevent our being split up into factions and becoming narrow-minded specialists: the more the student of chemistry—and every original worker must be and remain a student throughout his life—is brought directly into contact with the work which is being done in the several departments of his science, the better it will be for him; he cannot and need not read everything, but do not let us deprive him of the opportnnity of easily indulging in a mixed diet, and of exercising his mental faculties generally, while devoting himself specially to some one section of the vast subject which it is the privilege of the chemist to command.

"To complete my scheme—which I trust is not altogether visionary, for so great is the toleration and sympathy between all true-minded scientific workers that if union be possible in any field of human activity it is possible in the field of science—it will be necessary that the Scandinavian and Danish chemists, say, should unite; and also that the Russian chemists should give us a 'recueil des travaux chimiques' in *French*, so that the world may no longer be deprived of the knowledge of their labours, which we know, from experience, are of high value. As to America, it would be a great achievement if the political separation of our two nations could be disregarded and we were to unite with our cousins in establishing one journal for the publication of the work of chemists speaking English. There would be no real difficulty in doing this in these days of type-written manuscript, the proof of which need but be revised by the printers' reader. But if motives of expediency render such union impracticable, then it is to be hoped that steps may be taken to make the title *American Chemical Journal* truly and completely significant. I hope that we shall be successful in arranging to co-operate with all chemists in our own colonies and India. . . .

"There has been much discussion during the past few months, especially in the columns of NATURE, on the question of the publication of physical papers, which, strange to say, is in a very inchoate condition. I feel sure that the problem will soon be successfully solved by the Physical Society boldly coming forward and undertaking to do for physics what we have proved can be done for chemistry; there is no other solution possible, and the needs of physics are so great that no time should be lost. We, in this Society, can never be too grateful to Professor Williamson for having led the storming party to victory which established our system of abstracts; he foresaw that when such a scheme was successfully launched it was bound to become self-supporting, and such has long since proved to be the case. Let us hope that the physicists have at their disposal some one equally bold and far-sighted, who will overcome the fears of the timid, and initiate a thoroughly comprehensive scheme. Chemists are directly interested in the work, as we are bound to take notice of the progress of physics, and the want of an English record is much felt by us. We had no society with cognate aims to help us, so that the physicists are in a far stronger position than we were, as the Institution of Electrical Engineers should be prepared to forward such a cause. I believe it will be found to be of the utmost importance to them to do so. Indeed, the electrical engineer of the present day, I fear, is fast becoming a specialist of the deepest dye: having had expeiience of several hundreds, I know that when a student he is most difficult to deal with, as he will only pay attention, even in physics, to what he believes to be of immediate importance to him; as to chemistry, he will scarce notice it, forgetting, or not realising, that the whole field of electro-chemistry is yet untilled. It is, therefore, very necessary that no effort should be spared to make the electrical engineer better informed regarding physics generally. . . .

"The Royal Society of London has recently issued to the scientific world a circular having reference to the preparation of complete catalogues of science by *international co-operation*, which raises questions of such importance that I do not hesitate to reproduce it.

"'Sir,—The Royal Society of London, as you are probably aware, has published nine quarto volumes of *The Catalogue of Scientific Papers*, the first volume of the decade—1874-83—having been issued last year.

"'This catalogue is limited to *periodical* scientific literature, *i.e.* to papers published in the transactions, &c., of societies, and in journals; it takes no account whatever of monographs and independent books, however important. The titles, moreover, are arranged solely according to author's names; and though the Society has long had under consideration the preparation of—and is hoped may eventually issue as—a key to the volumes already published, a list in which the titles are arranged according to subject-matter, the catalogue is still being prepared according to author's names. Further, though the Society has endeavoured to include the titles of all the scientifie papers published in periodicals of acknowledged standing, the catalogue is—even as regards periodical literature—confessedly incomplete, owing to the omission of the titles of papers published in periodicals of little importance or not easy of access.

"'Owing to the great development of scientific literature the task of the Society in continuing the catalogue, even in its present form, is rapidly increasing in difficulty. At the same time it is clear that the progress of science would be greatly helped by—indeed, almost demands—the compilation of a catalogue which should aim at completeness, and should contain the titles of scientific publications, whether appearing in periodicals or independently. In such a catalogue the title should be arranged not only according to authors' names, but also according to subject-matter, the text of each paper and not the title only being consulted for the latter purpose. And the value of the catalogue would be greatly enhanced by a rapid periodical issue, and by publication in such a form that the portion which pertains to any particular branch of science might be obtained separately.

"'It is needless to say that the preparation and publication of such a complete catalogue is far beyond the power and means of any single society.

"'Led by the above considerations, the President and Council of the Royal Society have appointed a committee to inquire into and report upon *the feasibility of such a catalogue being compiled through international co-operation.*

"'The Committee are not as yet in a position to formulate any distinct plan by which such international co-operation might be brought about; but it may be useful, even at the outset, to make the following preliminary suggestions:—

"'The catalogue should commence with papers published on or after January 1, 1900.

"'A central office, or bureau, should be established in some place, to be hereafter chosen, and should be maintained by international contributions—either directly, that is, by annual or other subsidies—or indirectly, that is, by the guarantee to purchase a certain number of copies of the catalogue.

"'This office should be regularly supplied with all the information necessary for the construction of the catalogue. This might be done either by all periodicals, monographs, &c., being sent direct to the office to be catalogued there, or by various institutions undertaking to send in portions of the catalogue already prepared, or by both methods combined.

"'At such an office, arrangements might be made by which, in addition to preparing the catalogue, scientific data might be tabulated as they came to hand in the papers supplied.

"'The first step, however, is to ascertain whether any scheme of international co-operation is feasible and desirable. The Committee, accordingly, is desirous of learning the views upon this subject of scientific bodies and of scientific men.

"'We, therefore, venture to express the hope that you will be so good as, at some early opportunity, to make known to us, for the use of the Committee, your own views on the matter.

"'Should the decision you report be in any way favourable to the scheme, may we further ask you to communicate to us, for the use of the Committee, any suggestions which you may think it desirable to make, as to the best methods of inaugurating such a scheme, as to the constitution and means of maintenance of the Central Office, as to the exact character of the work to be carried on there, as to the language or languages in which the catalogue should be published, and the like?

"'We are,

"'Your obedient servants,

"'M. FOSTER, *Secretary R.S.*

"'RAYLEIGH, *Secretary R.S.*

"'J. LISTER, *Foreign Sec. R.S.*'

"If any such scheme as is here foreshadowed could be carried out, it would obviously be of the greatest value to the world and productive of much saving, both of time and treasure. But the subject is full of difficulty, owing to the very numerous interests concerned. I trust, however, that when the time comes to deal with the chemical section—and, indeed, in the case of any future catalogue of chemical work, that we shall not be satisfied with a mere alphabetical arrangement, but that we shall classify the subject-matter alphabetically in sections, so as to lighten the labour of ascertaining the state of knowledge in any particular group. Already we do not know very many of the names recorded in our indexes, and, in the future, we shall be ignorant of a still larger proportion, unless our system of nomenclature be made so significant that each name will explain itself; and in the case of an alphabetical arrangement, substances belonging to the same group, having names with different initial letters, occur interspersed throughout the index: so that it is a matter of the greatest difficulty, if not impossible, by consulting such an index, to ascertain the references to all the members of the group. An alphabetical index also affords no indication of the extent to which knowledge of any particular group has increased during the interval covered by it; and, in fact, it only becomes of real use when provided with a key, such as Beilstein affords, in which the names of the known members of any particular group may be first looked up before consulting the alphabetical index. Also, in using a lengthy alphabetical index it is very easy to miss entries, and it is necessary to pay far more attention when consulting it than is the case when one of limited extent is used.

"I do not believe that there would be any real difficulty in arriving at a system of classification which, at all events, would limit a reference to comparatively few pages. We are told that by the Bertillon system, dealing with the card records of 90,000 convicts, it is possible—when the necessary measurements have been taken—to ascertain whether a prisoner has been before convicted, as it may be said, with considerable, if not absolute, confidence, that, in that case, his card will be found in a drawer containing only about 400. Surely, we ought to be able to devise a system which would equally limit our search."

THE WORK OF HERTZ.

Additions and Corrections to the Lecture reported last week, by DR. OLIVER LODGE.

ON page 135, middle of first column, the word "clearly" ought to have been *probably*; for I am by no means clear that the gradual discharge of negative electrification from the clean surface of metals under the action of light is really a chemical phenomenon. It had been asserted by some experimenters that the most oxidisable metals acted most powerfully, but my own experience renders this doubtful; I now find that gold platinum and carbon discharge with very fair rapidity, and that nearly all substances have some discharging power. A few materials, cobalt among metals, discharge positive electrification more rapidly than negative. The whole matter is therefore now under investigation.

In the foot-note to same column, end of first paragraph, the word "even" should be deleted. The assertion intended is that dried soil discharges rapidly, while damp soil discharges only slowly.

Same page, middle of second column, "two years ago" should be *four years ago*; since Fitzgerald's Royal Institution Lecture was delivered in March 1890, and reported in NATURE of June 19 the same year.

Lower down, the name Kolaček, preceding that of D. E. Jones, has been omitted.

Page 138, second column, with reference to the reflecting power of different substances it may be interesting to give the following numbers, showing the motion of the spot of light when 8-inch waves were reflected into the copper hat, the angle of incidence being about 45°, by the following mirrors:—

Sheet of window glass	0, or at most 1, division.
Human body	7 divisions.
Drawing board	12 ,,
Towel soaked with tap-water ...	12 ,,
Tea-paper (lead ?)...	40 ,,
Dutch metal paper	70 ,,
Tinfoil	80 ,,
Sheet copper	100 and up against stops.

Page 139. It would have been clearer if the penultimate paragraph, beginning "To demonstrate," had run thus:—

To demonstrate that the so-called plane of polarisation of the radiation transmitted by a grid is at right angles to the electric vibration, *i.e.* that when light is reflected from the boundary of a transparent substance at the polarising angle the electric vibrations of the reflected beam are perpendicular to the plane of reflection, I use, &c.

The following is a copy of one of the wall-diagrams; it is interesting as showing how numerous the now-known detectors of radiation are:—

DETECTORS OF RADIATION.

Physiological	Chemical	Thermal	Electrical	Mechanical	Microphonic
					Selenium (?)
Eye	Photographic Plate	Thermopile	Spark (Hertz)	Electrometer (Blyth and Bjerknes)	Impulsion Cell (Minchin)
×Frog's leg (Hertz and Ritter)	Explosive Gases	Bolometer (Rubens and Ritter)	{ Telephone, Air-gap and Arc } (Lodge)	Suspended Wires (Hertz and Boys)	Filings (Branly)
	Photo-electric cell	Expanding Wire (Gregory)	Vacuum Tube (Dragoumis)		Coherer (Hughes and Lodge)
		Thermal Junction (Klemencic)	Galvanometer (Fitzgerald)		
			Air-gap and Electroscope (Boltzmann)		
			Trigger Tube (Warburg and Zehnder)		

× The cross against the frog's leg indicates that it does not appear really to respond to radiation, unless stimulated in some secondary manner. The names against the other things are unimportant, but suggest the persons who applied the detector to electric radiation. The query against Selenium is placed there because of uncertainty as to its most appropriate column.

STUDY OF FLUID MOTION BY MEANS OF COLOURED BANDS.[1]

IN his charming story of "The Purloined Letter," Edgar Allan Poe tells how all the efforts and artifices of the Paris police to obtain possession of a certain letter, known to be in a particular room, were completely baffled for months by the simple plan of leaving the letter in an unsealed envelope in a letter-rack, and so destroying all *curiosity* as to its contents; and how the letter was at last found there by a young man who was not a professional member of the force. Closely analogous to this is the story I have to set before you to-night—how certain mysteries of fluid motion, which have resisted all attempts to penetrate them, are at last explained by the simplest means and in the most obvious manner.

This indeed is no new story in science. The method adopted by the minister, *D.*, to secrete his letter appears to be the favourite of nature in keeping her secrets, and the history of science teems with instances in which keys, after being long sought amongst the grander phenomena, have been found at last not hidden with care, but scattered about, almost openly, in the most commonplace incidents of everyday life which have excited no curiosity.

[1] A lecture delivered at the Royal Institution of Great Britain by Prof. Osborne Reynolds, F.R.S.

This was the case in physical astronomy—to which I shall return after having reminded you that the motion of matter in the universe naturally divides itself into three classes.

(1) The motion of bodies as a whole—as a grand illustration of which we have the heavenly bodies, or more humble, but not less effective, the motion of a pendulum, or a falling body.

(2) The relative motion of the different parts of the same fluid or elastic body—for the illustration of which we may go to the grand phenomena presented by the tide, the whirlwind, or the transmission of sound, but which is equally well illustrated by the oscillatory motion of the wave, as shown by the motion of its surface and by the motion of this jelly, which, although the most homely illustration, affords by far the best illustration of the properties of an elastic solid.

(3) The inter-motions of a number of bodies amongst each other—to which class belong the motions of the molecules of matter resulting from heat, as the motions of the molecules of a gas, in illustration of which I may mention the motions of individuals in a crowd, and illustrate by the motion of the grains in this bottle when it is shaken, during which the white grains at the top gradually mingle with the black ones at the bottom—which inter-diffusion takes an important part in the method of coloured bands.

Now of these three classes of motion that of the individual body is incomparably the simplest. Yet, as presented in the phenomena of the heavens, which have ever excited the greatest curiosity of mankind, it defied the attempts of all philosophers for thousands of years, until Galileo discovered the laws of motion of mundane matter. It was not until he had done this and applied these laws to the heavenly bodies that their motions received a rational explanation. Then Newton, taking up Galileo's parable and completing it, found that its strict application to the heavenly bodies revealed the law of gravitation, and developed the theory of dynamics.

Next to the motions of the heavenly bodies, the wave, the whirlwinds, and the motions of clouds, had excited the philosophical curiosity of mankind from the earliest time. Both Galileo and Newton, as well as their followers, attempted to explain these by the laws of motion, but, although the results so obtained have been of the utmost importance in the development of the theory of dynamics, it was not till this century that any considerable advance was made in the application of this theory to the explanation of fluid phenomena; and although during the last fifty years splendid work has been done, work which, in respect of the mental effort involved, or the scientific importance of the results, goes beyond that which resulted in the discovery of Neptune, yet the circumstances of fluid motion are so obscure and complex that the theory has yet been interpreted only in the simplest cases.

To illustrate the difference between the interpretation of the theory of heavenly bodies and that of fluid motion, I would call your attention to the fact that solid bodies, on the behaviour of which the theory of the motion of the planets is founded, move as one piece, so that their motion is exactly represented by the motion of their surfaces; that they are not affected with any internal disorder which may affect their general motion. So surely is this the case that even those who have never heard of dynamics can predict with certainty how any ordinary body will behave under any ordinary circumstances, so much so that any departure is a matter of surprise. Thus I have here a cube of wood, to one side of which a string is attached. Now hold it on one side, and you naturally suppose that when I let go holding the string it will turn down so as to hang with the string vertical; that it does not do so is a matter of surprise. I place it on the other side, and it still remains as I place it. If I swing it as a pendulum it does not behave like one.

Would Galileo have discovered the laws of motion had his pendulum behaved like this? Why is its motion peculiar? There is internal motion. Of what sort? Well, I think my illustration may carry more weight if I do not tell you; you can all, I have no doubt, form a good idea. It is not fluid motion, or I should feel bound to explain it. You have here an ordinary-looking object which behaves in an extraordinary manner, which is yet very decided and clear, to judge by the motion of its surface, and from the manner of the motion I wish you to judge of the cause of the observed motion.

This is the problem presented by fluids, in which there may be internal motion which has to be taken into account before the motion of the surface can be explained. You can see no more of what the motion is within a homogeneous fluid, however opaque or clear, than you can see what is going on within the box. Thus without colour bands the only visual clue to what is going on within the fluids is the motion of their bounding surfaces. Nor is this all; in most cases the surfaces which bound the fluid are immovable.

In the case of the wave on water the motion of the surface shows that there is motion, but because the surface shows no wave it does not do to infer that the fluid is at rest.

The only surfaces of the air within this room are the surfaces of the floor, walls, and objects within it. By moving the objects we move the air, but how far the air is at rest you cannot tell unless it is something familiar to you.

Now I will ask you to look at these balloons. They are familiar objects enough, and yet they are most sensitive anemometers, more sensitive than anything else in the room; but even they do not show any motion; each of them forms an internal bounding surface of the air. I send an *aerial messenger* to them, and a small but energetic motion is seen by which it acknowledges the message, and the same message travels through the rest, as if a *ghost* touched them. It is a wave that moves them. You do not feel it, and, but for the surfaces of the air formed by the balloons, would have no notion of its existence.

In this tank of beautifully clear distilled water, I project a heavy ball in from the end, and it shows the existence of the water by stopping almost dead within two feet. The fact that it is stopped by the water, being familiar, does not raise the question, Why does it stop?—a question to which, even at the present day, a complete answer is not forthcoming. The question is, however, suggested, and forcibly suggested, when it appears that with no greater or other evidence of its existence, I can project a disturbance through the water which will drive this small disc the whole length of the tank.

I have now shown instances of fluid motion of which the manner is in no way evident without colour bands, and were revealed by colour bands, as I showed in this room sixteen years ago. At that time I was occupied in setting before you the manners of motion revealed, and I could only incidentally notice the means by which this revelation was accomplished.

Amongst the ordinary phenomena of motion there are many which render evident the internal motion of fluids. Small objects suspended in the fluid are important, and that their importance has long been recognised is shown by the proverb—straws show which way the wind blows. Bubbles in water, smoke and clouds, afford the most striking phenomena, and it is doubtless these that have furnished philosophers with such clues as they have had. But the indications furnished by these phenomena are imperfect, and, what is more important, they only occur casually, and in general only under circumstances of such extreme complexity that any deduction as to the elementary motions involved is impossible. They afford indication of commotion, and perhaps of the general direction in which the commotion is tending, but this is about all.

For example, the different types of clouds; these have always been noticed, and are all named. And it is certain that each type of clouds is an indication of a particular type of motion in the air; but no deductions as to what definite manner of motion is indicated by each type of cloud have ever been published.

Before this can be done it is necessary to reverse the problem and find to what particular type of cloud a particular manner of motion would give rise. Now a cloud, as we see it, does not directly indicate the internal motion of which it is the result. As we look at clouds, it is not in general their motion that we notice, but their figure. It is hard to see that this figure changes while we are watching a cloud, though such a change is continually going on, but is apparently very slow on account of the great distance of the cloud and its great size. However, types of clouds are determined by their figure, not by their motion. Now what their figure shows is not motion, but it is the history or result of the motion of the particular strata of the air in and through surrounding strata. Hence, to interpret the figures of the clouds we must study the changes in shape of fluid masses, surrounded by fluid, which result from particular motions.

The ideal in the method of colour bands is to render streaks or lines in definite position in the fluid visible, without in any way otherwise interfering with these properties as part of the homogeneous fluid. If we could by a wish create coloured lines in the water, these would be ideal colour bands. We cannot do this, nor can we exactly paint lines in the air or water.

I take this ladle full of highly coloured water, lower it slowly into the surface of the surrounding water till that within is level with that without; then turn the ladle carefully round the coloured water; the mass of coloured water will remain where placed.

I distribute the colour slowly. It does not mix with the clear water, and although the lines are irregular they stand out very beautifully. Their edges are sharp here. But in this large sphere, which was coloured before the lecture, although the coloured lines have generally kept their places, they have, as it were, swollen out and become merged in the surrounding water in consequence of molecular motion. The sphere shows, however, one of the rarest phenomena in nature—the internal state in almost absolute internal rest. The forms resemble nothing so much as stratus clouds, as seen on a summer day, though the continuity of the colour bands is more marked. A mass of coloured water once introduced is never broken. The discontinuity of clouds is thus seen to be due to other causes than mere motion.

Now, having called our attention to the rarity of water at rest, I will call your attention to what is apt to be a very striking phenomena, namely that when water is contained, like this, in a spherical vessel of which you cannot alter the shape, it is impossible by moving the vessel suddenly to set up relative motion in the interior of the water. I may swing this vessel about and turn it, but the colour band in the middle remains as it was, and when I stop shows the water to be at rest.

This is not so if the water has a free surface, or if the fluid is of unequal density. Then a motion of the vessel sets up waves, and the colour band shows at once the beautifully lawful character of the internal motion. The colour bands move backwards and forwards, showing how the water is distorted like a jelly, and as the wave dies out the colour bands remain as they were to begin with.

This illustrates one of the two classes of internal motion of water or fluid. Wherever fluid is not in contact with surfaces over which it has to glide, or which surfaces fold on themselves, the internal motions are of this purely wave character. The colour bands, however much they may be distorted, cannot be relatively displaced, twisted, or curled up, and in this case motion in water once set up continues almost without resistance. That wave motion in water with a free surface, is one of the most difficult things to stop is directly connected with the difficulty of setting still water in motion; in either case the influence must come through the surfaces. Thus it is that waves once set up will traverse thousands of miles, establishing communication between the shores of Europe and America. Wave motion in water is subject to enormously less resistance than any other form of material motion.

In wave motion, if the colour bands are across the wave they show the motion of the water; nevertheless, their chief indication is of the change of shape while the fluid is in motion.

This is illustrated in this long bottle, with the coloured water less heavy than the clear water. If I lay it down in order to establish equilibrium, the blue water has to leave the upper end of the bottle and spread itself over the clear water, while the clear water runs under the coloured. This sets up wave motion, which continues after the bottle has come to rest. But as the colour bands are parallel with the direction of motion of the waves, the motion only becomes evident in thickening and bending of the colour bands.

The waves are entirely between the two fluids, there being no motion in the outer surfaces of the bottle, which is everywhere glass. They are owing to the slight differences in the density of the fluids, as is indicated by the extreme slowness of the motion. Of such kind are the waves in the air, that cause the clouds which make the mackerel sky, the vapour in the tops of the waves being condensed and evaporated again as it descends showing the results of the motion.

The distortional motions, such as alone occur in simple wave motion, or where the surfaces of the fluid do not fold in on themselves, or wind in, are the same as occur in any homogeneous continuous material which completely fills the space between the surfaces.

If plastic material is homogeneous in colour it shows nothing as to the internal motion; but if I take a lump built of plates, blue and white, say a square, then I can change the surfaces to any shape without folding or turning the lump, and the coloured bands which extend throughout the lump show the internal changes. Now the first point to illustrate is that, however I change its shape, if I bring it back to the original shape the colour bands will all come back to their original positions, and there is no limit to the extent of the change that may thus be effected. I may roll this out to any length, or draw it out, and the diminution in thickness of the colour bands shows the extent of the distortion. This is the first and simplest class of motion to which fluids are susceptible. By this motion alone elements of the fluid may be, and are, drawn out to indefinitely fine lines, or spread out in indefinitely thin sheets, but they will remain of the same general figures.

By reversing the process they change back again to the original form. No colour band can ever be broken, even if the outer surface be punched in till the punch head comes down on the table; still all the colour bands are continuous under the punch, and there is no folding or lapping of the colour bands unless the external surface is folded.

The general idea of mixture is so familiar to us that the vast generalisation to which these ideas afford the key, remains unnoticed. That continued mixing results in uniformity, and that uniformity is only to be obtained by mixing, will be generally acknowledged, but how deeply and universally this enters into all the arts can but rarely have been apprehended. Does it ever occur to any one that the beautiful uniformity of our textile fabrics has only been obtained by the development of processes of mixing the fibres? Or, again, the uniformity in our construction of metals; has it ever occurred to any one that the inventions of Arkwright and Cort were but the application of the long-known processes by which mixing is effected in culinary operations? Arkwright applied the draw-rollers to uniformly extend the length of the cotton sliver at the expense of the thickness; Cort applied the rolling-mill to extend the length of the iron bloom at the expense of its breadth; but who invented the rolling-pin by which the pastrycook extends the length at the expense of the thickness of the dough for the pie-crust?

In all these processes the object, too, is the same throughout—to obtain some particular shape, but chiefly to obtain a uniform texture. To obtain this nicety of texture it is necessary to mix up the material, and to accomplish this it is necessary to attenuate the material, so that the different parts may be brought together.

The readiness with which fluids are mixed and uniformity obtained is a byword; but it is only when we come to see the colour bands that we realise that the process by which this is attained is essentially the same as that so laboriously discovered for the arts—as depending first on the attenuation of each element of the fluid—as I have illustrated by distortion.

In fluids, no less than in cooking, spinning and rolling—this attenuation is only the first step in the process of mixing—all involve the second process, that of folding, piling, or wrapping, by which the attenuated layers are brought together. This does not occur in the pure wave motion of water, and constitutes the second of the two classes of motion. If a wave on water is driven beyond a certain height it leaps or breaks, folding in its surface. Or, if I but move a solid surface through the water it introduces tangential motion, which enables the fluid to wind its elements round an axis. In these ways, and only in these ways, we are released from the restriction of not turning or lapping. And in our illustration, we may fold up our dough, or lap it—roll it out again and lap it again; cut up our iron bar, pile it, and roll it out again, or bring as many as we please of the attenuated fibres of cotton together to be further drawn. It may be thought that this attenuation and wrapping will never make perfect admixture, for however thin each element will preserve its characteristic, the coloured layers will be there, however often I double and roll out the dough. This is true. But in the case of some fluids, and only in the case of some fluids, the physical process of diffusion completes the admixture. These colour bands have remained in this water, swelling but still distinct; this shows the slowness of diffusion. Yet such is the facility with which the fluid will go through the process of attenuating its elements and enfolding them, that by simply stirring them with a spoon these colour bands can be drawn and folded so fine that the diffusion will be instantaneous, and the fluid become uniformly tinted. All internal fluid motion other than simple distortion, as in wave motion, is a process of mixing, and it is thus from the arts we get the clue to the elementary forms and processes of fluid motion.

When I put the spoon in and mixed the fluid you could not see what went on—it was too quick. To make this clear, it is necessary that the motion should be very slow. The motion should also be in planes, at right angles to the direction in which you are looking. Such is the instability of fluid that to accomplish this at first appeared to be difficult. At last, however, as the result of much thought, I found a simple process which I will now show you, in what I think is a novel experiment, and you will see, what I think has never been seen before by any one but Mr. Foster and myself, namely, the complete process of the formation of a cylindrical vortex sheet resulting from the motion of a solid surface. To make it visible to all I am obliged to limit the colour band to one section of the sheet, otherwise only those immediately in front would be able to see between the convolution of the spiral. But you will understand that what is seen is a section, a similar state of motion extending right across the tank. From the surface you see the plane vane extending halfway down right across the tank; this is attached to a float.

I now institute a colour band on the right of the vane out of the tube. There is no motion in the water, and the colour descends slowly from the tube. I now give a small impulse to the float to move it to the right, and at once the spiral form is seen from the tube. Similar spirals would be formed all across the tank if there were colours. The float has moved out of the way, leaving the revolving spiral with its centre stationary, showing the horizontal axis of the spiral is half-way between the bottom and surface of the tank, in which the water is now simply revolving round this axis.

This is the vortex in its simplest and rarest form (for a vortex cannot exist with its ends exposed). Like an army it must have its flanks protected; hence a straight vortex can only exist where it has two surfaces to cover its flanks, and parallel vertical surfaces are not common in nature. The vortex can bend, and, with a horse shoe axis, can rest both its flanks on the same surface, as this piece of clay, or unite its ends with a ring axis, which is its commonest form, as in the smoke ring. In both these cases the vortex will be in motion through the fluid, and less easy to observe.

These vortices have no motion beyond the rotation because they are half-way down the tank. If the vane were shorter they would follow the vane; if it were longer they would leave it.

In the same way, if instead of one vortex there were two vortices, with their axis parallel, extending right across, the one above another, they would move together along the tank.

I replace the float by another which has a vane suspended from it, so that the water can pass both above and below the vane extending right across the middle portion of the tank. In this case I institute two colour bands, one to pass over the top, the other underneath the vane, which colour bands will render visible a section of each vortex just as in the last case. I now set the float in motion, and the two vortices turn towards each other in opposite directions. They are formed by the water moving over the surface of the vane, downwards to get under it, upwards to get over it, so that the rotation in the upper vortex is opposite to that in the lower. All this is just the same as before, but instead of these vortices standing still as before, they follow at a definite distance from the vane, which continues its motion along the tank without resistance.

Now this experiment shows, in the simplest form, the *modus operandi* by which internal waves can exist in fluid without any motion in the external boundary. Not only is this plate moving flatwise through the water, but it is followed by all the water, coloured and uncoloured, enclosed in these cylindrical vortices. Now, although there is no absolute surface visible, yet there is a definite surface which encloses these moving vortices, and separates them from the water which moves out of their way. This surface will be rendered visible in another experiment I shall show you. Thus, the water which has only wave motion is bounded by a definite surface, the motion of which corresponds to the wave; but inside this closed surface there is also water, so that we cannot see the surface, and this water inside is moving round and round, but so that its motion at the bounding surface is everywhere the same as that of the outside water.

The two masses of water do not mix. That outside moves out of the way of and past the vortices over the bounding surface, while the vortices move round and round inside the surface in such a way that it is moving in exactly the same manner at the surface as the wave surface outside.

This is the key to the internal motion of water. You cannot have a pure wave motion inside a mass of fluid with its boundaries at rest, but you have a compound motion, a wave motion outside, and a vortex within, which fulfils the condition that there shall be no sliding of the fluid over fluid at the boundary.

A means which I hope may make the essential conditions of this motion clearer occurred to me while preparing this lecture, and to this I will now ask your attention. I have here a number of layers of cotton-wool (wadding). Now I can force any body along between these layers of wadding. They yield, as by a wave, and let it go through; but the wadding must slide over the surface of the body so moving through it. And this it must *not* do if it illustrate the conditions of fluid motion. Now, there is one way, and only one way, in which material can be got through between the sheets of wadding without slipping. It must roll through; but this is not enough, because if it rolls on the under surface it will be slipping on the upper. But if we have two rollers, one on the top of the other, between the sheets, then the lower roller rolls on the bottom sheet, the upper roller rolls against the upper sheet, so that there is no slipping between the rollers or the wadding, and, equally important, there is no slipping between the rollers as they roll on each other. I have only to place a sheet of canvas between the rollers and draw it through; both the flannel rollers roll on the canvas and on the wadding, which they pass through without slipping, causing the wadding to move in a wave outside them, and affording a complete parable of the vortex motion.

I will now show by colour bands some of the more striking phenomena of internal motion, as presented by nature's favourite form of vortex, the vortex ring, which may be described as two horse-shoe vortices with their ends founded on each other.

To show the surface separating the water moving with the vortex from that which gives way outside, I discharge from this orifice a mass of coloured water, which has a vortex ring in it formed by the surface, as already described. You see the beautifully-defined mass moving on slowly through the fluid, with the proper vortex ring motion, but very slow. It will not go far before a change takes place, owing to the diffusion of the vortex motion across the bounding surface; then the coloured surface will be wound into the ring which will appear. The mass approaches the disc in front. It cannot pass, but will come up and carry the disc forward; but the disc, although it does not destroy the ring, disturbs the motion.

If I send a more energetic ring, it will explain the phenomenon I showed you at the beginning of this lecture; it carries the disc forward as if struck with a hammer. This blow is not simply the weight of the coloured ring, but of the whole moving mass and the wave outside. The ring cannot pass the disc without destruction with the attendant wave.

Not only can a ring follow a disc, but, as with the plane vane, so with the disc; if we start a disc, we must start a ring behind it.

I will now fulfil my promise to reveal the silent messenger I sent to those balloons. The messenger appears in the form of a large smoke ring, which is a vortex ring in air rendered visible by smoke instead of colour. The origination of these rings has been carefully set so that the balloons are beyond the surface which separates the moving mass of water from the wave, so that they are subject to the wave motion only. If they are within this surface they will disturb the direction of the ring, if they do not break it up.

These are, if I may say so, the phenomenal instances of internal motion of fluids. Phenomenal in their simplicity, they are of intense interest, like the pendulum, as furnishing the clue to the more complex. It is by the light we gather from their study that we can hope to interpret the parable of the vortex wrapped up in the wave, as applied to the wind of heaven, and the grand phenomenon of the clouds, as well as those things which directly concern us, such as the resistance of our ships.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Curators of the University Chest have been authorised by Congregation to pay the following sums.

To the Delegates of the Museum, a sum of £140 for each of the years 1894, 1895, for the general expenses of the Museum.

To the Curators of the Botanic Garden a sum not exceeding £200, to provide for expenses incurred in connection with the erection of new houses in the garden.

The Curators of the University Chest have been authorised to expend a sum not exceeding £700 in making the rooms in the south corridor in the Museum, and the lofts over them, available for the use of the Hope Professor of Zoology, and to pay to the Hope Professor of Zoology, in addition to the statutable grant, the sum of £100 for each of the years 1894–1898, to provide for the salary of the attendant and other expenses of the Department.

The Delegates of Local Examinations have approved of the introduction of a new examination in the course for junior candidates in elementary physiology and hygiene.

Amongst those on whom it is proposed to confer the honorary degree of D.C.L. at the Encænia, is the name of Mr. Francis Galton, F.R.S.

One or more Natural Science Demyships, and Natural Science Exhibitions will be awarded by Magdalen College in October this year, the examination to commence on Tuesday, October 9.

At Wadham College, in the Scholarship examinations which will begin on Thursday, November 29, no papers in natural science will be set, but in the election to one of the Exhibitions preference will be given to any candidate who shall undertake to read for honours in natural science, and to proceed to a degree in medicine in the University of Oxford.

At Keble College an election will be held to one Scholarship in natural science of the value of £60 per annum, with laboratory fees not exceeding £20 per annum, on December 11 next. The examination will consist of papers in biology and chemistry, and all inquiries respecting the examination should be addressed to Mr. W. Hatchett Jackson, Keble College. The examination will begin on Thursday, December 6.

Mr. R. Warington, F.R.S., has been elected to the Sibthorpian Chair of Rural Economy, in succession to Sir John Gilbert.

CAMBRIDGE.—This year, for the first time on record, there is a bracket of two for the Senior Wranglership. In 1887 four names were bracketed for the highest place. These are the only instances in which the Senior Wrangler of the year has not stood "alone in his glory." Messrs. W. S. Adie and W. F. Sedgwick, both of Trinity College, share the honour. There is one lady wrangler, Miss E. H. Cooke, of Girton, who is bracketed twenty-eighth. In the second part of the Mathematical Tripos, a lady of Newnham, Miss A. M. J. E. Johnson, who was between fifth and sixth in the first part last year, heads the list, as she is placed alone in the first division of the first class. The Tyson Medal, for astronomy, offered this year for the first time, is not awarded.

Seven names appear in the first list of the Mechanical Sciences Tripo, all three of those in the first class having already taken the B.A. degree on some other examinination.

The Harkness Studentship in Geology has failed of award, in the absence of candidates.

The degree of Sc.D. is to be conferred on Professor Demetri Ivanovitch Mendeléef, of St. Petersburg, who was not able to accept the honour when it was offered him in 1889.

The following are appointed examiners for the new diploma in Agricultural Science: W. F. Darwin, Mr. W. G. P. Ellis, Professor Liveing, Mr. T. B. Wood, Professor Foster, Mr. A. Eichholz, Mr. A. E. Shipley, Mr. C. Warburton, Professor Hughes, Mr. P. Lake, Mr. O. P. Fisher, Mr. E. Clarke, and Mr. R. Menzies.

THE Scottish Association for the Promotion of Technical and Secondary Education have presented a memorial to Mr. Acland asking that the yearly examinations of the Department of Science and Art shall be held in the day as well as in the evening. It is pointed out that originally arranged, as they were, to suit the convenience of artisan pupils who could not be expected to attend during the day, these evening examinations are now taken by large and increasing numbers of pupils of secondary and higher grade schools. While, therefore, fully recognising the necessity which exists for examinations in all stages of art and science subjects being continued in the evening as heretofore, the memorialists urge the desirability of provision being made by the Department for the examination, within school hours, of pupils attending day schools.

SIR PHILIP MAGNUS has been appointed to represent the University of London at the bicentenary celebration of Halle University, to be held in August next.

SCIENTIFIC SERIALS.

Bulletin de l'Académie Royale de Belgique, No. 3.—Experimental demonstration of the purely accidental character of the critical state, by P. de Heen. A small quantity of amylene was introduced into the bottom of a tube, and surmounted by mercury, the tube being so thin that the mercury remained at the top. The tube was placed inside a box with glass windows, which was then heated to temperatures ranging from 201° C., the critical temperature of amylene, to about 350°. The tube was connected at the top with a Cailletet compression apparatus. It was found that even under pressures less than 5 atmospheres the amylene could be heated to 350° without evaporating. The critical state, characterised by turbulent movements, was never exhibited, but if by some accident a small quantity of vapour was formed the critical state set in at once. The author concludes that the critical state consists of a non-homogeneous mixture of "liquidogenic" and "gazogenic" molecules. At a certain high temperature, estimated for most liquids at 800° or 900°, the former are completely dissociated, and the pressure-volume curve becomes a simple isothermal. But the state of a fluid is not defined by pressure and temperature alone, since at the critical temperature, and at zero pressure, the volume can vary from unity to infinity.—Facts relating to the properties of carbon bisulphide, by H. Arctowski. The boiling point of pure carbon bisulphide is 46°·27, but this rises steadily during the process of determining it. The bisulphide is partially decomposed by the sun's rays, by moist air, and by a slight elevation of temperature continued for some time.—On the solubilities of the haloid salts of mercury in carbon bisulphide, by the same author. These salts show different solubilities, the iodide being the most, and the chloride the least soluble. The solubilities show a point of upward inflection at about 15° C. From 15° to −10° the lines of solubility converge in such a manner that if produced they would meet the axis of solubilities at a point corresponding to −25°.—Some experiments in experimental pathological embryology, by P. Francotte. Some ova of *Leptoplana tremellaris* were opened with a find steel point to admit schizomycetes. The microbes were either digested or excreted. The author concludes that microbian diseases cannot be transmitted by either ova or spermatozoa.

THE *Meteorologische Zeitschrift* for May contains a discussion of the results of meteorological observations on the Pic du Midi, by Dr. F. Klengel. The observations dealt with are those made during the years 1874-81 (excepting 1877), at the Plantade station, situated at a Pass, at an elevation of 7760 feet, and they furnish important materials respecting the climatic peculiarities of the high Pyrenees. The mean temperature was 34°·2; the absolute minimum was −11°·2 in Jauuary 1878, and the maximum 77°·4, in August 1881. Frost was observed on an average on 224 days in the year; the absolute maxima in all months were above 32°, and the minima mostly below 32°, even in July and August. The rainfall was exceedingly copious, amounting in the year to no less than 93·5 inches, a quantity which is only equalled at a few other places in Europe. The wettest month was April, with 18 inches, and the dryest July, with 2·7 inches. The distribution of rainfall throughout the year was extremely irregular; the number of wet days in the year amounted to 184. The most prevalent winds were from north-west, 25 per cent., and from south-west, 23 per cent. The French Meteorological Office has published in its *Annales* the observations made at the summit of the mountain since October 1881, at a still greater altitude; these will, no doubt, be dealt with in a subsequent paper.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 24.—"Measurements of the Absolute Specific Resistance of pure Electrolytic Copper." By J. W. Swan and J. Rhodin.

This paper is a record of measurements of the absolute specific resistance and temperature coefficient of pure electrolytic copper. The authors compared a large number of different specimens of electrolytic copper. Several of the specimens were at first roughly examined, and the best chosen for further investigation. The best of these was then electrolytically refined. This, without previous fusion, was drawn through sapphire dies to the requisite diameter, and the resulting wire subjected to careful measurements. The first specimen, "A," was measured both when hard and also after annealing at a red heat in an atmosphere of carbon dioxide gas; the second sample, "B," was only examined after annealing. The authors took extreme care in finding the dimensions of the wires and the temperatures at which they were measured.

The values of the two specimens in C.G.S. units were as follows, the density being 8·9587 at 15° C.

		Absolute specific resistance. C.G.S. units.	Temp. coefficient. Δt.
Sample A.	Hard, as drawn......	1603	0·00408
,, A.	Soft, as annealed....	1566	0·00418
,, B.	Soft, as annealed....	1559	0·00415

May 31.—"On Rapid Changes of Atmospheric Temperature, especially during Föhn, and the Methods of observing them." By J. Y. Buchanan, F.R.S.

In July 1893, on the west coast of Scotland, föhn of a well-defined type prevailed. It was characterised by puffs of very hot air occurring every two or three minutes in the midst of the abnormally warm air of the day. On July 7 and 8 these hot puffs were felt very strongly, and especially on the water. Attempts to measure their temperature with a thermometer proved unavailing, as their temperature was so high and their duration so short that the thermometer had only begun to rise when the heating cause had passed. Between August 18 and 23 exactly the same character of weather was observed in the valleys around Pontresina in the Engadine. The hot puffs were very remarkable. The weather was recognised by the people as "föhn." Here the inadequacy of the thermometer as usually employed was again apparent. Observations were made on the exchange of heat taking place between the hot föhn wind and the Morteratsch glacier over which it was blowing. The temperature of the air was observed at a station on the glacier, and at a station at the same altitude on the mountain at its side. The temperature of the air at the land station was found very variable, altering as much as 2° C. in five minutes. By making a number of observations during quarter of an hour a mean value was obtained for comparison with the temperature over the ice. On land the average temperature of the air in the afternoon was 16·5 C.; over the ice, and at a height of one metre above it the temperature was 10° C., and when the thermometer was laid horizontally with its bulb at distances between two centimetres and two millimetres from the ice, the lowest temperature of the air in that position was 5°·5 and the highest 7°·5. The wind blew over the glacier at a speed of eight to ten kilometres per hour, and was a fresh breeze, which might have been expected to thoroughly mix the air, yet the result of repeated observations showed that well-defined temperature gradients were produced and maintained in the air between the ice and a height of a metre above it. Between one metre and one millimetre above the ice the gradient is moderate, averaging 3°·5 per metre. In the thin layer next the ice the gradient is precipitous. The occurrence of the highly-heated puffs of air due to the föhn directed attention to the measurement of rapid variations of temperature generally. An approximation was made to their estimation by noting the rate at which the thermometer began to rise in one of these puffs, and then determining experimentally the excess of temperature of the air required to produce this effect. This could not be satisfactorily done at the time, but attention was paid to it later.

This method seemed to be the only one by which ordinary thermometers can be made to indicate truthfully changes of temperature which are not extremely slow. The method was applied in the case of a series of temperatures observed at very close intervals during the first two hours after sunrise on several days in February at St. Moritz. The temperature of a thermometer freely exposed to the north was observed at intervals of twenty seconds. These are summarised in a table. The temperature exhibited generally two falls for every three to four rises; the largest rise or fall in twenty seconds was 0°·5 C. From careful experiments on the rate of cooling of the thermometer, both in a room and in the open air when the air was still, it resulted that to produce a rise of temperature of 0°·5 in twenty seconds, the temperature of the air at the beginning of the interval must have been at least 2°·25 C. higher than that of the thermometer at the same instant. If there had been a fall of the same amount, then the temperature of the air must have been as much lower than that of the thermometer at the beginning of the interval. So that if, in any two consecutive intervals of twenty seconds, the thermometer showed a rise of 0°·5 and a fall of the same amount, the apparent temperature of the air at the beginning and the end of the interval is the same, whereas the true temperatures differ by $2 \times 2·25 - 0°·5$ or 4°·0 C. A table is given in the paper of the temperatures observed at intervals of twenty seconds during a few minutes on February 26, when the variations were considerable. The differences of temperatures required to produce the observed changes are given, and from them the amended or true temperatures are deduced and tabulated. The true variations of temperature are naturally much more abrupt than the apparent ones.

The concluding part of the paper deals with the employment of the thermometer as a calorimeter. For this purpose it is necessary, besides the rate of cooling, to know the "thermal mass" or water value of the bulb. A method is indicated by which this can be ascertained with very considerable accuracy by the measurement of the volume of the bulb. The circumference of the bulb is best determined by winding fine thread round it in a close spiral for a certain number of turns, then measuring the length of the unrolled thread. When the specific heat of mercury and that of ordinary glass are expressed in terms of unit volume they are very nearly identical; namely, 0·449 for mercury, and 0·466 for glass. It is clear that if the mean of the two is taken to represent the specific heat of the bulb, an error of not more than two per cent. is made in the extreme case when the bulb consists of all mercury or all glass. When the thermal mass and the rate of cooling of a thermometer have been determined, its usefulness as a metereological instrument is increased manifold.

Chemical Society, May 17.—Dr. Armstrong, President, in the chair.—The following papers were read:—The influence of moisture on chemical change, by H. B. Baker. Highly purified lime and carefully dried copper oxide do not combine with sulphur trioxide; dry ammonium chloride may be sublimed from a mixture with lime without the liberation of ammonia. Pure dry nitric oxide gives no brown fumes with dry oxygen, although the addition of a trace of moist air causes immediate interaction. Carefully dried ammonium chloride does not dissociate on volatilisation, the vapour having the density 28·7.—New volatile compounds of lead sulphide, by J. B. Hannay. The observed volatility of lead sulphide in water vapour may be explained by assuming the existence of gaseous compounds of lead sulphide and water; the author concludes that a definite compound of the composition PbS, H_2O exists. Evidence in support of the existence of a compound of the composition PbS, SO_2 is also brought forward; both these substances are colourless gases at a red heat, but decompose below 800°.—Notes on the cupellation of bismuth-silver alloys, by E. A. Smith.—Azo-*p*-cresol derivatives, by R. Meldola and F. Southerden. The authors have endeavoured to determine the constitution of several ortho-azo-derivatives of paracresol by treating their acetyl derivatives with nitric acid or bromine.—Effect of heat on iodates and bromates, by E. H. Cook. During the fusion of potassium bromate and iodate, bromine and iodine are respectively evolved; no halogen is given off after melting is complete, and after continued heating to drive off all the oxygen, only potassium bromide or iodide remains.

Geological Society, May 23.—Dr. Henry Woodward, F.R.S., President, in the chair.—On the stratigraphy and physiography of the Libyan Desert of Egypt, by Captain H. G. Lyons, R.E. The Nubian sandstone, wherever seen, rests unconformably on the old rocks called by Sir J. W. Dawson Archæan, and the author found no case of alteration of sandstone by these rocks, though in one case it is altered by an intrusive dolerite. The author considered the Nubian sandstone to be an estuarine deposit which was formed on an area afterwards gradually invaded by the Cretaceous sea. He considered the whole of the sandstone in the region which he had examined to be of Cretaceous age. He described a series of anticlinals, one set running W.N.W.-E.S.E., and the other N. by E. and S. by W. Many springs of the oases seem to occur along these anticlinals, owing to the beds which contain the water being brought nearer to the surface. Historical evidence was discussed which points to the Nile having reached a higher level in Nubia than it does at present, and it was suggested that variations in the level of the river were caused by earth-movement opposing obstructions to the river's flow. The sandstone of Jebel Ahmar near Cairo was described, and its occurrence over a wide area west of Cairo recorded. The author considered its age to be later Miocene. He believed that, with the exception of some erosion after the deposition of the Eocene beds, the greatest erosion, including the cutting-out of the Nile Valley, took place in Miocene times, while a certain amount, bringing the area to its present condition, was done in Quaternary times. This agrees with the observations of the French geologists in Algeria. The origin of the silicification of the fossil trees of the sandstone-deposits was discussed, and the action of water containing sodium carbonate suggested as a cause. The President, Mr. Hudleston, and the Rev. G. Henslow having made remarks upon the paper, Prof. Hull said he concurred with the view of the author that the course of the Nile above Cairo had been determined by the line of fault, which follows the valley for many miles upward. As regards the age of the Nile in Egypt, he considered it as referable to the Miocene stage rather than to the Pliocene. The Miocene period in that part of the world was one in which the main features of the present land-areas received their general contours. Referring to an observation by Mr. Hudleston regarding the absence of carboniferous beds in the Nile Valley, he reminded the Society that deposits of this age had been discovered by Dr. Schweinfurth in the Wady-el-Arabah between the Nile and the Gulf of Suez. Dr. Irving, remarking on the silicification of wood, said he wished again to emphasise the difference in the action of carbonic acid in petrological changes, according as it existed as a free acid or in combination with a base, as in sodium carbonate. The extent of the "Natron" deposits pointed to the supply of alkaline waters over large areas in former times, holding the mineral in solution. The reaction of such waters upon the potash-felspar of the sands, furnished by the disintegration of the crystalline rocks, would not lead to the deposition of free silica (as in the ordinary process of kaolinisation), because, while the potassium was taken up as a carbonate and carried away, the silica was also removed in solution, through combination with the sodium, to form sodium silicate. This last-named salt in solution would be readily decomposed by the organic acids and the carbonic acid furnished by decaying vegetable tissue, the silica being then deposited as a colloid *in situ*, and thus retaining the structural forms of the original tissue. The author briefly replied.—Notes on the geology of South Africa, by Mr. D. Draper. The district considered includes Natal, Zululand, Swaziland, the south-east part of the Transvaal, and the eastern part of the Orange Free State and of Basutoland. Physically it comprehends:—(1) The Drakensberg Range; divided into (*a*) mountain portion; (*b*) hill-covered plateau; (*c*) Highveld plateau; (2) the terrace along its foot; (3) the coast-belt. Their main features and characteristics were described. The geological formations are:—

Karoo Beds.	Upper.	1. Volcanic Beds.
		2. Cave Sandstone.
		3. Red Beds.
		4. Molteno Beds.
	Lower.	5. Beaufort Beds.
		6. Ecca Beds.
		7. Dwyka (Ecca) Conglomerate.
Palæozoic.		[Bokkeveld Beds, wanting,]
		8. Gats Rand (Zuurberg) Quartzite.
		9. Dolomitic Limestone.
		10. Table-mountain Sandstone.
		11. Malmesbury Schists.
		12. Gneiss and Granite.

—On the occurrence of dolomite in South Africa, by the same author. A peculiar calcareo-siliceous rock, near Lydenburg, described by Messrs. Penning and Crutwell as "Chalcedolite," and a similar rock mentioned by Mr. Penning as overlying the "Blackreef Series" of the Megaliesberg formation, have been recognised as a dolomite. Mr. C. Alford has described a "calcareous quartzite" as passing into dolomite and ultimately into chert, and known as the "Elephant-rock" in Transvaal, sometimes cavernous with underground waters. From his own experience Mr. Draper has recognised the "Elephant-rock" in the Potschefstroom, Lichtenburg, Malmani, and Lydenburg districts as a real dolomite, with interstratified siliceous bands, weathering into a brown earth like manganese oxide and superficial siliceous débris. It has its place between the Table-mountain sandstone and the quartzite of the Gats Rand (= Zuurberg quartzite of the Cape). It has auriferous veins in Malmani and Lydenburg. Dr. Schrenck has noticed a similar dark-blue dolomitic limestone in Great Namaqualand. The deep water-holes in it in Malmani are comparable with those found by F. Galton in West Central Africa. The great caves in Mashonaland may belong to it. The extensive tufaceous deposits in Griqualand-West, the Transvaal, and Orange Free State were probably derived from this extensive dolomite. Mr. Rutley, Mr. Nicol Brown, and Prof. T. Rupert Jones took part in the discussion that followed. — Contributions to the geology of British East Africa, by Dr. J. W. Gregory. The author described moraines, striæ, glacial lake-basins, perched blocks, and *roches moutonnées* below the present limits of the glaciers of Mount Kenya, which he maintained to indicate the existence of a "calotte" or ice-cap extending at least 5400 feet farther down the mountain than the termination of the present glaciers, and possibly farther, for in the belt of forest detailed observations could not be made. He agreed that this more extensive glaciation was produced by a greater elevation of Mount Kenya, and that any theory of universal glaciation is unnecessary, and indeed opposed by many facts in African geology. He discussed the probable influence of this former glaciation on the meteorological conditions of the surrounding area and the distribution of its flora and fauna.

PARIS.

Academy of Sciences, June 4.—M. Lœwy in the chair.—On the composition of apophyllite, by M. C. Friedel. No positive evidence of the presence of fluorine in this mineral could be obtained with specimens from Bou Serdoun (Algeria). Instead of an acid reaction, the water evolved possessed an alkaline reaction in the cases of specimens from Bou Serdoun, Andreasberg, Guanajuato (Mexico), Greenland, Nova Scotia, and Utö (Sweden). There is no fluorine in the samples examined; that reported by previous observers is probably due to the imperfect methods of analysis employed; on the other hand, they contain ammonia in quantity varying from 0·03 to 0·5 per cent., possibly replacing a part of the potassium. The evidence available is insufficient to settle the formula expressing the composition of apophyllite.—Report on a memoir by M. Bazin on experiments on the contraction of liquid jets and the distribution of velocities in their interior, by MM. Resal, Maurice Levy, Sarrau, and Boussinesq.—Transmission of sounds, by M. Henri Gilbault. The amplitudes of vibration being represented by y, and distances by x, it is shown that the law xy = a constant is not verified in practice for small values of x.—On the value of the theoretical ohm, by M. A. Leduc. The author shows that a part of a correction, considered unimportant by M. Wuilleumier, must be applied to the results obtained by the latter according to M. Lippmann's method. These results then give for the length of a column of mercury at 0° C. and of 1 sq. mm. section representing the theoretical ohm, the value 106·32 cm. in place of 106·267 cm. The revised value is in close accord with the mean of the best determinations made by other methods.—On the method of transformation of work into electric energy, by M. Vaschy.—On alternating currents and Wheatstone's bridge, by M. H. Abraham. A method is described for obtaining the frequency of the alternations by bridge measurements.—The *skiascope-optomètre*, by M. H. Sureau. A description of the use and parts of an instrument for the examination of the eye by opticians.—New researches on the chloroboracites, by MM. G. Rousseau and H. Allaire. The author describes the production and properties of compounds of zinc, cadmium, nickel, cobalt, and manganese having the general formula $6MO \cdot 8B_2O_3 \cdot MCl_2$.—On the *rôle* of the transformations of iron and carbon in the hardening of steel, by M. Georges Charpy. The following conclusions are drawn from the experimental results given. Hardening produces, among other modifications, a transformation of the iron (characterised by the breaking strain) and a transformation of the carbon (characterised by the variation of the results by the Eggertz test). The transformation of the iron appears to have but a feeble influence on the breaking strain, whereas the transformation of the carbon appears to be correlative with the augmentation of hardness.—On a hydrobromide of cupric bromide and on a red bromide of copper and potassium, by M. Paul Sabatier. The formula $CuBr_2 \cdot HBr \cdot 2H_2O$ is attributed to the substance obtained in black *chatoyant* crystals by cooling a concentrated solution of cupric bromide into which hydrogen bromide has been passed. The double compound with potassium is $CuBr_2 \cdot KBr$. It forms fine, deliquescent, rhombic plates, which are very opaque and apparently black, but are seen to be red in thin sections.—On the analytical separation of chlorine and bromine, by M. R. Engel. The bromine is separated by oxidation with ammonium persulphate, and distilled off into a sulphurous acid solution, from which it is precipitated as silver bromide. Under the conditions given, the chlorine is not affected.—On the detection of hydrobromic acid, by MM. A. Villiers and M. Fayolle.—New derivatives of cyanacetic and cyanosuccinic esters, by M. L. Barthe.—Combinations of pyridine with the permanganates, by M. T. Klobb. A series of compounds parallel with the ammonia derivatives previously described and of the general formula $MMnO_4 \cdot 2C_5H_5N$ or $MMn_2O_8 \cdot 4C_5H_5N$ are given.—On the emetics, by M. Paul Adam. The conclusion is drawn that substances of the emetic type should be considered as ether salts and not double salts.—On monoethylphosphoric acid, by M. J. Cavalier. This acid exhibits, thermally, two clearly distinct functions and gives two series of definite salts, corresponding with the formulæ PO_4EtMH and PO_4EtM_2.—Action of trioxymethylene on alcohols in presence of ferric chloride, and on the new methylene derivatives which result, by MM. A. Trillat and R. Cambier.—Mechanism of the action of chlorine on isobutylic alcohol, by M. A. Brochet.—Researches on the red pigmentary matter of *Pyrrhocoris apterus* (L.), by M. C. Phisalix.—On the relations between the dorsal cord and the hypophysis in birds, by M. G. Saint-Remy.—On a new *grégarine* of the family of the Dactylophorides, parasitic on Geophiles, by M. Louis Léger.—On a *Ustilaginée* parasitic on the beet-root (*Entyloma leproideum*), by M. L. Trabut.—On a vine disease caused by *Botrytis cinerea*, by M. L. Ravaz.—Contribution to the study of *géoclases conjuguées*, by M. Stanislas Meunier.—Variations of the latent period of coagulation of milk soured by rennet, by M. C. Pagès.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, JUNE 14.

ROYAL SOCIETY, at 4.30.—Flame Spectra at High Temperatures—Part II. The Spectrum of Metallic Manganese, of Alloys of Manganese, and of Compounds containing that Element. Part III. The Spectroscopic Phenomena and Thermo-chemistry of the Bessemer Process: Prof. Hartley, F.R.S.—The Complexity and the Dissociation of the Molecules of Liquids: Prof. Ramsay, F.R.S.—(1) The Molecular Surface-energy of the Esters, showing its Variation with Chemical Constitution; (2) The Molecular Surface-energy of Mixtures of Non-associating Liquids: Prof. Ramsay, F.R.S., and Miss Emily Aston.—On a Method of Determining the Thermal Conductivity of Metals, with Applications to Copper, Silver, Gold, and Platinum: James H. Gray.

MATHEMATICAL SOCIETY, at 8.—The Solutions of Two Differential Equations: F. H. Jackson.—A Theorem in Inequalities: A. R. Johnson.—Some Properties of a Circle: R. Tucker.—Note on Four Special Circles of Inversion of a System of Generalised Brocard Circles of a Plane Triangle: J. Griffiths.—On the Order of the Eliminant of Two or more Equations: Dr. R. Lachlan.

FRIDAY, JUNE 15.

QUEKETT MICROSCOPICAL CLUB (20 Hanover Square, W.) at 8.

SATURDAY, JUNE 16.

GEOLOGISTS' ASSOCIATION.—Excursion to Gravesend and Northfleet. Directors: Prof. T. Rupert Jones, F.R.S., and F. C. J. Spurrell.

YORKSHIRE NATURALISTS' UNION.—Meeting at Pontefract for the Investigation of the Neighbourhood of Ferrybridge, &c.

MONDAY, JUNE 18.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A Survey of the English Lakes (with Illustrations): Dr. Hugh Robert Mill.

TUESDAY, JUNE 19.

ROYAL STATISTICAL SOCIETY (Museum of Practical Geology, 28 Jermyn Street, S.W.), at 7.45.—A Comparison of the Realised Wealth and of the Economic Condition of France and England, especially as relating to their Agricultural Production and their Security in case of War: Mr. William J. Harris.

ZOOLOGICAL SOCIETY, at 8.30.—On Lepidosiren and Protopterus: Prof. Ray Lankester, F.R.S.—Notes on some Specimens of Antlers of the Fallow Deer showing Continuous Variation and the Effect of Total or Partial Castration: Dr. G. Herbert Fowler.—On the Perforated Flexor Muscles in some Birds: Mr. P. Chalmers Mitchell.

MINERALOGICAL SOCIETY, at 8.—A Chemical Study of some Native Arseniates and Phosphates: Prof. A. H. Church, F.R.S.—The Occurrence of Mispickel in the Stewartry of Kirkcudbright: P. Dudgeon.

WEDNESDAY, JUNE 20.

GEOLOGICAL SOCIETY, at 8.—On Deep Borings at Culford and Winkfield, with Notes on those at Ware and Cheshunt: W. Whitaker, F.R.S., and A. J. Jukes-Browne.—On the Bargate Stone and the Pebble-beds of Surrey, with especial regard to their Microscopic Contents: Frederick Chapman.—On Deposits from Snowdrift, with special reference to the Origin of the Loess and the Preservation of Mammoth-remains: Charles Davison.—Additions to the Fauna of the Olenellus-zone of the North-West Highlands: B. N. Peach, F.R.S.—Questions relating to the Formation of Coal-Seams, including a New Theory of them: suggested by Field and other Observations made during the past decade on both sides of the Atlantic: W. S. Gresley.—Observations regarding the Occurrence of Anthracite generally, with a New Theory of its Origin: W. S. Gresley.—The Igneous Rocks of the Neighbourhood of Builth: Henry Woods.—On the Relations of some of the Older Fragmental Rocks in North-West Caernarvonshire: Prof. T. G. Bonney, F.R.S., and Miss Catherine Raisin.

ROYAL MICROSCOPICAL SOCIETY (20 Hanover Square, W.), at 8.—On the Unreliability of certain Characters generally accepted for Specific Diagnosis in the Diatomaceæ: Mr. T. Comber.—Foraminifera of the Gault of Folkestone: Mr. T. Chapman.

ROYAL METEOROLOGICAL SOCIETY, at 8.—Fogs reported with Strong Winds during the Fifteen Years 1876-90 in the British Isles: Robert H. Scott, F.R.S.—Some Characteristic Features of Gales and Strong Winds: Richard H. Curtis.

THURSDAY, JUNE 21.

ROYAL SOCIETY, at 4.30.—The following Papers will *probably* be read:—On the Absorption Spectra of Dilute Solutions: Dr. T. Swan.—On some Phenomena in Vacuum-tubes: Sir D. Salomons.—On Operators in Physical Mathematics, Part III.: O. Heaviside.—On the Structure and Affinities of Heliopora cærulea (Pall.), with some Observations on the Structure of Xenia and Heteroxenia: Albert C. Bourne.—On the Differential Invariants of Twisted Curves, with some Illustrations of the Application to Quartic Curves: R. F. Gwyther.—Degenerations consequent on Experimental Lesions of the Cerebellum: Dr. Risien Russell.—Measurement of Colour produced by Contrast: Captain Abney, F.R.S.—On the Singular Solutions of Simultaneous Ordinary Differential Equations and the Theory of Congruencies: Prof. A. C. Dixon.—And other Papers.

LINNEAN SOCIETY, at 8.—On Tabulation Areas: C. B. Clarke, F.R.S.

CHEMICAL SOCIETY, at 8.—The Specific Character of the Fermentation Functions of Yeast Cells: Adrian J. Brown.—The Interaction of Lead Sulphide with Lead Sulphate and Oxide: J. B. Hannay.—The Oxidation of Tartaric Acid in the Presence of Iron: H. J. H. Fenton.—The Relation between the Solubility of a Gas and the Viscosity of its Solvent: Prof. Thorpe, F.R.S., and J. W. Rodger.—And other Papers.

FRIDAY, JUNE 22.

PHYSICAL SOCIETY, at 5.—An Exhibition of Photographs of Flames: Captain Abney.—An Elementary Theory of Planimeters: Prof. Henrici.—The Hatchet Planimeter: F. W. Hill.—A New Integrating Apparatus: A. Sharp.—Other Papers if time allows.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Histoire de L'Alimentation, L. Bourdeau (Paris, Alcan).—On the Development and Transmission of Power: Prof. W. C. Unwin (Longmans).—Quain's Elements of Anatomy: edited by Profs. Schäfer and Thane, Vol. 3, part 3, 10th Edition (Longmans).—Ostwald's Klassiker der Exakten Wissenschaften, Nos. 46, 47, 52, 53 (Leipzig, Engelmann).—Report of the Department of Public Works (N. S. W.) for the Year 1892 (Sydney, Potter).—U.S. Commission of Fish and Fisheries Report, 1889-91 (Philadelphia).—Iowa Geological Survey, Vol. 1 (Des Moines).—Publications of the Washburn Observatory of the University of Wisconsin, Vol. 8 (Madison).—Report of the Chief of the Weather Bureau, 1891-92 (Washington).—The Frena Handbook, No. 2 (Beck).—Catalogue of the Mesozoic Plants in the Department of Geology, British Museum (Natural History), the Wealden Flora, Part 1: A. C. Seward (London).—Sitzungsberichte der K. B. Gesellschaft der Wissenschaften, 1893 (Prag).

PAMPHLETS.—Report on the Social Condition of the People: J. Nyland (Davy).—Sulla Solidificazione delle Amalgame: D. Mazzotto, i. and ii. (Venezia, Ferrari).—Sui Sistemi Nodali delle onde Elettriche: Ditto, ii. and iii. (Torino, Clausen).—Technogeography: O. T. Mason (Washington).—The Birth of Invention: O. T. Mason (Washington).—The Progress of Anthropology: O. T. Mason (Washington).—National Academy of Sciences, Vol. 64th; Memoir—The Proteids or Albuminoids of the Oat Kernel; T. B. Osborne.—Dry Methods of Sanitation: G. V. Poore (Stanford).—Rapport Annuel sur l'État de l'Observatoire de Paris pour l'Année 1893 (Paris).—North American Species of Sagittaria and Lophotocarpus: J. G. Smith (St. Louis).

SERIALS.—Gazetta Chimica Italiana, 1894, fasc. 5 (Roma).—Indian Museum Notes, Vol. 3, No. 3 (Calcutta).—Bulletin of the Essex Institute, Vol. 26, Nos. 1, 2, 3 (Salem).—Essex Institute Historical Collections, Vols. 29 and 30 (Salem).—Illustrated Archæologist, June (Clark).—Bulletin de la Société d'Anthropologie de Paris, No. 2, 1894 (Paris, Masson).—Mémoires de la Société d'Anthropologie de Paris, Tome 1 (3e series), 2e fasc. (Paris, Masson).—Bulletin de la Société Impériale des Naturalistes de Moscou, 1893, No. 4 (Moscou).—Himmel und Erde, vi. Jahrg. Heft 9 (Berlin).—Journal of the Anthropological Institute, May (K. Paul).—Medical Magazine, June (Southwood).—Proceedings of the Edinburgh Mathematical Society, Vol. 1, Session 1883 (Williams and Norgate).—Proceedings of the American Philosophical Society, Vol. 31, No. 142 (Philadelphia).—American Meteorological Journal, June (Ginn).—Verhandlungen des Naturhistorischen Vereins, Fünfr. Jahrg. Zweite Hälfte (Bonn).—Journal of the Asiatic Society of Bengal, Vol. 62, Part 2, No. 4 (Calcutta).

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