THURSDAY, APRIL 13, 1893.

THE PLANET MARS.

La Planète Mars et ses Conditions d'Habitabilité. Par Camille Flammarion. (Gauthier-Villars et Fils, 1892.)

IN this very handsome volume the author brings together every available observation and piece of information that can be gathered from published and unpublished works with respect to our sometimes very near neighbour, the planet Mars. To make such a compilation as this, is, as every one will acknowledge, no light task; and since up to the present no one has made any attempt to collect existing observations and discuss them (although perhaps the value of this book is the more enhanced thereby) the difficulty of the undertaking has been very considerable, but in such hands as M. Flammarion's it has been thoroughly mastered.

With regard, first, to the form of arrangement which the author has thought advisable to adopt—since in a work of this kind many courses are open depending on the standpoint from which the book is written—the writer might, in the first instance, have divided the text into chapters dealing with the climate, calendar, heat, mass, density, geography, &c., treating each of these at full length, and discussing all the observations bearing on each separately. That this would have formed a good and logical sequence is unquestionable, but it is accompanied by many drawbacks, the chief of them being that as observations increased and our knowledge consequently advanced, each part of the work would have to be rewritten, or, at any rate, undergo a thorough revision. The method actually chosen is one which will seem more simple and therefore appeal more to the astronomer, and will perhaps be productive of better discussion. M. Flammarion places the facts before the reader in simple, chronological order, tracing out the work on the planet from the very first observations, step by step, down to those made during the opposition of 1892.

The volume is divided into two main parts, the first including the exposition and discussion of the observations themselves, and the latter containing the conclusions that have been drawn from the study of all the facts. The interval from 1636 to 1892—that is the whole time covered by our records—is divided into three chief periods, the first two of which terminate in the years 1830 and 1877 respectively.

Dealing first with the period commencing with the observations of Fontana (1636-1638), we are at one of the most interesting parts of the book. Here the author has been plunging into all the old original records, and has treated us to the tit-bits both as regards illustrations and text. As we cannot here conveniently produce the earlier drawings of the planet as made by Fontana, but which are represented in this volume, we may at least give the original observations as recorded in words:—

"1636. Martis figura perfecte spherica distincte atque clare conspiciebatur. Item in medio atrum habebat conum instar nigerrimæ pilulæ.

"Martis circulus discolor, sed in concava parte ignitus deprehendebatur. Sole excepto, reliquis aliis planetis, semper Mars candentior demonstratur."

The second drawing, which was made on August 24, two years later, was accompanied with the text:—

"Martis pilula, vel niger conus, intuebatur distincte ad circuli, ipsum ambientis, deliquium, proportionaliter deficere: quod fortarse Martis gyrationem circa proprium centrum significat."

Following Fontana; Riccioli, Hirzgarter, Schyrle de Rheita, Hévélius, and Huygens (1656) were the next to make a special study of this planet, the last mentioned of whom added much to the knowledge of the planet's surface markings. Up to the end of this period (1830) the number of observers, and consequently the number of observations had very much increased, while the rapid stride made in the perfection of the telescope was not the least important factor in this advance. Summing up the conclusions which can be drawn from these 192 years of observations it may be said that they related more to the elements of the planet than to its surface features, although spots varying in size had been many times noticed; the general idea of the different shadings as representing land and water had been thrown out, and the polar caps had been recorded as variable and not coincident with the geographical poles.

The second period, commencing in the year 1830, opens with an account of the fine series of observations made by Beer and Mädler. It was about this time that the real geography of the planet's surface began to be better known, and a systematic method of mapping brought into vogue. Following these two workers come a host of others, all adding their mite, in some cases rather a large one, to solve the riddle relating to this orb. Among these we may mention; Warren de la Rue, Secchi, several of whose fine drawings are here inserted; Lockyer, whose drawings, sixteen of which appear here, and "sont les plus important pour la connaissance de Mars de tous ceux que nous ayons étudiés depuis les premières pages de cet ouvrage"; Phillips, Lord Rosse, Lassell, Kaiser, Flammarion, Trouvelot, &c. With such observers as these, and many others as able, but whose names are too numerous to mention, it is no wonder that good work was done, and our knowledge by the year 1877 greatly extended. More accurate values for the elements were deduced, land and water features confirmed, cloud drifts observed, variations in the polar caps again noticed, &c., in fact, to put it shortly, all observations pointed to a singular likeness of Mars, physically speaking, to the earth herself.

In the third and last period—the Martian cycle from 1877 to 1892—we have observations extending over as many as 239 pages of the volume. The epoch commences very appropriately with Prof. Asaph Hall's discovery of the two small satellites, and introduces to us the observations of Schiaparelli, whose work on this planet has been rewarded by such brilliant discoveries. To enter, however briefly, into the mine of interesting and valuable material here brought together would lead us far beyond the limits of this article, but we must leave it to the readers of this journal to refer to the book itself; suffice it to say that M. Flammarion has given each observer his just due and merit.

Arriving now at the second part, which gives the results deduced from the general study of the planet, M. Flammarion is also quite at home, and in his masterly way brings all the main facts to a focus, sifting and sorting them and ultimately deriving the final results. In the following few brief extracts we propose to give in the author's own words some of the more important conclusions to which the examination of the facts has led him, and we will commence with the ruddy appearance that the planet puts on, the cause of which has always been and still is doubtful. *Apropos* of the suggestion that there may be red and not necessarily green vegetation on the surface of Mars, he says—

"Pourquoi, dira-t-on, la végétation de Mars ne serait-elle pas verte?"

"Pourquoi le serait-elle? répondrons-nous. La terre ne peut pas être considérée à aucun point de vue, comme le type de l'univers."

"D'ailleurs, la végétation terrestre pourrait être rougeâtre elle-même, et elle l'a été en majorité pendant bien des siècles, les premiers végétaux terrestres ayant été des lycopodes, dont la couleur est d'un jaune roux tout martien. La substance verte que donne aux végétaux leur coloration, la chlorophylle, est composée de deux éléments, l'un vert, l'autre jaune. Ces deux éléments peuvent être séparés par des procédés chimiques. Il est donc parfaitement scientifique d'admettre que, dans des conditions différentes des conditions terrestres, la chlorophylle jaune puisse seule exister, ou dominer. Sur la terre, la proportion est de 1 pour 100. Ce peut être le contraire sur Mars."

In a most interesting chapter comparing the Martial with the terrestrial seasons, many important points of similarity and difference are indicated. While the seasons of Mars are of nearly the same intensity as ours, yet the respective "working powers," so to speak, last nearly twice as long. The cold and hot seasons in the northern hemisphere continues for 381 and 306 days respectively, and it is this fact which explains the great difference between the two hemispheres. The polar caps, as with us, vary with the seasons, but attain their maxima and minima three to six months after the winter and summer solstices respectively. The dimensions which they assume cover in winter 45° to 50° in diameter, and become reduced in summer to 4° or 5°. Just outside the polar regions, "des chutes de neige ont été observées dans les régions tempérées, et parfois même jusqu'à l'équateur. On a vu dans l'hémisphère boréal des traînées en spiral venant du pôle, indiquant des courants atmosphériques influencés par le mouvement de rotation de la planète. La calotte polaire boréale paraît centrée sur le pôle. L'Australe en est éloignée à 5°, 4 ou 340 kilomètres, à la longitude 30°, de sorte qu'aux époques de minimum le pôle sud est entièrement découvert: *la mer polaire est libre.*"

That actual changes have taken place on the planet's surface, in spite of the numerous sources of errors to which such delicate observations are liable, seems to have been proved by the discussion of the material. In speaking of these sources of errors he says, "Ces diverses causes de variations apparentes dans les aspects des configurations géographiques de Mars suffisent-elles pour rendre compte de toutes les variations observées?"

"Non."

"Des changements réels ont lieu à la surface de la planète, changements qui n'ont rien d'analogue dans ce qui passe à la surface de la terre." . . . "Nous voulons parler de celle de l'étendue des taches sombres regardées comme mers, lacs ou cours d'eau."

The channels, the origin of which has been productive of so many hypotheses, are, according to the author, "dus à des fissures superficielles produites par les forces géologiques ou peut-être même à la rectification des anciens fleuves, par les habitants, ayant pour but la répartition général des eaux à la surface des continents." With regard to their doubling, after an examination of several hypotheses, he is led to look upon this fact as the result of refraction, although he remarks that "notre savoir est insuffisant," and "le connu n'est qu'une île minuscule au sein de l'océan de l'inconnu." He says,

"Quant aux dédoublements, il est difficile d'admettre que réellement de nouveaux canaux se forment du jour au lendemain, semblables et parallèles aux premiers: nous préférons imaginer qu'ils puissent être dus soit aux brumes dont nous avons parlé, soit plutôt à une double réfraction dans l'atmosphère martienne. Etant données les conditions de température (la chaleur solaire traversant facilement l'atmosphère martienne pour échauffer le sol), l'évaporation doit être très intense, et il doit y avoir constamment, au-dessus de ces cours d'eau, une grande quantité de vapeur rapidement refroidie, qui peut donner naissance à des phénomènes de réfraction spéciaux."

In the concluding chapter, giving us a *résumé* of the conditions of life at the planet's surface, the author sums up some of the main results. The world of Mars "paraît être, comme le remarquait déjà William Herschel, de toutes les planètes de notre système solaire, celle qui ressemble le plus à la nôtre. Nous pouvons répéter aujourd'hui, sur les habitants de Mars, ce que ce grand observateur écrivait, il-y-a plus d'un siècle, le 1er Décembre 1783: 'its inhabitants probably enjoy a situation in many respects similar to ours.'" It is possible, he adds, that this world may be peopled with beings analogous to our own: a race superior and in a more advanced stage, for the globe of Mars, M. Flammarion holds, is an older member of the solar system than our own.

Such, then, is a general sketch of the contents of this handsome volume of 600 pages. A glance through it is sufficient to show that no pains have been spared either by the writer or by the publisher, which might in any way add to its completeness; while the illustrations, which in such a work as this are of the highest importance, have been scattered with a lavish hand, and with all due regard to accuracy and purpose, no less than 580 telescopic drawings and 23 maps appearing.

In such a collection of facts as we have here, only one slight erratum has been observed, and this occurs on page 287, where it is stated that M. (now Prof.) Schur, at the observatory of *Breslau* made some measurements of the planet's diameter, while it should have been, "at *Strassburg* with a Breslau heliometer."

Throughout the work M. Flammarion has in every case given full references, which greatly enhances its value, while in the appendix several drawings made during the opposition of 1892 are inserted.

Never before was the planet viewed with such keenness by astronomers as was the case last year, and it is by these, as well as by those that have never had such an opportunity, that this work will be found of absorbing interest; astronomical literature is considerably enriched by its appearance. WILLIAM J. S. LOCKYER.

MAGNETIC OBSERVATIONS IN THE NORTH SEA.

Magnetische Beobachtungen auf der Nordsee angestellt in den Jahren 1884 *bis* 1886, 1890 *und* 1891. Von A. Schück. (Hamburg: Selbstverlag des Verfassers, 1893.)

THE extended and valuable magnetic surveys—notably those of Rücker and Thorpe in England, and of Moureaux in France—which have been made during the last ten or fifteen years, have provided magneticians with considerable information as to the conditions of the earth's magnetism in the countries bordering on the North Sea. From such data, there should be no difficulty in calculating normal curves of the three magnetic elements for the comparatively small intervening region covered by that sea.

The surveys on land have, moreover, shown that there are several regions of local magnetic disturbance, and therefore the chief interest of a magnetic survey of the North Sea, would lie in the discovery from observation on board ship, whether local magnetic disturbance existed in the land under the sea. The settlement of such a point would be a valuable contribution to our knowledge of terrestrial magnetism, and certainly if large disturbance were observed in any locality, of great practical importance to navigation.

Captain A. Schück has, for some years, past been making observations of the three magnetic elements with a special set of instruments well designed for observations at sea. Great pains have been taken by him to eliminate all sources of instrumental error, and he selected those wooden ships which appeared to him so far free from iron in their construction, that his magnetic instruments when mounted on board would be undisturbed. The results of his four years' work are given in the text with full descriptions, and illustrated by drawings of the instruments, as well as a chart of curves of equal value for each magnetic element.

The execution of these charts leaves much to be desired, for the figures on the land are in many places so crowded together as to be almost illegible, and it would have been much more to the purpose, if the lines of equal values had been at once taken from the published maps of the several observers, whose work the author fully acknowledges, instead of crowding together the data upon which their lines are based.

Again, the curves for those regions covered by the sea are in places so abnormal that they invite inquiry as to the accuracy of the small number of observations upon which they in many parts depend.

Although the author gives general assurances as to the selected ships being free from any source of magnetic disturbance, there are really no results recorded, to show that the observations at sea were really free from the effects of iron in the several vessels on board which the magnetic instruments were used. Long experience shows, that unless specially built, no wood-built ship is so far free from iron that its action can be neglected, especially when minutes of arc in an observation are of importance.

If observations at sea over so small an area as the North Sea, and the channels south and west of Great Britain, are to effectually supplement those extensive magnetic surveys made on the countries adjacent thereto, they must be stripped of every source of error. It does not appear that the observations recorded in this work are of the exact order suitable to modern requirements, however useful they might have been many years ago.

A work like that undertaken by the author, requires a specially-constructed vessel, devoted for the time to magnetic observations and other subjects of scientific inquiry. His objects were evidently delayed in execution by insufficient means to a satisfactory end.

MANUAL OF DAIRY WORK.

Manual of Dairy Work. By James Muir, M.R.A.C., Professor of Agriculture in the Yorkshire College, Leeds. 93 pp. (London: Macmillan and Co., 1893.)

THIS small primer on dairy work is in several respects a contrast to some of the books and pamphlets relating to dairy matters which have appeared within the last two or three years. Many of these have had too many points in common with a dairy utensil manufacturer's catalogue, and the information they contain has not always been either condensed or trustworthy. It is therefore a pleasure to take up Prof. Muir's little manual, which gives in small compass a great deal of information likely to be of value to every one interested in the production and use of milk. Apparently the book is intended for those who, having practical knowledge of the management of milk and its products, desire further knowledge of the principles upon which their practice is based, together with hints as to the best means of utilising their commodity according to the demands of their own particular market.

The information given is in most cases well up to date, but at the same time the discussion of obscure matters connected with the bacteriology of milk is carefully avoided. This is the more to be commended because every teacher of agriculture must know that looseness in describing the work of micro-organisms producing decay, or nitrification, or fixation of free nitrogen, has in many cases caused utter confusion in the minds of students; and more especially harmful is the imagination sometimes exercised by reporters and writers for the agricultural press. It is difficult to estimate the importance of Bacteriology in its relations to Agriculture and to Dairying, but in all discussion of the subject it is well to keep to ascertained and confirmed fact.

Prof. Muir's book is divided into ten chapters, the first of which deals with the formation and composition of milk. The description of the formation of milk in the udder is a trifle loose, the entire process being described as a casting off and breaking down of the cells which line the alveoli of the mammary glands. Milk is no doubt largely produced in this way, and especially must this be the case with colostrum when the glands commence or resume their activity; but it is more than probable that afterwards the milk is to some extent elaborated from the blood through the activity of the cells without so much actual shedding of the cells taking place. The great difference in composition between colostrum and normal milk shows that this latter process must be an important one.

In the third chapter some tests of the quality of milk are discussed. The value of milk is gauged by the percentage of butter-fat, and although there are many methods of estimating this, most of those which are trustworthy are troublesome to work. Prof. Muir does not speak well of the lactobutyrometer—an instrument designed for the separation and direct reading of the fat. The method is certainly rough, and almost useless, except in the hands of a very careful worker. There are two methods, not described by Prof. Muir, which are of much greater value and not more troublesome; these are the Babcock milk test and Soxlet's method of estimating fat in milk from a determination of the specific gravity of an ether extract.

In speaking of cream separation on p. 45, Prof. Muir mentions that "some kinds of separator have an arrangement for regulating the thickness of the cream," and also "that frequently separated cream is rather frothy." A fuller treatment of these points would have been useful. The methods of regulating thickness of cream from a separator depend upon varying the rate of revolution of the separator bowl, or else upon varying the time the milk remains in the bowl. The latter plan is most convenient, and is usually effected by diminishing the inflow of milk In the Danish separator the same end may be secured by adjusting the movable skimming tube. Frothiness of cream is most marked in the case of the Danish machine when the cream is taken off thick. This frothiness might possibly be remedied by using a smaller nozzle for the cream delivery tube.

In dealing with the principles of cheesemaking on p. 69, the author says, "The state of the milk with regard to acidity is of the greatest importance just when the rennet is added, and should it then be too acid little can afterwards be done to counteract the mistake. On the other hand, should the amount of acid be slightly too little, it may be counteracted to some extent in the subsequent processes."

As a matter of fact even the most skilful workers sometimes find the milk too ripe, and in such cases, by hastening the curd into the curd-sink and then washing with water at 100° F., good results may be obtained, at least by the "stirred-curd process."

The book concludes with a short appendix on cream-raising trials, made at the Yorkshire College.

Prof. Muir's manual, though small, is to be welcomed as a most useful addition to our dairy literature.

WALTER THORP.

OUR BOOK SHELF.

William Gilbert of Colchester, Physician of London, on the Loadstone and Magnetic Bodies, and on the Great Magnet the Earth. A New Physiology, Demonstrated with Many Arguments and Experiments. A Translation, by P. Fleury Mottelay. (London: B. Quaritch, 1893.)

AMONG men of science there is no difference of opinion as to the value of the original Latin work, "De Magnete," of which this is a translation. Some time ago (NATURE, vol. xlii. p. 279) we gave an account of a meeting held at Colchester by members of the Essex Field Club and the Gilbert Club, for the purpose of doing honour to the memory of Gilbert, who was born there in 1540. In a speech delivered at this festival Lord Rayleigh not only spoke highly of Gilbert's work, but went on to say that although we owe to an investigator who lived so long ago the theory that the earth is a great magnet, we are not much in advance of that position at the present time, as nobody has yet explained the origin of terrestrial magnetism. It was most desirable that a work which may be said to have marked a definite stage in the evolution of physical science should be presented in an English form, and this has now been done by an American scholar, who, as he himself explains, has "translated with latitude, keeping in view the author's sense more particularly than his words, and amplifying without altering the former." Mr. Mottelay has also brought together in a short biographical memoir the leading facts relating to Gilbert's career. The volume is well printed on good paper, and will be very welcome to students of the history of scientific ideas.

Report on Manurial Trials. By Dr. William Somerville. (Newcastle: Ward, 1893.)

THIS pamphlet, extending to 61 pages, gives the results of manurial trials in the county of Northumberland during the season 1892.

The plan of the experiments is an extensive one, but we may say that many of the experiments are designed to show what manures can be economically applied in the growth of turnips and potatoes in ordinary rotation.

From the experiments made upon farms at Rothbury, Ilderton, Tweedmouth, and Wark-on-Tyne, Dr. Somerville concludes that (1) basic slag is the cheapes phosphatic manure, though the best result is obtained with a mixture of slag and superphosphate; (2) kainit up to 2 cwt. per acre is a profitable dressing to turnips and potatoes; (3) the turnip crop requires nitrogenous manure; and (4) small dressings of artificial manures are more directly profitable than large dressings.

It is to be hoped than many of these experiments will be repeated in the county this year. W. T.

The Food of Plants. By A. P. Laurie, M.A., B.Sc. (London: Macmillan Co., 1893.)

THIS little book is intended to be an introduction to agricultural chemistry. It contains descriptions of a series of simple experiments which may be undertaken without any previous knowledge of chemistry. These experiments illustrate the part played by water in the nutrition of plants, the nature of the soil and of the air, and how plants obtain their food from these sources, &c.

The experiments are carefully chosen and described, and can be performed with inexpensive materials, and the book, especially if used as the author suggests, in conjunction with a Chemistry Primer, can well be recommended as an interesting guide to the study of agriculture.

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.*]

Fossil Floras and Climate.

I HAVE read with some interest the communications in recent numbers of NATURE based on a review by my friend Mr. Starkie Gardner of a book which I have not yet seen; and as an exile in the south owing to a serious illness, I have not means of reference even to my own papers on the topic in discussion. I think, however, it may be well to direct attention to some Canadian facts published in the Transactions of our Royal Society and elsewhere, to which neither Mr. Gardner nor Mr. De Rance have referred.[1]

[1] See Report of Dr. G. M. Dawson on the 49th Parallel 1875; Reports Geol. Survey of Canada, 1871-'77-'79; Transactions Royal Society of Canada 1883 to 1892.

In Western Canada, in the Rocky Mountains, and in the Queen Charlotte Islands (latitude 55°) we have a lower cretaceous flora, characteristically mesozoic, and even allied to the jurassic. Two of its characteristic species are closely allied to *Dioon eduli* of Mexico (*Dioonites Columbianus* and *D. borealis*, Dawson). Along with these are species of *Zamites* and of *Podozamites*, and leaves of Salisburya, very near to those described by Heer from the so-called jurassic of Siberia. The lowest beds of this series contain no angiosperms; but in beds a little higher these begin to occur. This has been named in Canada the Kootanie flora, from the river of that name in the Rockies. The late Dr. Newberry, in one of his latest papers, described the same flora with identical species as occurring in Montana, and it coincides in part with the Potomac flora of Fontaine in the south-eastern states. Its character and distribution show an extension of warm climate from Florida to the Queen Charlotte Islands, coincident with a great northward extension of the warm waters of the Gulf of Mexico, which in my judgment is sufficient to account for the climatal conditions. This lower cretaceous flora may be considered to be Neocomian in age, and to correspond with the Wealden of England, and the Komé of Heer in Greenland, which shows the extension of at least a temperate climate beyond the latitude of 60°.

The middle cretaceous brought in a still greater extension of the warm Mediterranean Sea of interior North America, indicated by the chalky foraminiferal Niobrara beds of the United States geologists, which extend into Canada. North of these marine beds, however, we have in Canada, in N. lat. 55°, the Dunvegan sandstones and shales, which hold not only cycadaceous plants but a rich angiospermous flora, including such warm temperate genera as *Magnolia* and *Laurus*, with more northern forms as *Betula* and *Populus*. This we regard as a middle cretaceous flora, in its older part approaching the well-known Dakota flora of the United States, and corresponding to the Atané of Heer in Greenland. The climate in this period must have been humid, equable, and temperate, all around the great American Mediterranean; but it is not impossible that our Dunvegan collections may include some plants of mountain districts mixed with those of lower grounds.

This was succeeded by the upper cretaceous, in the older part of which we have the magnificent flora of the coal series of Vancouver Island, which represents a Pacific coast flora, with fan palms, live oaks, and other trees comparable with those of modern Georgia and Florida. By this time, however, there would seem to have been a geographical separation between the Pacific coast and the plains, as the latter have not yet afforded anything equivalent to the Vancouver flora, and there are some indications that, toward the close of the cretaceous, the climate was cooler than previously. This is equivalent to the Patoot series of Heer in Greenland.

The Laramie period proper, that of the lignite tertiary formations of the plains, seems to indicate a swampy and lacustrine condition of the interior plateau, and the rich angiospermous and gymnospermous flora of this time, characterised very markedly by species of *Platanus* and *Sequoia*, has a temperate aspect in Canada, as far north as the McKenzie river. It corresponds with the so-called miocene of Heer in Greenland, but is shown by stratigraphy and by its affinity with the eocene of England and Scotland, as described by Mr. Starkie Gardner, to be of that age if not constituting a transition group between the cretaceous and tertiary. The palæobotanists of the United States, at first, following Heer, regarded this flora as miocene. More recently some are disposed to consider it upper cretaceous. In Canada it has all along been regarded as paleocene or eocene, and so far as its flora is concerned this is its true position. In a recent number of NATURE I see that Prof. Osborn is disposed to regard the small mammalia of the Laramie of the United States as of eocene affinities. If so, they will agree with the plants. It seems more difficult to account for the great northward extension of the Laramie temperate climate than for that of the preceding cretaceous, as the great Mediterranean of the latter seems to have dried up, though still existing in part, or replaced by swamps and lakes. Possibly some other arrangement of the warm Atlantic currents, as suggested by Mr. Starkie Gardner, may have produced some effect, in conjunction with obstruction of the Arctic currents, and a lower level of Greenland.

The general bearing of these facts on American climate is that we have no evidence of a tropical climate in Northern Canada or Greenland, but that both the geographical and botanical facts indicate a warm temperate climate, at least in the cretaceous period, and that in the earlier eocene the climate was becoming cooler and less equable.

We have little to show for the miocene; but what there is, as in the Similkameen flora of British Columbia, would go to show a cooler climate and more of local variation.

I have little faith in attempts to deduce a mean temperature in degrees of Fahrenheit from fossil plants; but if carefully collected, so as to keep separate those that belong to different horizons, and if studied in strict relation to the geological conditions of their occurrence, they must afford excellent general indications of climate. Allowance must, however, be made just as in the case of animal fossils, for differences of station, altitude, &c., and for extent of probable driftage or occurrence *in situ*.[1] In studying large collections of our mesozoic and tertiary fossil plants, from different localities and horizons, I have as a geologist naturally had reference to these points, and the work of such men as Selwyn, Richardson, G. M. Dawson, and Mr. Connell has left nothing to be desired as to careful collecting and determination of stratigraphical relations, while the study of animal fossils by Mr. Whiteaves has gone on *pari passu* and in harmony with that of the plants.

I sympathise with Mr. De Rance in his defence of Heer's studies of the Greenland plants, for I know that my own work in Canada would be liable to still more severe criticism. It must be borne in mind that the palæobotanist has very imperfect material, and that he is always liable unconsciously to multiply species. If, however, his names serve to designate the things, and if their geological relations are known, an important work has been accomplished—always, however, provisional and liable to correction as new discoveries are made. One of my Kootanie leaves is scarcely distinguishable on the one hand from Heer's *Salisburya sibirica*, and on the other from Lindley's *Cyclopteris digitata*, even when I have specimens of both to compare it with. All may be the same, though referred on the one hand to ferns, on the other to coniferæ, and this may not be settled till specimens in fruit are found. But in any case something has been done, and a widely distributed vegetable form has been recognised at a particular stage of the world's history.

I hope to discuss some of these points more fully in a work now in the press. WM. DAWSON.

Augusta, Georgia, March 13.

P.S.—Since writing the above I have obtained access to a copy of Dall and Harris's "Neozoic Correlation Papers,"[2] which throws some additional light on the cretaceous and eocene floras of Alaska, which, from its high northern latitude, affords a good term of comparison with Greenland. It would appear that fossil plants occur at two horizons. One of these (Cape Beaufort), according to Lesquereux and Ward, holds species of Neocomian age, equivalent to the Kootanie of British Columbia and to the Komé of Greenland. The other, which occurs at several localities (Elukak, Port Graham, &c.), has a flora evidently of Laramie (eocene) age, and equivalent to the "miocene" of Heer and Lesquereux and to the McKenzie river and lignite tertiary of Canada. The plants are accompanied by lignite, and evidently *in situ*, and clearly prove harmony with Greenland and Northern Canada in two of those periods of high Arctic temperature indicated above.

Notes on a Spider.

I SEND you the following notes on a spider, whose curious habits I had an opportunity of observing, last year, on the West Coast of Africa:—

In the month of August, 1892, I was travelling by hammock from Chama to Sekundi, two small towns on the Gold Coast. That part of the country is somewhat hilly and is covered with "bush" and other forest growth. The road skirts the sea-shore, sometimes following the beach itself, at other times taking turns inland and winding round bases of small hills.

It was about three in the afternoon and I was being leisurely carried along by my bearers, when I noticed in the bushes that bordered the path something which appeared to me to be a sort of white flower.

[1] Ward, of the U.S. Geol. Survey, has directed attention to these points in an excellent paper published by the Survey.
[2] *Bulletin U.S. Geol. Survey*, 1892.

I stopped and examined it. Instead of being a flower, I found it was the web of a spider, and it was hanging between the branches of a shrub about three feet from the ground.

The outer lines of the web were of considerable strength and were stretched between points from eight to ten inches apart. From these lines, supported by a few radii, hung a beautiful rosette-shaped centre, much resembling a delicate pattern in white silk lace. The central space was open and measured about a quarter of an inch in diameter. The notched space was adorned by three circular zig-zag cords of thick white flossy silk. I did not notice any of MacCook's so-called "ribbon braces." The spiral space was very open and the threads composing it were so slight as to be almost invisible. So thin were they that the ribboned centre appeared to be hanging in the air without any support whatever. The appearance of this web was almost exactly similar to that of the web of *Uloborus*, shown in Fig. 57, p. 58 of MacCook's "American Spiders." I did not notice any "fenders" or protective wings on the outer side of the web; there were, however, a few strengthening strands on the side turned towards the bush.

The web, however, especially bore a strong resemblance to a flower, the more so as in the exact centre of its outward side was stationed a spider with a light blue body. This light blue colour gave one the impression that it was the centre of the flower, while the yellow legs spotted with brown were symmetrically disposed in the shape of an X across the ribboned hub, thus dividing it into the semblance of petals. The illusion was remarkable.

The spider remained motionless until I touched the web. She then fell into the net which I was holding under the snare.

As soon as she touched the net (a white gauze one) she changed colour. From blue she became white and then, on being shaken, her body turned a dark greenish brown. I then placed her in a glass tube and gradually she resumed her blue tint. Whenever shaken, however, she turned a greenish brown. I placed her in spirits and her colour remained a grey brown.

On the same road later in the day, I noticed another strange web which bore even a stronger resemblance to a flower.

The "foundation space" was the same as in the other, but somewhat larger and stronger. The white silk ribbon, however, instead of being disposed around the centre in circular zig-zag lines, was extended in two thick white ribbons stretched crosswise along four of the radii. In this instance also the spiral space was very open and the spirals very delicate.

The spider inhabiting this web was considerably larger than the foregoing specimen, but appeared to be otherwise exactly similar to it. Her body was a very light blue, placed exactly in the centre of the cross, head downwards, while her long legs were disposed in pairs over the four arms of the white silk pattern. The whole thing bore a great resemblance to an orchid, and the legs of the spider gave it just sufficient stability for it to be taken for a flower.

When I touched the web the spider immediately darted through two strands in the spiral space and placed herself on the reverse side of her web, being almost completely concealed by the thick flossy white ribbons.

I captured this spider, and her body, like the other specimen's, immediately turned a dark greenish brown. I did not, however, see her turn white. I placed the insect in a glass tube, and five days later put her in a cage.

I also took the web and succeeded in fastening the centre of it on to a black card, where it remains in exactly the same shape as when it was hanging on the bushes. I have this web, and also a photograph of it.

The day after the spider was placed in the cage she made a web. It was spun during the night, and I did not observe the operation. The web was of the same pattern as the one on which I discovered her on the bush. It did not have any circular zig-zag cords.

This spider remained in her cage for four or five weeks, and then I placed her in spirits. She was fed principally with flies.

On one occasion I put a very large blue-bottle fly into the cage. The spider seized it immediately, violently vibrated her web, and at the same time rolled the fly round and round between her legs. In the space of three or four seconds the fly was completely swathed in an envelope of white silk, and was motionless. The spider then fastened her fangs into the body, and sucked it for about two hours.

I have since seen several of these spiders on their webs, and have noticed that the pattern of the snare appears to depend on the size of the insect, the smaller specimens making the circular rosette-shaped snare, while the larger insects weave the cross orchid-like flower. I saw one small web composed of two little rosettes, joined side by side, but I did not notice whether it was inhabited by two spiders. I frequently found wings and other debris of insects hanging to the rosettes of the webs, and in one case saw a wing of what must have been a butterfly of considerable size.

When does the spider alter the pattern of her snare? Can it be that, when the spider attains to full growth, finding that the rosette shape, becoming too large, no longer deceives butterflies and other insects, she adopts the orchid-like pattern which has more *vraisemblance*, and over which she can dispose her long legs with a better chance of successful trickery.

The web of this spider being so like a flower would appear to be intended as a veritable "snare." The insect by assuming its bright blue colour increases the resemblance and the mimicry is probably practised not so much for the protection of the spider herself, but rather for the attraction it presents to butterflies and other flower frequenting insects.

MacCook in "American Spiders," writing of the mimicry of spiders, and of their perception of colour, says (vol. ii. p. 346):—"There is indeed another theory which may be suggested, namely, that the colour surroundings of the spider, in some manner not now explicable, so rapidly influence the organism of the creature that a change of colour is produced in harmony with its environment. *Can we suppose in this case that the spider possesses the power to influence at will the chromatophores or pigment bodies, so that she may change her colour with changing site?*"

The specimen observed by me would seem to be an answer to MacCook's suggestion, and I should be very glad to know, through the medium of NATURE, or otherwise, whether the spider described by me, as above, is already known to naturalists.

I took the specimens which I possess to the Natural History Museum, at South Kensington, and the spiders were declared to be a species of Argiope.

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Origin of Lake Basins.

ONE of the chief reasons for the prevalence of lake basins in glaciated countries has not been alluded to in the letters which have recently appeared in NATURE on the origin of lake basins.

Whenever earth movements take place in limited areas such movements will tend to form basins, but as the movements are as a rule gradual such basins will only come into existence under exceptional conditions. Water-borne detritus, the growth of vegetation, and erosion will obliterate them in most cases as fast as they are formed by slow unequal movements of subsidence or elevation.

In glaciated countries, however, basins in the course of formation by unequal earth movements will be largely protected from such destructive action by being filled with ice, and will thus be preserved to appear as lake basins when the ice melts.

So, too, in countries where the rainfall is very small and the action of the forces destructive to lake basins is accordingly much diminished basins may be and are formed by earth movements. In rainless countries they are probably more numerous than we are aware of, for there is little to attract attention to them, but they will become of more importance as works of irrigation are required in such countries. An important depression, the Raiân basin, has lately been surveyed in Egypt by Mr. Cope Whitehouse with a view to utilising it for irrigation purposes (Proceedings Royal Geographical Society, 2nd series, vol. ix. p. 608).

Wind-borne detritus will tend to diminish the depths of such basins in rainless countries. So, too, the capacity of ice-filled basins to hold water in the future will be diminished somewhat by the erosion of the sub-glacial river, but on the other hand as the movement of the earth deepens the basin the ever-thickening mass of ice will acquire increased power to grind it deeper still. This grinding action cannot be ignored, and some shallow lake basins may be almost entirely due to it, but there is scarcely a limit to the formation of such basins by earth movements under suitable conditions.

J. C. HAWKSHAW.
33, Great George Street, Westminster, S.W., March 29.

THE MUSK-OX.

THE Zoological Society of London being anxious to obtain living specimens of the musk-ox (*Ovibos moschatus*), well known as one of the characteristic inhabitants of Arctic regions, the Council of the Society have determined to offer the sum of five hundred pounds for five examples of this animal (two males and three females) delivered alive and in good condition in the Regent's Park Gardens, or a proportionate sum for a smaller number. It has been pointed out by Col. Feilden, in an article upon "Animal Life in East Greenland," published in *The Zoologist* for February last, that the southern range of the musk-ox, which was formerly supposed to be met with only in Arctic America, has now been satisfactorily shown to extend as far south on the east coast of Greenland as midway between the parallels of 70° and 71° N.L., and that it will in all probability be found in the future to extend along the coast line of Egede Land as far as the sixty-fifth parallel. Thus the abode of the musk-ox is brought comparatively close to Europe, and there seems to be no insuperable difficulty in procuring living specimens. Young musk-oxen are very easily reared and tamed, and there could not be any very great difficulty in catching either old or young in Jameson's Land.

Although the more southern portion of the coast of East Greenland is shut off from access by an almost impenetrable ice barrier, it has been ascertained of late years that the more northern portion of this coast may

Musk-ox (from Flower and Lydekker's "Introduction to the Study of Mammals," p. 358).

be reached with comparatively little difficulty. In 1889 Captain Knudsen, of the Norwegian sealer *Hekla*, landed on Clavering Island in 74° 10′ N.L., and found musk-oxen in considerable numbers. Again, during the recent Danish East Greenland Expedition of 1891–92, Lieut. Ryder managed to land on Jameson's Land in Scoresby's Sound, although the year was very unfavourable, and passed the winter there with great success, no sickness having occurred amongst the members of the expedition during all the time they were there.

Animal life, Lieut. Ryder tells us, is rich, especially in Jameson's Land, where reindeer are seen in wonderful numbers. Many musk-oxen were seen around Hurry's Inlet, and traces of foxes, hares, bears, ermines, and lemmings were observed in Jameson's Land. The richness of vegetation (150 flowering plants having been gathered in Scoresby's Sound) and the size attained by it, especially around the western basin, are most astonishing, especially in comparison with what is the case on the western coast of Greenland.

It is, therefore, evident that it is quite possible for the well-equipped Arctic navigator to land on this part of the east coast of Greenland in almost any ordinary year, and that he will find there an abundant supply of both animal and vegetable life. In the former category are the musk-oxen, the young of which, as already stated, are easily captured and reared. When they are once placed on board ship there would appear to be no great difficulty in bringing them safe to England.

We subjoin the description of the musk-ox given in Flower and Lydekker's "Introduction to the Study of Mammals," the publishers of which (Messrs. Black) have kindly allowed us the use of the accompanying illustration.

The animal commonly known as the musk-ox (*Ovibos moschatus*), though approaching in size the smaller varieties of oxen, is in structure and habits closely allied to the sheep, its affinities being well expressed by the generic name *Ovibos* bestowed upon it by De Blainville. The specific name, as also the common English appellatives, "Musk-Ox," "Musk-Buffalo," or "Musk-Sheep," applied to it by various authors, refer to the musky odour which the animal exhales. This does not appear to be due to the secretion of a special gland, as in the case of the musk-deer; but it must be observed that, except as regards the osteology, very little is known of the anatomy of this species. It about equals in size the small Welsh and Scotch cattle. The head is large and broad. The horns in the old males have extremely broad bases, meeting in the median line, and covering the brow and whole crown of the head. They are directed at first downwards by the side of the face, and then turn upwards and forwards, ending in the same plane as the eye. Their basal halves are of a dull white colour, oval in section and coarsely fibrous; their middle part smooth, shining, and round; their tips black. In the females and young males the horns are smaller, and their bases are separated from each other by a space in the middle of the forehead. The ears are small, erect, and pointed, and nearly concealed in the hair. The space between the nostrils and the upper lip is covered with close hair, as in sheep and goats, without any trace of the bare muffle of the oxen. The greater part of the animal is covered with long brown hair, thick, matted, and curly on the shoulders, so as to give the appearance of a hump, but elsewhere straight and hanging down; that of the sides, back, and haunches reaching as far as the middle of the legs and entirely concealing the very short tail. There is also a thick woolly underfur, shed in the summer. The hair on the lower jaw, throat, and chest, is long and straight, and hangs down like a beard or dewlap, though there is no loose fold of skin in this situation as in oxen. The limbs are stout and short, terminating in unsymmetrical hoofs, the external one being rounded, the internal pointed, and the sole partially covered with hair.

It is gregarious in habit, assembling in herds of twenty or thirty head, or, according to Hearne, sometimes eighty or a hundred, in which there are seldom more than two or three full grown males. The musk-ox runs with considerable speed, notwithstanding the shortness of its legs. Major H. W. Feilden, Naturalist to the Arctic Expedition of 1875, says:—"No person watching this animal in a state of nature could fail to see how essentially ovine are its actions. When alarmed they gather together like a flock of sheep herded by a collie dog, and the way in which they pack closely together and follow blindly the vacillating leadership of the old ram is unquestionably sheep-like. When thoroughly frightened they take to the hills, ascending precipitous slopes and scaling rocks with great agility." They feed chiefly on grass, but also on moss, lichens, and tender shoots of the willow and pine. The female brings forth a single young one in the end of May or beginning of June, after a gestation of nine months.

ON THE CARBURISATION OF IRON.

II.

In a previous communication (Nature, vol. xlvi. p. 283) the problem of the distribution and absorption of carbon by iron has been discussed, and it has been shown that the process is akin to that of the solution of a salt soluble in water or an acid liquid, that at low temperature solution proceeds slowly, the solubility increasing with the temperature, until at the final high heat of Bessemer blown metal, or fluid nearly pure iron, the reaction is almost instantaneous; the carbon, and also manganese, contained in the spiegel-eisen used for this purpose diffusing throughout the fluid metal in a very short space of time. The same occurs when carbon only, in the form of charcoal or coke, is added in lieu of spiegel, as in the Darby process of carburising. By this latter process, however, about 30 per cent. excess of carbon must be added over and above the theoretical quantity required to insure a given percentage of carbon, for instance, ½ per cent. For lower percentages the excess must still be maintained, but with a corresponding diminution of the total weight of carbon used. In some instances more than 30 per cent. is used, according to the methods of procedure. In practice this holds good and the quantity of carbon required can thus be regulated.

A priori this would seem impossible. An excess 30 per cent. above the quantity necessary being used, it seems strange that, at the high temperature in the presence of a considerable excess of fluid metal, that nearly the whole of the carbon is not taken up, more especially when iron, as is well known, may absorb as much as 5 per cent. of carbon in the blast furnace; usually, however, cast iron contains not more than 4 and spiegel eisen 5 per cent. carbon, the latter alloy of manganese and iron apparently conferring greater solubility. It even suffices to pour the fluid metal on the pulverised carbon previously placed in the ladle, and a very even product is thus obtained, sufficing for all practical purposes, the variation in the percentage of carbon absorbed or dissolved falling within the limits of experimental error. It is possible that after absorption of carbon equalling say ½ per cent., if the iron were left in contact with carbon for a longer period, more might be taken up; and that with iron already charged with carbon, solution may be retarded; the rate at which the latter is taken up probably bearing a certain ratio to the amount previously absorbed. If carbon simply exists in solution this is very probable, and yet the theory would hardly afford at first sight a feasible explanation of the even absorption of carbon which thus takes place, were it not well known that most chemical reactions, so to speak, fall into the same category.

Chemical affinities are not entirely governed by actual values; or the affinity of one element for another; the mass or relative weight of the bodies present influences the final result; and it is conceivable that, assuming we have two bodies in solution, the addition of a reagent having a greater affinity for one of these may not, in the presence of an excess of the other, exert its full power, the greater mass or weight of the latter apparently weakening, or rather partly neutralising, the chemical force of the reagent added.

Further cases can be quoted where relative masses in solution are so evenly balanced that a slight excess of the reagent added determines the precipitation of one or the other at the will of the operator.

Barium sulphate is somewhat soluble in acids, and by prolonged digestion a portion is dissolved. Either barium or sulphuric acid may be precipitated by merely, as regards barium, adding a slight excess of sulphuric acid. On the contrary the addition of a little barium chloride determines the precipitation of sulphuric acid. Apparently, then, excess or mass of one element overcomes the greater affinity of the other for the reagent added, or, as often happens, a portion is left uncombined and in solution, requiring an excess of the reagent for the complete precipitation or combination.

Such cases as those above quoted are not uncommon in metallurgical processes conducted at high temperatures. Thus in the case of the manufacture of Bessemer steel, analysis indicates the presence of diverse elements existing together.

One has—silicon, carbon, hydrogen, oxygen, manganese —also sulphur and phosphorus together with, it is said, carbon monoxide in solution—also probably dissolved oxygen in addition to iron oxide. Further, steel with more than ½ per cent. of carbon, and also silicon and manganese in sensible quantities, always contains O and H; and thus we have the elements of water side by side in the presence of a tolerable excess of no less than three bodies, Si, C, and Mn, having affinities for oxygen.

It is quite true that the abnormally high temperature of the process may weaken ordinary chemical reactions by a species of dissociation; this has been acknowledged. Yet mass or relative proportions of the elements present must, one would think, influence final results, and thus prevent the complete elimination of the elements named for the reasons already stated.

The treatment of fluid iron with reagents such as C, Si, Mn, or alkalies, as now practised, is as strictly a chemical process as that pursued by the chemist in his laboratory. In both, reagents are employed which are known to be suitable for the elimination or precipitation of substances known to be present; and, so far as can be ascertained from actual practice, the steel-caster deals with molten metal containing certain elements in solution, and endeavours to get rid of some of these, or adds others assumed to be beneficial, just as the chemist works with solutions known to contain bodies possibly existing or combined with the fluid solvent in much the same manner as the worker with fluid iron. There seems but little difference, take it as one may; the same laws of combination, solution, &c., seem equally applicable; and differences of opinion as to what is really meant by the terms solution, chemical combination, or simply mixtures, are common to both. Further, it must not be forgotten that pure fluid iron, although exerting a direct solvent action on certain bodies, may take up or dissolve a chemical combination or double salt, just as pure water does. This, however, remains an open question, but it would be interesting to know if certain combinations of iron with other elements are thus held in solution.

As regards carbon there can be little doubt of the existence of definite carbides of iron; and it may be that combinations of iron with bodies other than carbon may play a part. Some recent work on certain alloys of iron points to the probability of the formation of these. Assuming the presence of a definite carbide of iron which may not be in solution, but diffused evenly throughout the fluid iron, although we cannot be absolutely sure of this, the behaviour of steel under certain conditions of heating and manipulation may be explained on the assumption that iron carbide, being certainly more fusible than pure iron, must become soft and plastic at a temperature at which the mass of pure metal is scarcely at all affected. This plastic compound would bind the noncoherent particles of the greater mass of iron together, and this mixed or heterogeneous body could be welded or beaten out under the hammer. It is the general opinion that the weldable metals are mixed bodies, are not homogeneous, inasmuch as bodies purely homogeneous cannot as a rule be welded together.

Wrought iron welds easily, far more easily than steel, and it is certain that the former is not homogeneous, whatever may be said of the latter. Wrought or puddled iron is well known as an irregular mixture, composed of grains of pure metal intermixed with carburised metal, and also slag. The latter is said to play its part in rendering the total mass more coherent when heated and worked. This latter material when fused and cast into ingots is a totally different material, and behaves somewhat like steel. If this now comparatively homogeneous substance contain enough carbon (which sometimes is not the case; in the latter instance it is brittle and redshort, behaving somewhat like Bessemer blown metal) it works like a soft steel.

It follows, therefore, that if fusible compounds are present, and evenly diffused throughout the pure metal, their effect on steel is purely physical, and a heterogeneous metal like steel may be compared with rocks, which are known to be composed of siliceous particles, cemented or bound together by other compound bodies. Dr. Sorbys long ago noted this, and drew attention to the comparative uselessness of ordinary chemical elementary analysis, simply stating the percentage of elements present, and suggested that proximate analyses were equally required. The writer is fain to agree with him, his own experience of the comparative failure of ordinary analysis as a trustworthy guide in the manufacture having been somewhat extensive. The purest form of iron known to the writer is the Bessemer blown metal, beyond traces of carbon, with less than $\frac{1}{10}$th per cent. of sulphur and phosphorus. It is pure iron (with some kinds of iron only traces of these latter can be detected). This metal is worthless for commercial purposes, and this is said to be due to the presence of oxide of iron or possibly dissolved oxygen absorbed during the blow; to a certain extent this has been proved to be true. But the writer thinks that on the whole the pure material, even when freed from oxygen, would be commercially valueless, and if, shortly speaking, the cement theory or mixture of bodies (the one more fusible than the other), be true, pure iron is unworkable.

The opinions quoted are apparently not in accord with the theory of solution previously summarised, and leave unexplained the undoubted fact of the diffusion or solution of carbon in iron at low temperatures, tending, of course, if time be allowed, to the formation of a homogeneous material. Yet a carbide of iron is known, "Fe_4C," and has been isolated. It appears to the author that one somewhat reasonable explanation of this anomaly has been afforded by W. Mattieu Williams. He compares the union of carbon and iron to the processes of tinning or galvanising. If a plate of copper is immersed in melted tin a film of tin adheres to its surface, and if continued the tin will gradually soak into the copper, and in time will go through. Tin or zinc penetrates iron in the same way; mercury also amalgamates with copper; therefore carbon (Fe_4C) may be similarly distributed in iron.

This may or may not be the case, but in the author's opinion it does not meet all the difficulties, or afford a complete explanation of the phenomena taking place when iron is heated and worked in contact with carbon. Neither does the alternative theory of solution, either in the ordinary sense of the word or, better, as defined by modern physicists, afford a complete explanation. Yet on the whole the latter seems to afford a better and more complete all-round explanation of some curious changes observable when steel is heated up to certain varying temperatures, the results of which are now familiar to us.

Referring once again to the curious fact of the even distribution of carbon throughout iron, when plates of uneven composition as regards the percentage of carbon are heated together, it appears as the outcome of recent research [1] that chemical action, "or something closely approximating to it," takes place between solids, and even at low temperatures. Many experiments are given—thus dry ice and rock salt unite when placed in contact at a temperature decidedly below zero.

[1] William Hollock, *American Journal of Science*, vol. xxxvii. 1889.

This is a very old experiment, but it is interesting as an example of the union of two solids below the fusing point of either, but above that of the product. He obtained similar results in other cases with sodium, potassium, calcium, and ammonium chloride, &c. This suggests the question, Are the metals combining to form an alloy "in the new way," *i.e.* in the form of solids, a freezing mixture?

Space does not admit of further quotation; the fact remains that solids combine with solids to form an alloy, or possibly what is termed a chemical combination.

At first sight this seems inconceivable and irrational. Many alternative theories and explanations of these curious phenomena are at our disposal. Yet there remains one simple way of accounting, at least in some degree, for this alloyage—or one ought perhaps to say the interpenetration of one element into another, as with carbon and iron. It is now, we think, generally admitted, in the light of recent researches on the vaporisation of the elements, "both in vacuo and at ordinary pressures," that no known element, however infusible, can be said to be *perfectly* stable at any temperature when freely exposed in space; and it is extremely probable that even such substances as iron and carbon are slowly dissociating at ordinary temperatures very much as water evaporates, and it follows that these are always enveloped in a thin atmosphere of their own vapour. The *quantity* of matter present in this form may never be recognisable; it may indeed be beyond the limit of our senses. Yet if such a process takes place, it affords a probable explanation of the diffusion of solids into each other. For admitting this it is evident that any mass or mixed masses of matter exist in an atmosphere formed by themselves. Such masses of matter cannot be discontinuous, strictly speaking, the sensible particles of which they are composed are not completely isolated from each other, and from this point of view the conception of the interpenetration of iron by carbon, or indeed other bodies, is, one thinks, rendered more easy.

JOHN PARRY.

NOTES.

BOTANISTS all over the world will be sorry to hear of the death of the famous Swiss botanist, Alphonse de Candolle. He was in his eighty-seventh year. We hope to give on a future occasion some account of his services to science.

WE regret to hear, through the *Botanical Gazette*, of the death of the Rev. T. Wolle, pastor of the Moravian Church, Bethlehem, Pennsylvania, an ardent student of freshwater algæ. Of his three most important publications, "Freshwater Algæ of the United States," "Desmids of the United States," and "Diatoms of the United States," at least the first two will always be standard works in the subject of which they treat.

THE ordinary general meeting of the Institution of Mechanical Engineers will be held on Thursday evening and Friday evening, April 21 and 22, at 25, Great George Street, Westminster. The chair will be taken at half past seven p.m. on each evening by the president, Dr. William Anderson, F.R.S. The following papers will be read and discussed, as far as time permits:—Second report to the Alloys Research Committee, by Prof. W. C. Roberts-Austen, F.R.S. (Thursday, and discussion possibly continued on Friday); tensile tests and chemical analyses of copper plates from fire-boxes of locomotives on the Great Western Railway, by Mr. William Dean (in connection with the above report); Research Committee on marine-engine trials: abstracts of results of experiments on six steamers, and conclusions drawn therefrom in regard to the efficiency of marine boilers and engines, by Prof. T. Hudson Beare. The anniversary dinner will take place on Wednesday evening, April 19.

The Council of the Marine Biological Association of the United Kingdom have appointed Mr. Edward J. Bles director of the Laboratory at Plymouth. Mr. Bles has held an honorary research fellowship in zoology at the Owens College, Manchester.

The seventh annual photographic conference, organised by the Camera Club, was opened yesterday in the theatre of the Society of Arts, under the presidency of Captain Abney. Various papers were read, and others are to be read to-day. The annual exhibition of photographs by members will be on view at the club after conference week, and will remain open for about six weeks.

The thirteenth annual general meeting of the Essex Field Club will be held at Chelmsford on Saturday, April 15. It is proposed that before the meeting the members shall have a ramble in the neighbourhood of Chelmsford, and thus open the field meetings for the season. After the transaction of official business an address will be delivered by Dr. Laver, the retiring president, on "periodicity in organic life." His object will be to show that animals have periods of abundance and rarity, and that this is not due either to meteorological causes or to the agency of man.

The Council of the City and Guilds of London Institute, recognising the increasing importance in the mechanical reproduction of pictures, will, in the forthcoming examinations, to be held on May 3 and 13 next, give special importance to this branch, by dividing the examination in the Honours Grade into two classes, one for pure Photography, and the other for photo-mechanical Photography. Special examiners have been appointed for each branch, and candidates have the option of declaring in which branch it is their intention of entering. They will not, however, be allowed to compete in both branches. The certificates granted will show in which of the two divisions the candidate has passed. The Council of the Institute hope that the encouragement thus given to the photo-mechanical division will tend to form in this country a school of competent craftsmen in this branch of photographic work.

The twenty-fourth annual meeting of the Norfolk and Norwich Naturalists' Society was held recently at the Museum, Norwich, the president (Mr. H. B. Woodward) in the chair. Mr. T. Southwell was elected president for the ensuing year, and after the usual routine business the retiring president delivered the annual address. After giving some account of the work of the society during the session, he remarked that there was a slight increase in the number of members; also that the financial position was satisfactory. Turning attention to the geology of Norfolk, he expressed regret that the gaps left by the deaths of the older geologists were not filled by new-comers. Even collectors of fossils, who rendered such good service, were not nowadays so plentiful as formerly. Enthusiasm was damped by the difficulties in naming specimens, and these difficulties were increased by modern palæontological work. There were varieties of species which co-existed with the type; and there were variations which followed the type in chronological succession, and to the latter the name "mutations" had been given. He regarded the giving of specific names to these mutations as the most serious obstacle ever placed in the pathway of the student of nature. Allusion was made to the subject of geological "zones," and mention was made of the discovery of layers of phosphatic chalk in Buckinghamshire, and to their possible occurrence in Norfolk. Having referred to various other matters, Mr. Woodward expressed a hope that some day Norwich might have a university college, where prominence would be given to subjects of special practical importance in East Anglia.

Sir Thomas Gresham's Reader in Geometry at Gresham College being unable, owing to ill-health, to give the Easter course of lectures, the City Side of the Gresham Committee have permitted their delivery by deputy. The following course of lectures on special applications of the laws of chance is to be given:—April 18, "On Frequency Curves, their Nature, Variety, and Use," by Dr. John Venn, F.R.S.; April 19, "Chance in the Field of Biology," by Prof. W. F. R. Weldon, F.R.S.; April 20, "On some Points in the Philosophy of Chance," by the Rev. W. A. Whitworth; April 21, "Probability as the Guide of Astronomers," by Sir Robert S. Ball, F.R.S., Lowndean Professor of Astronomy in the University of Cambridge. The lectures are free to the public, and begin at six o'clock p m.

Miss Caroline A. Foley contributes to the new number of *Mind* a vivid and very interesting account of the late Prof. Croom Robertson as a teacher. No one who reads it will have any difficulty in understanding the affection and respect with which his memory is cherished by his old pupils. Miss Foley, while regretting, as many others have done, that Prof. Robertson did not live to present "an integral view of his thoughts on any great questions of philosophy," suggests that some who heard him give expression to his ideas may have in their possession as much recorded material as would enable "any of his more competent contemporaries to synthesise and perpetuate what of it is chiefly and worthily distinctive." The editor of *Mind*, in a note, states that "this suggestion will probably be carried out."

A report of the first annual meeting of the Association of Head Masters of Higher Grade and Organised Science Classes has been issued. The meeting was held lately at Manchester, the chair being occupied by Mr. James Scotson, of the central higher grade school, Manchester. The report includes not only Mr. Scotson's address, but a vigorous paper by Dr. David Forsyth, head master of the central higher grade school, Leeds, on "higher education for the children of the people."

On April 8 several shocks of earthquake were felt over a wide area of south-eastern Europe. They were especially severe in western Servia. Shocks were also felt in Bulgaria and at various places in Hungary. They are said to have occurred in Hungary between 2 and 3 o'clock in the afternoon, in Servia at 2.55 P M., at Sofia about 4 o'clock P.M. From Sofia the movement is reported to have been of an undulatory character and to have lasted about thirty seconds, the direction being from west to east. On Sunday and Monday fresh shocks were experienced in various parts of western Servia, but they were less severe than those of the previous day. According to a Reuter's telegram from Belgrade, the districts most seriously affected by the earthquake of Saturday are those of Morava and Pozarevac. Great damage was done in the towns of Svilajinac and Gradista, where the shocks followed one another in quick succession. At Livadica-Cuprija, as well as at Svilajinac, great fissures were opened in the earth, whence streams of water and quantities of yellowish matter were still issuing forth on Monday. Thousands of houses and a great number of churches are either in ruins or have become so severely cracked that the people are afraid to enter them. So great is the panic in the two districts named that not a single person ventures to sleep indoors.

Mr. W. R. Elliott, writing to us from Prince Ruperts, Dominica, W.I., on March 19, says that the northern end of the island of Dominica had for some time been the scene of what he calls "a most extraordinary display in the way of earthquakes." The house in which he was staying at the time is situated on a spur off the main ridge of the island, and, therefore, somewhat in the direct line of volcanic action in these islands. The shocks began on February 17, and were felt occasionally until March 18. They seem to have been most intense on March 12. Mr. Elliott says with regard to the shocks on that day:—"The shocks between 7.10 p.m. and 7.20 p.m. were very sharp, and followed one another rapidly. The sharp succession of shocks at 3.10 a.m. on the 13th inst. very much resembled this batch. The loud roar that accompanied each shock was very noticeable, and we could hear it distinctly immediately before each shock, in fact, could hear the earthquake coming along the hills to us. None of the shocks had that long undulatory motion that is usually felt when we have an earthquake that is felt throughout the islands, but the feeling was that we were being heaved up and twisted round, and the bumps seemed to give us a push northwards, and I could not help imagining that we were being pushed up to Guadaloupe. I mention this as showing how marked was the direction of the shocks. After 3.10 a.m. on the 13th the shocks became so frequent that I stopped noting them down, until after a short lull a sharp one was felt at 9.15 a.m."

THE weather has continued very fine over the British Islands during the past week, scarcely any rain having fallen in any part. With a very trifling exception in the south and east, the drought has continued since March 4, and in the south-east of England there has been no rain for upwards of three weeks. The temperature has been somewhat lower generally in the daytime, although in the inland and southern portions of the Kingdom the maxima during several days varied between 60° and 70°, but at the eastern coast stations the maximum temperature on several days did not exceed 45°, owing to the sun's rays being obscured by cloud and fog. During the latter part of the period the barometer fell slowly but uniformly; in the north of our islands the weather became less settled, and on Tuesday snow was falling in the Shetlands, still the general conditions indicated a probable continuance of dry weather, and an anticyclone in the north was spreading southwards. The *Weekly Weather Report* of the 8th instant showed that the percentage of bright sunshine for that period ranged from 38° to 60° in Scotland, from 53° to 66° in Ireland, and from 61° to 74° in England, while in the Channel Islands it was as high as 79°.

A SUMMER excursion to the Giant's Cause way for scientific study is being organised by Mr. C. Carus-Wilson. It is proposed that the party shall start for Portrush on July 1 or earlier, and return, if possible, through Dublin, so that they may have an opportunity of meeting the members of the Geologists' Association, who are this year to visit the Wicklow Mountains.

WE have received a copy of a new prospectus of the electrical and general engineering college and school of science, Penywern House, of which Mr. G. W. de Tunzelmann is principal. It gives an account of recent extensions, and of others which are in progress.

IN the "Annals of Natural History" for the present month will be found an account of a very interesting zoological novelty. Mr. R. T. Günther describes and figures a remarkable new form of *Medusa*, or jelly-fish, that occurs in Lake Tanganyika. Until recent years, when the little *Limnocodium* was found living in the Victoria Lily-tank of the Botanic Gardens, Regent's Park, it was believed that the *Medusæ* were nearly exclusively oceanic. It is now shown that the freshwater lake Tanganyika is the home of a peculiar member of this group. The existence of such an organism in Tanganyika was asserted some years ago by the German naturalist, Dr. Boehm, and Prof. v. Martens, of Berlin, even went so far as to name it *Tanganjicæ*, although he had never seen a specimen. Mr. Günther now supplies us with a full description of this singular Hydrozoon, which he refers to a new genus, *Limnocnida*, adopting the suggestion of v. Martens as to its specific name. *Limnocnida tanganjicæ* is, as might have been anticipated, perfectly different from all the members of the group hitherto known, and probably represents a distinct family, but its exact position cannot be settled positively until the mode of its development has been ascertained.

A GOOD descriptive article on the prehistoric remains at Abury is contributed by Mr. A. L. Lewis to *Science* of March 24. The editor appends a note in which he says it has been thought that many Americans who, when in England, visit Stonehenge, may not be aware how many remains of a similar character, which they might also wish to inspect, exist in the British Isles. He has accordingly made arrangements for a series of short articles which shall give a description of each ot the principal circles, and state what points should be noted and how it may be most easily visited.

MR. H. L. JONES records, in the *Botanical Gazette*, an example of a graft-hybrid between two different varieties of geranium, a red and a white. In several successive years the flowers partook of the characters of both parents; some were pure red, and others pure white; others had some of the petals white, others red; while in others again the petals were red mottled with white, or white mottled with red.

IF we may judge from the tone of an article on "conditions of forestry as a business," contributed by Dr. W. J. Beal to the New York *Engineering Magazine*, a good deal of anxiety is felt by some Americans about the extraordinary rapidity with which trees are vanishing from their country. Michigan had at one time a supply of standing pine which was believed to be well-nigh inexhaustible. Now it is found only in "small tracts in the back counties." The fathers and grandfathers of the present generation of Americans "cut down and burned the finest of the trees to make room for crops and pasture." "We have been taught," says Dr. Beal, "to destroy trees, not to save them—much less to replant." The growth of interest in forestry will, he thinks, be slow for some time yet, but he anticipates that popular feeling about the matter will be greatly changed, and that salutary laws will be passed, before the close of the present century.

MR. L. J. TREMAYNE notes, in the current number of the *Entomologist*, that he was walking down the Thames Embankment about two o'clock on March 8 (the sun being just at the time rather powerful), when a specimen of *Vanessa polychloros* alighted on the pavement about a couple of yards from him. The insect was, he thinks, perfect, and appeared very fresh. He tried to catch it, but it flew into the gardens on his left, and he saw no more of it. There was, however, no mistaking the specimen, which expanded its wings right in front of Mr. Tremayne. This occurred just above Waterloo Bridge.

AT the Technical Institute of St. Petersburg, M. Vladimiroff has deduced from experiment a set of rules for estimating the quality of vulcanised caoutchouc (*Rev. Sci.*). Recourse is had to physical properties, chemical analysis not giving any sure result. The following, in brief, are the conclusions:—(1) Caoutchouc should not give the least sign of cracking when bent to an angle of 180°, after 5 hours' exposure in an air-bath at 125° C. (the specimens 2·4 in. thick). (2) Caoutchouc having not more than half its weight of metallic oxides should bear stretching 5 times its length before rupture. (3) Caoutchouc exempt from all foreign matter except sulphur should be capable of stretching at least 7 times its length before rupture. (4) The extension measured just after rupture should not exceed 12 per cent. of the original length (with given dimensions). (5) Suppleness may be determined by calculating the percentage of ash after incineration. This may form the basis of choice for certain uses. (6) Vulcanised caoutchouc should not harden in cold. These rules are adopted for the Russian Navy.

The French Minister of War has recently had some experiments made on the resistance of ice. With a thickness of 4 centimetres (say 1·6 inches), it begins to bear the weight of a man marching alone; at 9 centimetres detachments of infantry in files may go on it; at 12 centimetres it will carry "pièces de 8" on carriages, and so on; till at 29 centimetres, it will bear the heaviest weights. M. Forel (*Rev. Sci.*) sees danger in this note; if an officer, trusting in the figures, ordered a troop on ice of measured thickness, he might, in some cases, be courting catastrophe. Those estimates, in fact, apply only to young ice, lamellar ice in process of freezing. When ice has for a few weeks been subject to alternations of temperature it changes in structure and loses much of its tenacity. The old ice of a pond, absolutely compact in appearance, is traversed by a multitude of vertical fissures dividing it into irregular prismatic needles, comparable in arrangement to columns of basalt, and from a half-centimetre to 1 or 2 centimetres in thickness. The structure becomes evident on breaking suddenly, in sunlight, a block of ice taken from a pond. Under these conditions old ice has not nearly such resistance as young ice.

The Michigan Mining School has published a "Catalogue," in which a full account is given of the various departments of its work. The institution was established and is supported by the State of Michigan "in accordance with that liberal educational policy which has placed the university of Michigan amongst the foremost educational institutions of America." It is stated with admirable directness that students at the school are supposed "to understand what they are there for, to attend strictly to that business, and to conduct themselves as gentlemen."

The new number of the *Internationales Archiv für Ethnographie* (Band vi., Heft i.) is occupied wholly with the concluding part of Dr. W. Svoboda's interesting notes (in German) on the inhabitants of the Nicobar Islands. The illustrations, as usual, are excellent.

The American Philosophical Society, Philadelphia, has issued a new instalment of its Proceedings (vol. xxx., no. 139). It opens with a paper on the mutual relations between the orbits of certain asteroids, by Daniel Kirkwood. There are also articles by Dr. D. G. Brinton on the Betoya dialects, and on the Etrusco-Libyan elements in the song of the Arval brethren; and by Prof. E. D. Cope on the phylogeny of the vertebrata (with two cuts), on some points in the kinetogenesis of the limbs of vertebrates, and on false elbow joints (with two plates).

A "Catalogue of Australian Mammals, with Introductory Notes on General Mammalogy," by J. D. Ogilby, has been published by order of the trustees of the Australian Museum, Sydney. Mr. E. P. Ramsay states in the preface that the work contains descriptions of all known mammals indigenous to Australia, with notes on allied fossil forms, compiled from various sources which are duly acknowledged by the author. Nearly all the species, Mr. Ramsay says, are represented by one or more specimens in the Museum.

The new number of *Records of the Australian Museum* (vol. ii. no. 4) contains the following papers:—On further traces of *Meiolania* in N. S. Wales, by R. Etheridge, jun.; notes on Australian Aquatic Hemiptera (No. 1) by Frederick A. A. Skuse; remarks on a new *Cyria* from New South Wales, by Frederick A. A. Skuse; geological and ethnological observations made in the valley of the Wollondilly River, at its junction with the Nattai River, Counties Camden and Westmoreland, by R. Etheridge, jun.

A volume on "Ironwork from the Earliest Times to the End of the Mediæval Period," by J. Starkie Gardner, has been issued as one of the South Kensington Museum art handbooks. It is mainly artistic, but the author has a good deal to say that is of scientific interest, and his scientific training enables him to present in an orderly way the historical facts with which he is chiefly occupied. Ironwork of later times will be dealt with in a second volume.

Some time ago Mr. C. E. de Rance prepared for the information of the County Councils a very useful map of the river basins in England and Wales, the object being to define the natural jurisdiction of joint committees of county councils for the prevention of pollution of rivers under section 14 (iii.) of the Local Government Act, 1888, and other matters requiring united control. The map has now been reprinted by J. E. Cornish, Manchester.

The Geological Survey of Canada is issuing a valuable series of "Contributions to Canadian Palæontology." The fourth part of the first volume, by J. F. Whiteaves, has just been published. It deals with the fossils of the Devonian rocks of the islands, shores, and immediate vicinity of Lakes Manitoba and Winnipegosis, and is well illustrated.

The York School Natural History, Literary, and Polytechnic Society has issued its fifty-ninth annual report. Much genuine interest in science is evidently maintained among the members of this society by the part they take in its work. The Natural History Club held in the course of the year twenty-three meetings, sixteen of which were occupied with the club's regular business of reporting and commenting on finds and observations.

The first part of an elaborate "Topographische Anatomie des Pferdes," by W. Ellenberger and H. Baum, has just been issued, the publisher being Paul Parey, Berlin.

A new sclerometer, constructed by M. Paul Jannetaz, was recently presented to the French Academy of Sciences. Like that invented by Seebeck, it measures the hardness of bodies defined as their resistance to scratching. It consists essentially of a platform rendered horizontal by means of leveling screws, and furnished with various motions which enable the observer to place any part of the body whose hardness is to be determined underneath a vertical point. This point is carried by an arm of a balance, which can be adjusted by a coarse and a fine movement, so as to bring the point and the body into contact without a shock. The beam is provided with pans carrying the weights which produce the pressure. At one extremity the beam carries a screw for horizontal adjustment, at the other a hollow bar to hold one of a set of points, such as copper or steel points of various angles, straight or curved, forming certain definite angles with the platform when mounted, or crystalline points clamped in metallic jaws. A very light aluminium beam is used for bodies which are only tested with light weights. As a rule the points trace a small circle on the body, which, when examined under the microscope, indicates the hardness of the substance in various directions. Homogeneous bodies like metals need only be moved in one direction. The scratch is viewed by reflection, greater softness being indicated by greater breadth. An interesting fact concerning the relative hardness of copper and zinc has been brought to light by means of this apparatus. Most authors regard zinc as harder than copper. If, however, the metals are examined in a sufficiently pure state, it appears that copper is the harder of the two. This removes an exception to the rule that the harder the body the less its atomic volume.

In a paper communicated to the Royal Prussian Academy of Sciences (see also *Electrician*, vol. xxx. p. 660) Dr. Philipp Lenard gives an account of some interesting experiments on the rays given out by the kathode of a Geissler tube which produce phosphorescence. Thin metal plates being to a great extent transparent to these rays by closing a small hole in the observing tube by a plate of aluminium 0·003 mm. thick, it was possible to study their properties outside the tube. It was found that the rays produce a slight luminosity in air, and when they fall on phosphorescent bodies, held near the window, cause the latter to shine with the same light they show when enclosed within the vacuum tube itself. The brightness diminishes rapidly as the distance from the window increases, so that in air all glow ceases at about 6 cm. On bringing a magnet near the tube so that the kathode rays no longer fall on the inner surface of the window, all phosphorescence ceases without the tube. A quartz plate half a millimetre thick entirely stopped the rays; ordinary gold, copper, and aluminium leaf, however, allowed them to pass almost undiminished. In air at the ordinary pressure these rays are not propagated in straight lines but are diffused, so that it is impossible to obtain a sharp shadow of a body placed between the window and the phosphorescent substance. As these waves cannot be generated in a high vacuum it has been up to now impossible to say whether they are only propagated when matter is present. By enclosing the observing tube in another, the author has shown that in the best vacuum attainable with a mercury pump, these waves are transmitted with as great facility as in air at the pressures ordinarily existing within Geissler tubes. Different gases transmit the rays to very different extents, thus, with hydrogen at atmospheric pressure, phosphorescence is produced in a body placed at a distance of 20 cm. from the window. These experiments seem to show that while for light of the smallest known wave-length the matter behaves as if it completely filled the space it appears to occupy, in the case of these kathode rays even gases behave as non-homogeneous media, and each separate molecule acts as an obstacle diffusing the rays.

NOTES from the Marine Biological Station, Plymouth:—Recent captures include the Polyclada *Eurylepta cornuta*, *Cycloporus papillosus* and *Leptoplana*, the Actinian *Zoanthus Couchii*, and the Opisthobranchs *Scaphander lignarius* and *Ægirus punctilucens*. The sea has lately become increasingly richer in diatoms and floating algæ, esp. *Coscinodiscus*, *Rhizosolenia* and the so-called "gelatinous alga." In the floating fauna the Dinoflagellate *Ceratium tripos* has been constantly plentiful throughout the winter; *Noctiluca* is very scarce. Of the Hydroid medusæ, small *Obeliæ* are still abundant; medusæ of *Clytia Johnstoni* are generally present; and Forbes's *Thaumantias octona* has been again observed. The Actinian larva *Arachnactis* occurs in most townettings. Zoææ of *Porcellana* have slightly increased in number. The Actinian *Bunodes verrucosa* (= *gemmacea*) is now breeding.

THE additions to the Zoological Society's Gardens during the past week include a Leopard (*Felis pardus*) from India, presented by Admiral W. B. Kennedy, R.N., F.Z.S.; a Common Squirrel (*Sciurus vulgaris*) British, presented by Miss Edith Mackenzie; two Black Rats (*Mus rattus*) British, presented by Mr. Sydney Wedlock; a Panama Amazon (*Chrysotis panamensis*) from Panama, presented by Mrs. Mackey; a European Pond Tortoise (*Emys europæa*) European, presented by Mast. J. F. Harben; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; a Common Pintail (*Dafila acuta*) European, a Bell's Cinixys (*Cinixys belliana*), a Home's Cinixys (*Cinixys homeana*) from West Africa, purchased; a Mute Swan (*Cygnus olor*) European, received in exchange; three Coypus (*Myopotamus coypus*) born in the Gardens.

OUR ASTRONOMICAL COLUMN.

SOLAR OBSERVATIONS AT ROME.—In the *Memorie degli Spettroscopisti Italiani* for March, Prof Tacchini communicates the solar observations made at the Royal College. These observations refer to the 4th trimestre of 1892, and are given here somewhat in detail. Taking prominences first, the numbers show a great falling off when compared with the preceding three months; thus for the northern and southern hemispheres the frequency of these phenomena for the three months was 81, 78, 61 for the former (sum 220) and 105, 138, 90, for the latter (sum 333) the foregoing trimestre giving 431 and 493 for each hemisphere. The greatest frequencies took place in latitudes + 60° + 70° N. and – 30° – 40° S., but the numbers indicate really two other maxima for each hemisphere, and they lie in the zones + 30° + 20° and – 50° – 60°.

The frequency of groups of faculæ recorded for both north and south latitudes are given as 100 and 132 respectively; the average for each month amounted to 37, but for the southern zones during October an increase to 20 above this average was noted; the greatest frequencies occurred in zones + 10° + 20° and – 20° – 30°. In dealing with the spots their frequency may be generally stated to be about half that of the faculæ. The table gives 46 and 58 for the two zones, and in this case also the greatest disturbances seem to have occurred in the southern hemisphere during October; the numbers for the monthly records are, for the northern zones 18, 13 and 15, and for the southern 26, 12, and 20, the greatest frequencies occurring in latitudes + 10° + 20° N. and – 20° – 30° S.

Prof. Tacchini, in addition to the above communication, describes in a short note a large protuberance observed on November 20 of last year, and gives 10 figures to illustrate the various forms which it successively assumed. The height and velocity of ascent can be gathered from the few numbers below:—

″		H.	M.
146·3	about	10	57
155·5	,,	11	22·5
188·8	,,	1	21
184·1	,,	1	58
186·4	,,	2	38
154·6	,,	2	52

PARALLAXES OF μ AND θ CASSIOPEIÆ.—In No. 5 of the contributions from the Observatory of Columbia College, New York, Mr. Harold Jacoby presents us with the results he has obtained with regard to the parallaxes of μ and θ Cassiopeiæ, as deduced by him from an examination of the Rutherfurd photographic measures of the stars surrounding μ Cassiopeiæ. The negatives, which were twenty-eight in number, two impressions being on each plate, were made between July, 1870, and December, 1873, and as they were specially taken for parallax determinations, the observations were restricted to the months of July, January, and December. The study of the parallax here made is based upon measures of distance only. Each pair of stars was selected so as to differ approximately 180° in position angle with respect to μ Cassiopeiæ, and the scale value was determined for each pair, on each plate, in order to make the sum of the distances from μ constant. By taking the difference of the same distances as the quantity from the variation of which the parallax should appear, "the excess of the parallax of the principal star over the mean of the parallaxes of the two comparison stars" is, satisfying certain conditions, finally obtained. The values for the parallaxes which he has obtained are—

Parallax of μ Cassiopeiæ ... 0″·275 ± 0″·024
,, ,, θ ,, ... 0″·232 ± 0″·067

On comparing the former of these values with the work of other observatories the discordances, he says, are large. The Oxford photographic result was 0″·036 ± 0″·018, while the Rutherfurd plates gave 0″·249 ± 0″·045, the same pair of comparison stars being used in each case. Struve from distant measures deduced the value 0″·251 ± 0″·075, and from position angles the value 0″·425 ± 0″·072. "It is therefore plain that the photographic method of determining parallaxes cannot be regarded as free from systematic error."

FALL OF A METEORITE.—A brief account of the fall of a meteorite at a place in South Dakota, 4 km. south of Bath, on August 29 of last year, is given in the current number of *Prometheus*, No. 183. It was observed about four o'clock in the afternoon, attention being first drawn to it by the sound of a series of explosions. As the observer looked upwards he saw a meteoritic stone flying through the air, leaving a trail of smoke behind it. On reaching the ground it plunged to a depth of 40 cm., and was so hot that the observer was unable to put his hand on it. At the explosion of the meteor several small portions weighing from 30-60 gr. were scattered, while the weight of the chief mass amounted to 22 kg. The description of the exterior says that it showed the general, smooth, black crust, while from the fracture it was noticed to be finely granulated; one could also see easily small particles of iron, which could without any difficulty be separated by pulverisation. Chemical analysis showed that nickel and cobalt was present in considerable quantities.

Jahrbuch der Astronomie und Geophysik.—This volume, which is edited by Dr. Hermann J. Klein, contains a very interesting account and summary of the work done in various branches of astronomical science during the past year. Dunér's, Deslandres', Hale's, and Young's sun observations are referred to, while several other references to solar work are given. The numerous observations made with reference to the major and minor planets are here all brought together; Trouvelot's Venus observations, the opposition of Mars, and the recent discovery of Jupiter's fifth satellite being rather prominent. Under the heading of "The Moon" Wernik's enlargements, Boddiker's and Hartmann's researches and are referred to at some length. Comets, meteorites, and shooting stars also come in for a good share, and under the fixed stars, in which are included all variables, nebulæ, &c., are included references to the Nova in Auriga, stellar spectroscopic observations, motion in line of sight, &c.

The Observatory.—From the cover of the *Observatory* one quite misses the familiar name of Dr. Common, in place of which are now inserted Messrs. T. Lewis and H. P. Hollis. In an editorial notice Mr. Turner says a few words to account for this perturbation, mentioning that it is owing to pressure of work, which has made it impossible for either of them to conduct the magazine. He concludes by saying, "It would be with the keenest satisfaction that we should return to the management of the magazine if the future should have that in store for us."

GEOGRAPHICAL NOTES.

The *Scottish Geographical Magazine* for April contains a paper of some value by Colonel Justin C. Ross on irrigation and agriculture in Egypt, giving the result of his experience as Director-General of Irrigation in that country. In consequence of the indisposition of Colonel Bailey the *Magazine* is now edited by Mr. W. A. Taylor, Librarian to the Royal Scottish Geographical Society, who has for several years had charge of the book reviews and geographical notes.

The April number of the *Deutsche Rundschau für Geographie* contains a coloured map of the density of population in Holland which illustrates in a manner very rare in continental map-work an ignorance of the first principles of map colouring. The objects of map-colouring are two—one is to indicate the areas occupied by discontinuous and unlike conditions, such as countries, races of people, or geological formations. For this the colours have to be as strongly contrasted as possible and the map is necessarily and properly a patchwork. The other object is to show the distribution of a continuously varying quantity, like altitude, temperature, or rainfall, and in order to attain it the colours ought to merge one into the other so that the eye is carried from the lowest to the highest value by just perceptible gradations. The Austrian map referred to applies the first method to bring out the second result, each different density of population being coloured so as to contrast with the others, and to show no definite gradation from less to greater.

Globus states that the Russian Government, dissatisfied with the foreign sound of the names Dorpat and Dünaburg, have resolved to rename those towns Jurjew and Dwinsk respectively.

The Paris Geographical Society held a special meeting in commemoration of the discoveries of Columbus on March 4, the four hundredth anniversary of his return from the first transatlantic voyage. A masterly address by M. Levasseur on the moral and material consequences of the discovery of America, and a paper by Dr. Hamy on the traces of Columbus in Spain and Italy were the principal features of the meeting.

Some recent measurements in Russia, noticed by M. Venukoff in the last number of the *Comptes Rendus* are valuable as leading to some conclusions regarding the form of the geoid. Determinations of the value of the degree of longitude along the parallels of 47°30' and 52° accord closely with Bessel's geoid (polar flattening $\frac{1}{299}$) and are widely divergent from Clarke's result of $\frac{1}{293}$.

THE AMIDE AND IMIDE OF SULPHURIC ACID.

Further details concerning these interesting substances are communicated by Dr. Traube of the laboratory of the Berlin University to the current number of the *Berichte*. It has long been surmised that an amide of sulphuric acid was capable of existence, and Regnault assumed that the product which he obtained by leading ammonia gas into a solution of sulphuryl dichloride in ethylene chloride consisted of that substance mixed with sal-ammoniac. Dr. Traube has further investigated the reaction and has at length isolated not only sulphuryl diamide, $SO_2(NH_2)_2$, but also sulphuryl imide, SO_2NH, the imide of sulphuric acid, and has, moreover, prepared several metallic derivatives of each.

Sulphuryl Diamide.

The most advantageous mode of preparing sulphuryl diamide consists in saturating a solution of sulphuryl dichloride, SO_2Cl_2, in chloroform with ammonia. It is necessary to dilute the sulphuryl dichloride with 15-20 times its volume of chloroform, and to maintain a low temperature by extraneous cooling in order that the reaction may be under complete control, and the ammonia gas must be carefully dried before being allowed to bubble through the liquid. The main reaction occurs in accordance with the following equation:—

$$SO_2Cl_2 + 4NH_3 = 2NH_4Cl + SO_2(NH_2)_2.$$

The products are gradually deposited in the form of a white solid, which, after the completion of the reaction, is agitated with water until the whole of it is dissolved. The ammoniacal aqueous solution is then separated from the chloroform, acidified with nitric acid, and the whole of the chlorine removed by the addition of silver nitrate. After removal of the silver chloride by filtration the acid solution is neutralised with alkali and silver nitrate again added, when a crystalline precipitate is obtained consisting of a silver derivative of sulphuryl diamide, $SO_2(NHAg)_2$, together with another silver compound, whose composition has not yet been definitely ascertained. In order to isolate the silver compound of sulphuryl diamide, the washed precipitate is decomposed with the calculated quantity of hydrochloric acid, and the resulting acid liquid carefully neutralised with ammonia; upon now adding silver nitrate only the silver compound of unknown and complex composition is deposited. The pure silver compound of sulphuryl diamide is finally deposited upon adding a further quantity of silver nitrate and sufficient ammonia to render the liquid strongly alkaline.

When the precipitated silver compound of sulphuryl diamide is decomposed with hydrochloric acid a feebly acid liquid is obtained, which, when evaporated to a syrup *in vacuo*, at a temperature not exceeding 40°, and afterwards allowed to stand *in vacuo* over oil of vitriol, gradually deposits large colourless crystals of pure sulphuryl diamide, $SO_2(NH_2)_2$.

Sulphuryl diamide is an extremely deliquescent substance. The crystals are rapidly dissolved by water, but are practically insoluble in organic solvents. They soften at 75° and melt at 81°. As the liquid cools, however, it exhibits the property of superfusion to a very marked extent, remaining liquid many degrees below its melting-point. The moment, however, it is disturbed by contact with a sharp body, it instantly solidifies. When heated above its melting-point sulphuryl diamide loses ammonia even below 100°; up to 250° no further decomposition than the loss of ammonia occurs, the residual compound being the sulphuryl imide to be presently described. Above 250° complete decomposition ensues with the evolution of acid fumes.

The aqueous solution of sulphuryl diamide reacts neutral to litmus and possesses a bitter taste. It yields no precipitates in acid solutions either with salts of barium or platinic chloride. On long boiling with acids, however, it is gradually converted into sulphuric acid and ammonia, and then yields the usual precipitates for those substances with barium or platinic chloride. Its behaviour with nitrous acid is interesting. Upon adding to an acid solution of sulphuryl diamide a few drops of the solution of a nitrite nitrogen is at once evolved, in the cold, and sulphuric acid is formed.

Sulphuryl diamide does not combine with acids. Alkalies appear to be only capable of removing one amido group, converting the diamide into sulphaminic acid, $SO_2(NH_2)(OH)$.

As described in the course of the preparation of sulphuryl diamide, ammonia precipitates from a solution mixed with silver nitrate a silver compound. If the precipitate is allowed to remain in contact with the excess of the reagents for some time, it invariably yields numbers upon analysis which agree with the formula $SO_2(NHAg)_2$. If, however, it is at once separated, it is found to consist of a mixture of this salt with the salt $SO_2(NH_2)(NHAg)$.

These silver compounds of sulphuryl diamide are amorphous, even after deposition from solution in hot water. When dry they are white powders very slightly sensitive to light. Upon heating to 200° they decompose with evolution of sulphur dioxide.

Sulphuryl diamide likewise forms a compound with mercuric oxide when its solution is mixed with one of mercuric nitrate. The composition of this precipitate, however, appears to vary with the degree of concentration of the solutions employed, and if chlorides are present a precipitate is only obtained with a very large excess of mercuric nitrate. Mercuric chloride produces no precipitate at all.

A somewhat similar lead compound is also formed when lead acetate is added to a moderately concentrated solution of sulphuryl diamide.

Sulphuryl Imide.

As previously mentioned, when sulphuryl diamide is heated for a considerable time above its melting-point it loses ammonia and becomes converted into sulphuryl imide:

$$SO_2(NH_2)_2 = NH_3 + SO_2NH.$$

The best temperature for the rapid production of sulphuryl imide is 200°-210°. The evolution of ammonia at this temperature is very vigorous, occurring with much frothing, but after a time diminishes and finally ceases, the mass becoming eventually solid. To purify it from impurities the solution in water is treated with a solution of silver nitrate when the silver compound of sulphuryl imide, SO_2NAg, is precipitated, and may be recrystallised in long acicular crystals, first from water slightly acidified with nitric acid, and finally from pure water.

Upon decomposing the silver compound with the calculated quantity of dilute hydrochloric acid an aqueous solution of free sulphuryl imide is obtained, which reacts strongly acid, and liberates carbon dioxide from carbonates. Upon evaporation, however, it decomposes, and deposits hydrogen ammonium sulphate. Even evaporation *in vacuo* is sufficient to decompose it, so that crystals of the imide itself have not been obtained. It exists, however, in the solid form, although somewhat contaminated with smaller quantities of other products, in the residue obtained by heating sulphuryl diamide as previously described.

Salts of sulphuryl imide, however, are readily obtained, either by decomposition of the silver salt with metallic chlorides, or by the neutralisation of solutions of sulphuryl imide with metallic oxides or carbonates.

The potassium salt, SO_2NK, was obtained in the form of well-developed colourless crystals by adding a quantity of the silver salt to a hot solution of the calculated quantity of potassium chloride, removing the precipitated silver chloride by filtration, and evaporating the solution. Both the solution and the salt are very stable; it requires long boiling with acids to convert it into sulphuric acid. When the dry salt is heated it decomposes with considerable violence and production of flame. Nitrogen and sulphur dioxide escape, and potassium sulphate and sulphide are left.

The sodium salt, SO_2NNa, obtained by neutralising a solution of sulphuryl imide with caustic soda and subsequent evaporation, forms small crystals, which decompose upon heating in a manner similar to the crystals of the potassium salt.

The ammonium salt, SO_2NNH_4, isomeric with sulphuryl diamide, was likewise obtained in colourless needles by neutralisation of the free imide with ammonia. It is interesting to note that this substance is not capable of being converted into its isomer by repeated crystallisation, but is partially so converted by rapidly heating it to its melting-point over a small gas flame.

Acicular crystals of a hydrated barium salt, $(SO_2N)_2Ba.2H_2O$, have been obtained by saturating a solution of the imide with barium carbonate and afterwards adding alcohol; also needles of a lead salt and a green amorphous copper salt.

The acid character of sulphuryl imide, so different from the neutral nature of sulphuryl diamide, is thus seen to be quite conclusively established. A. E. TUTTON.

THE DENSITIES OF THE PRINCIPAL GASES.[1]

IN former communications ("Roy. Soc. Proc.," February, 1888; February, 1892) I have described the arrangements by which I determined the ratio of densities of oxygen and hydrogen (15·882). For the purpose of that work it was not necessary to know with precision the actual volume of gas weighed, nor even the pressure at which the containing vessel was filled. But I was desirous before leaving the subject of ascertaining not merely the relative, but also the absolute, densities of the more important gases—that is, of comparing their weights with that of an equal volume of water: To effect this it was necessary to weigh the globe used to contain the gases when charged with water, an operation not quite so simple as at first sight it appears. And, further, in the corresponding work upon the gases, a precise absolute specification is required of the temperature and pressure at which a filling takes place. To render the former weighings available for this purpose, it would be necessary to determine the errors of the barometers then employed. There would, perhaps, be no great difficulty in doing this, but I was of opinion that it would be an improvement to use a manometer in direct connection with the globe, without the intervention of the atmosphere. With respect to temperature, also, it was thought better to avoid all further questions by surrounding the globe with ice, as in Regnault's original determinations.

The Manometer.

The arrangements adopted for the measurement of pressure must be described in some detail, as they offer several points of novelty.

The object in view was to avoid certain defects to which ordinary barometers are liable, when applied to absolute measurements. Of these three especially may be formulated:—

(*a*) It is difficult to be sure that the vacuum at the top of the mercury is suitable for the purpose.

(*b*) No measurements of a length can be regarded as satisfactory in which different methods of reading are used for the two extremities.

(*c*) There is necessarily some uncertainty due to irregular refraction by the walls of the tube. The apparent level of the mercury may deviate from the real position.

(*d*) To the above may be added that the accurate observation of the barometer, as used by Regnault and most of his successors, requires the use of a cathetometer, an expensive and not always satisfactory instrument.

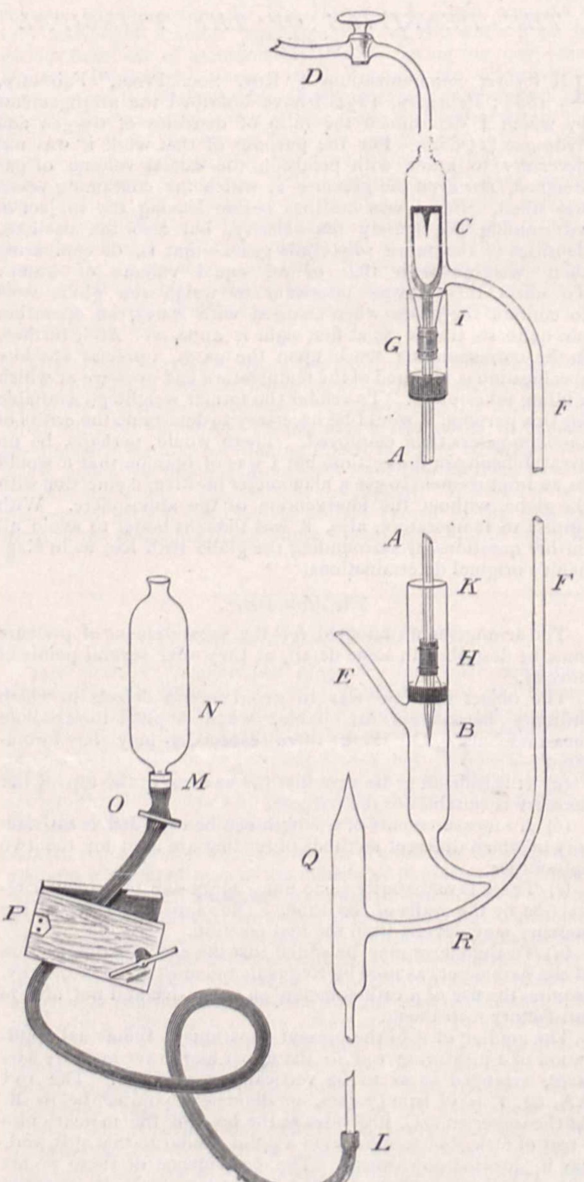
The guiding idea of the present apparatus is the actual application of a measuring rod to the upper and lower mercury surfaces, arranged so as to be vertically superposed. The rod AA, fig. 1, is of iron (7 mm. in diameter), pointed below B. At the upper end, C, it divides at the level of the mercury into a sort of fork, and terminates in a point similar to that at B, and, like it, directed downwards. The coincidence of these points with their images reflected in the mercury surfaces, is observed with the aid of lenses of about 30 mm. focus, held in position upon the wooden framework of the apparatus. It is, of course, independent of any irregular refraction which the tube may exercise. The verticality of the line joining the points is tested without difficulty by a plumb-line.

The upper and lower chambers C, B are formed from tubing of the same diameter (about 21 mm. internal). The upper communicates through a tap, D, with the Töppler, by means of which a suitable vacuum can at any time be established and tested. In ordinary use, D stands permanently open, but its

[1] Abstract of a paper read by Lord Rayleigh before the Royal Society on March 23.

introduction was found useful in the preliminary arrangements and in testing for leaks. The connection between the lower chamber B and the vessel in which the pressure is to be verified takes place through a side tube, E.

The greater part of the column of mercury to which the pressure is due is contained in the connecting tube FF, of about 3 mm. internal diameter. The temperature is taken by a thermometer whose bulb is situated near the middle of FF. Towards the close of operations the more sensitive parts are protected by a packing of tow or cotton-wool, held in position between two wooden boards. The anterior board is provided



with a suitable glass window, through which the thermometer may be read.

It is an essential requirement of a manometer on the present plan that the measuring rod pass air-tight from the upper and lower chambers into the atmosphere. To effect this the glass tubing is drawn out until its internal diameter is not much greater than that of the rod. The joints are then made by short lengths of thick walled india-rubber H, G, wired on and drowned externally in mercury. The vessels for holding the mercury are shown at I,K.

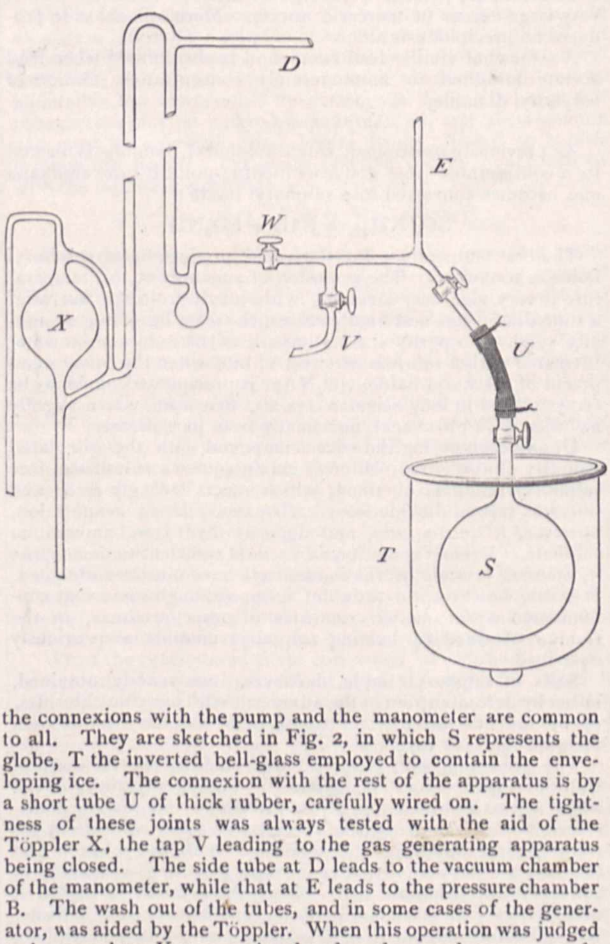
The distance between the points of the rod is determined under microscopes by comparison with a standard scale, before the apparatus is put together. As the rod is held only by the rubber connexions, there is no fear of its length being altered by stress.

The adjustment of the mercury (distilled in a vacuum) to the right level is effected by means of the tube of black rubber LM, terminating in the reservoir N. When the supply of mercury to the manometer is a little short of what is needed, the connexion with the reservoir is cut off by a pinch-cock at O, and the fine adjustment is continued by squeezing the tube at P between a pair of hinged boards, gradually approximated by a screw. This plan, though apparently rough, worked perfectly, leaving nothing to be desired.

It remains to explain the object of the vessel shown at Q. In the early trials, when the rubber tube was connected directly to R, the gradual fouling of the mercury surface, which it seems impossible to avoid, threatened to interfere with the setting at B. By means of Q, the mercury can be discharged from the measuring chambers, and a fresh surface constituted at B as well as at C.

Connexions with Pump and Manometer.

Some of the details of the process of filling the globe with gas under standard conditions will be best described later under the head of the particular gas; but the general arrangement and



the connexions with the pump and the manometer are common to all. They are sketched in Fig. 2, in which S represents the globe, T the inverted bell-glass employed to contain the enveloping ice. The connexion with the rest of the apparatus is by a short tube U of thick rubber, carefully wired on. The tightness of these joints was always tested with the aid of the Töppler X, the tap V leading to the gas generating apparatus being closed. The side tube at D leads to the vacuum chamber of the manometer, while that at E leads to the pressure chamber B. The wash out of the tubes, and in some cases of the generator, was aided by the Töppler. When this operation was judged to be complete, V was again closed, and a good vacuum made in the parts still connected to the pump. W would then be closed, and the actual filling commenced by opening V, and finally the tap of the globe. The lower chamber of the manometer was now in connexion with the globe, and through a regulating tap (not shown) with the gas-generating apparatus. By means of the Töppler, the vacuum in the manometer could be carried to any desired point. But with respect to this a remark must be made. It is a feature of the method employed[1] that the exhaustions of

[1] Due to von Jolly.

the globe are carried to such a point that the weight of the residual gas may be neglected, thus eliminating errors due to a second manometer reading. There is no difficulty in attaining this result, but the delicacy of the Töppler employed as a gauge is so great that the residual gas still admits of tolerably accurate measurement. Now in exhausting the head of the manometer it would be easy to carry the process to a point much in excess of what is necessary in the case of the globe, but there is evidently no advantage in so doing. The best results will be obtained by carrying both exhaustions to the *same* degree of perfection.

The Water Contents of the Globe.

The globe being packed in finely-divided ice, was filled with boiled distilled water up to the level of the top of the channel through the plug of the tap, that is, being itself at 0°, was filled with water also at 0°. Thus charged the globe had now to be weighed; but this was a matter of some difficulty, owing to the very small capacity available above the tap. At about 9° there would be a risk of overflow. Of course the water could be retained by the addition of extra tubing, but this was a complication that it was desired to avoid. In February, 1882, during a frost, an opportunity was found to effect the weighing in a cold cellar at a temperature ranging from 4° to 7°. The weights required (on the same side of the balance as the globe and its supports) amounted to 0·1822 gram. On the other side were other weights whose values did not require to be known so long as they remained unmoved during the whole series of operations. Barometer (corrected) 758·9 mm.; temperature 6°·3.

A few days later the globe was discharged, dried, and replaced in the balance with tap open. 1834·1701 grams had now to be associated with it in order to obtain equilibrium. The difference,

$$1834{\cdot}170 - 0{\cdot}182 = 1833{\cdot}988,$$

represents the weight of the water less that of the air displaced by it.

It remains to estimate the actual weight of the air displaced by the water under the above mentioned atmospheric conditions. It appears that, on this account, we are to add 2·314, thus obtaining

$$1836{\cdot}30$$

as the weight of the water at 0° which fills the globe at 0°.

A further small correction is required to take account of the fact that the usual standard density is that of water at 4° and not at 0°. According to Broch (Everett's "C.G.S. System of Units"), the factor required is 0·99988, so that we have

$$\frac{1836{\cdot}30}{0{\cdot}99988} = 1836{\cdot}52$$

as the weight of water at 4° which would fill the globe at 0°.

Air.

Air drawn from outside (in the country) was passed through a solution of potash. On leaving the regulating tap it traversed tubes filled with fragments of potash, and a long length of phosphoric anhydride, followed by a filter of glass wool. The arrangements beyond the regulating tap were the same for all the gases experimented upon.

In deducing the weight of the gas we compare each weighing "full" with the mean of the preceding and following weights "empty," except in the case of October 15, when there was no subsequent weighing empty. The results are

September	27	2·37686
,,	29	2·37651
October	3	2·37653
,,	8	2·37646
,,	11	2·37668
,,	13	2·37679
,,	15	2·37647
Mean	... ...	2·37661

There is here no evidence of the variation in the density of air suspected by Regnault and v. Jolly.

To allow for the contraction of the globe (No. 14) when weighed empty, discussed in my former papers, we are to add 0·00056 to the apparent weight, so that the result for air becomes

$$2{\cdot}37717.$$

This is the weight of the contents at 0° and under the pressure defined by the manometer gauge at 15° of the thermometer. The reduction to standard conditions is, for the present, postponed.

Oxygen.

This gas has been prepared by three distinct methods: (*a*) from chlorates, (*b*) from permanganate of potash, (*c*) by electrolysis.

In the first method mixed chlorates of potash and soda were employed, as recommended by Shenstone, the advantage lying in the readier fusibility. Two sets of five fillings were effected with this oxygen. In the first set (May, 1892) the highest result was 2·6272, and the lowest 2·6266, mean 2·62691. In the second set (June, July, 1892) the highest result was 2·6273 and the lowest 2·6267, mean 2·62693.

The second method (*b*) proved very convenient, the evolution of gas being under much better control than in the case of chlorates. The recrystallised salt was heated in a Florence flask, the wash-out, in this case also, being facilitated by a vacuum. Three fillings gave satisfactory results, the highest being 2·6273, the lowest 2·6270, and the mean 2·62714. The gas was quite free from smell.

By the third method I have not as many results as I could have wished, operations having been interrupted by the breakage of the electrolytic generator. This was, however, of less importance, as I had evidence from former work that there is no material difference between the oxygen from chlorates and that obtained by electrolysis. The gas was passed over hot copper, as detailed in previous papers. The result of one filling, with the apparatus as here described, was 2·6271. To this may be added the result of two fillings obtained at an earlier stage of the work, when the head of the manometer was exhausted by an independent Sprengel pump, instead of by the Töppler. The value then obtained was 2·6272. The results stand thus:—

Electrolysis (2), May, 1892	2·6272
,, (1) ,, ...	2·6271
Chlorates (5), May, 1892	2·6269
,, (5), June, 1892	2·6269
Permanganate (3), January, 1893 ...	2·6271
Mean	2·62704
Correction for contraction ...	0·00056
	2·62760

It will be seen that the agreement between the different methods is very good, the differences, such as they are, having all the appearance of being accidental. Oxygen prepared by electrolysis is perhaps most in danger of being light (from contamination with hydrogen), and that from chlorates of being abnormally heavy.

Nitrogen.

This gas was prepared, in the usual manner, from air by removal of oxygen with heated copper. Precautions are required, in the first place, to secure a sufficient action of the reduced copper, and secondly, as was shown by v. Jolly, and later by Leduc, to avoid contamination with hydrogen which may be liberated from the copper. I have followed the plan, recommended by v. Jolly, of causing the gas to pass finally over a length of unreduced copper. The arrangements were as follows:—

Air drawn through solution of potash was deprived of its oxygen by reduced copper, contained in a tube of hard glass heated by a large flame. It then traversed a U-tube, in which was deposited most of the water of combustion. The gas, practically free, as the event proved, from oxygen, was passed, as a further precaution, over a length of copper heated in a combustion furnace, then through strong sulphuric acid,[1] and afterwards back through the furnace over a length of oxide of copper. It then passed on to the regulating tap, and thence through the remainder of the apparatus, as already described. In no case

[1] There was no need for this, but the acid was in position for another purpose.

did the copper in the furnace, even at the end where the gas entered, show any sign of losing its metallic appearance.

Three results, obtained in August, 1892, were :—

August 8	2·31035
,, 10	2·31026
,, 15	2·31024
Mean	2·31028

To these may be added the results of two special experiments made to test the removal of hydrogen by the copper oxide. For this purpose a small hydrogen generator, which could be set in action by closing an external contact, was included between the two tubes of reduced copper, the gas being caused to bubble through the electrolytic liquid. The quantity of hydrogen liberated was calculated from the deflection of a galvanometer included in the circuit, and was sufficient, if retained, to alter the density very materially. Care was taken that the small stream of hydrogen should be uniform during the whole time (about 2½ hours) occupied by the filling, but, as will be seen, the impurity was effectually removed by the copper oxide.[1] Two experiments gave—

September 17	2·31012
,, 20	2·31027
Mean	2·31020

We may take as the number for nitrogen—

	2·31026
Correction for contraction ...	56
	2·31082

Although the subject is not yet ripe for discussion, I cannot omit to notice here that nitrogen prepared from ammonia, and expected to be pure, turned out to be decidedly lighter than the above. When the oxygen of air is burned by excess of ammonia, the deficiency is about 1/1000th part.[2] When oxygen is substituted for air, so that all (instead of about one-seventh part) of the nitrogen is derived from ammonia, the deficiency of weight may amount to ½ per cent. It seems certain that the abnormal lightness cannot be explained by contamination with hydrogen, or with ammonia, or with water, and everything suggests that the explanation is to be sought in a dissociated state of the nitrogen itself. Until the questions arising out of these observations are thoroughly cleared up, the above number for nitrogen must be received with a certain reserve. But it has not been thought necessary, on this account, to delay the presentation of the present paper, more especially as the method employed in preparing the nitrogen for which the results are recorded is that used by previous experimenters.

Reduction to Standard Pressure.

The pressure to which the numbers so far given relate is that due to 762·511 mm. of mercury at a temperature of 14°·85,[3] and under the gravity operative in my laboratory in latitude 51° 47′. In order to compare the results with those of other experimenters, it will be convenient to reduce them not only to 760 mm. of mercury pressure at 0°, but also to the value of gravity at Paris.

The product of the three factors, corrective for length, for temperature, and for gravity, is 0·99914. Thus multiplied, the numbers are as follows :—

Air.	Oxygen.	Nitrogen.
2·37512	2·62534	2·30883

and these may now be compared with the water contents of the globe, viz. 1836·52.

The densities of the various gases under standard conditions, referred to that of distilled water at 4°, are thus :—

Air.	Oxygen.	Nitrogen.
0·00129327	0·00142952	0·00125718

With regard to hydrogen, we may calculate its density by means of the ratio of densities of oxygen and hydrogen formerly given by me, viz. 15·882. Hence

Hydrogen.
0·000090009.

The following table shows the results arrived at by various experimenters. Von Jolly did not examine hydrogen. The numbers are multiplied by 1000 so as to exhibit the weights in grams per litre :—

	Air.	Oxygen.	Nitrogen.	Hydrogen.
Regnault, 1847	1·29319 ...	1·42980 ...	1·25617 ...	0·08958
Corrected by Crafts ..	1·29349 ...	1·43011 ...	1·25647 ...	0·08988
Von Jolly, 1880	1·29351 ...	1·42939 ...	1·25787	—
Ditto corrected.......	1·29383 ...	1·42971 ...	1·25819	—
Leduc, 1891[1].........	1·29330 ...	1·42910 ...	1·25709 ...	0·08985
Rayleigh, 1893	1·29327 ...	1·42952 ...	1·25718 ...	0·09001

The correction of Regnault by Crafts (*Comptes Rendus*, vol. cvi., p. 1664) represents allowance for the contraction of Regnault's globe when exhausted, but the data were not obtained from the identical globe used by Regnault. In the fourth row I have introduced a similar correction to the results of von Jolly. This is merely an estimate founded upon the probability that the proportional contraction would be about the same as in my own case and in that of M. Leduc.

In taking a mean we may omit the uncorrected numbers, and also that obtained by Regnault for nitrogen, as there is reason to suppose that his gas was contaminated with hydrogen. Thus

Mean Numbers.

Air.	Oxygen.	Nitrogen.	Hydrogen.
1·29347	1·42961	1·25749	0·08991

The evaluation of the densities as compared with water is exposed to many sources of error which do not affect the comparison of one gas with another. It may, therefore, be instructive to exhibit the results of various workers referred to air as unity.

	Oxygen.	Nitrogen.	Hydrogen.
Regnault (corrected)	1·10562 ...	0·97138 ...	0·06949
v. Jolly (corrected)	1·10502 ...	0·97245 ...	—
Leduc..................	1·1050 ...	0·9720 ...	0·06947
Rayleigh	1·10535 ...	0·97209 ...	0·06960
Mean............	1·10525 ...	0·97218 ...	0·06952

As usually happens in such cases, the concordance of the numbers obtained by various experimenters is not so good as might be expected from the work of each taken separately. The most serious discrepancy is in the difficult case of hydrogen. M. Leduc suggests (*Comptes Rendus*, July, 1892) that my number is too high on account of penetration of air through the blow-off tube (used to establish equilibrium of pressure with the atmosphere), which he reckons at 1 m. long and 1 cm. in diameter. In reality the length was about double, and the diameter one-half of these estimates; and the explanation is difficult to maintain, in view of the fact, recorded in my paper, that a prolongation of the time of contact from 4^m to 30^m had no appreciable ill effect. It must be admitted, however, that there is a certain presumption in favour of a lower number, unless it can be explained as due to an insufficient estimate for the correction for contraction. On account of the doubt as to the appropriate value of this correction, no great weight can be assigned to Regnault's number for hydrogen. If the atomic weight of oxygen be indeed 15·88, and the ratio of densities of oxygen and hydrogen be 15 90, as M. Leduc makes them, we should have to accept a much higher number for the ratio of volumes than that (2·0002) resulting from the very elaborate measurements of Morley. But while I write the information reaches me that Mr. A. Scott's recent work upon the volume ratio leads him to just such a higher ratio, viz. 2·00245, a number *a priori* more probable than 2·0002. Under the circumstances both the volume ratio and the density of hydrogen must be regarded as still uncertain to the 1/1000th part.

[1] Much larger quantities of hydrogen, sufficient to reduce the oxide over several centimetres, have been introduced without appreciably altering the weight of the gas.

[2] Nature, vol. xlvi. p. 512.

[3] The thermometer employed with the manometer read 0°·15 too high.

[1] *Bulletin des Séances de la Société de Physique.*

ELECTRICAL RAILWAYS.[1]

ONE of the most striking of the many new departures in the practical application of electrical science, which made the Paris Exhibition of 1881 memorable, was a short tramway laid

[2] Friday evening discourse delivered at the Royal Institution by Dr. Edward Hopkinson on February 24.

down, under the direction of the late Sir William Siemens, from the Palais de l'Industrie to the Place de la Concorde, upon which a tramcar worked by an electric motor plied up and down with great regularity and success during the period of the Exhibition. Yet few of those who saw in this experiment the possibilities of a great future for a new mode of traction would have ventured to predict that within ten years' time, in the United States alone, over 5,000 electric cars would be in operation, travelling 50,000,000 miles annually, and carrying 250,000,000 passengers, or that electrical traction would have solved the problem of better communication in London and other large cities. Two years before the exhibition in Paris the late Dr. Werner Siemens had exhibited at the Berlin Exhibition in 1879 an experimental electric tramway on a much smaller scale, and his firm had put down in 1881 the first permanent electric railway in the short length of line at Lichterfelde, near Berlin, which, I believe, is still at work. In the same year Dr. William Siemens undertook to work the tramway, then projected, between Portrush and Bushmills, in the north of Ireland, over six miles in length, by electric power, making use of the water power of the Bush River for the purpose, an undertaking which I had the advantage of carrying out under his direction. It is no part of my object to-night to follow further the history of electric traction, which is so recent that it is familiar to all; but, in alluding to these initial stages of its development, I have desired to recall that it was to the foresight and energy of Dr. Werner and Dr. William Siemens, and their skill in applying scientific knowledge to the uses of daily life, which gave the first impulse to the development of the new electrical power.

The problem of electric traction may be naturally considered under three heads:—

(1) The production of the electrical power.

(2) Its distribution along the line.

(3) The reconversion of electrical into mechanical power, in the car motor or locomotive.

The first of these here in England at any rate is dependent upon the economical production of steam power, although there are essential points of difference between the conditions under which steam power is required for electric traction purposes and for electric lighting. But in Scotland and Ireland and in many countries abroad there is abundant water power, now only very partially utilised. The Portrush line is worked in part by water and in part by steam power, but in the Bessbrook and Newry Tramway (of which there is a working model on the table) water power is exclusively used.

A few experiments will show that the demand for power on the generating plant is greatest at the moment of starting the car or train, when in addition to the power required to overcome the frictional resistances power is also required to accelerate the velocity. Thus, if instead of a single car there are a number of trains moving on the one system, and it so happens that several are starting together, the demand made upon the generating plant may at one moment be three or four times as great as that made a few seconds after. This is shown in the diagrams which exhibit the variation of current supplied by the generators on the City and South London Railway, with eight trains running together, the readings being taken every ten seconds. The maxima rise as high as double the mean; thus the generating plant must be capable of instantly responding to a demand double or even treble the average demand upon it.

In electric lighting it is true there is not less variation between the maximum demand and the mean taken during the ordinary hours of lighting, but it is only in the event of sudden fog that the probable demand cannot be accurately gauged beforehand, and provided for by throwing more generators into action. Thus in a lighting station each generator may be kept working approximately at its full load, and therefore under conditions of maximum economy, whereas in a traction station the whole plant must be kept ready to instantaneously respond to the maximum demands which may be made upon it, and must therefore necessarily work with a low load factor, and consequently with diminished economy. So important is the influence on cost of production of the possible demand in relation to average demand, that the Corporation of Manchester under their order for electric supply, have decided upon the advice of their engineer to annually charge a customer £3 per quarter for each unit per hour of maximum supply which he may require, in addition to 2*d*. per unit for each unit actually consumed, *i.e.* for being ready to supply him with a certain amount of electrical power if required to do so, they charge an additional sum equivalent to the charge for its actual consumption for 1440 hours.

In one respect water power has an economic advantage over steam power, because although steam engine and turbine alike work with greatly reduced efficiency at reduced loads, when the turbine gates are partially closed and the water restrained in the reservoir, it is not subject to loss of potential energy, whereas the energy of the steam held back by the valves of the engine suffers loss through radiation and condensation.

At Bessbrook the turbine and generator dynamo combined yield 60 per cent. of the energy of the water as electrical energy available for work on the line, but when the load is reduced to a third of the full load the efficiency is reduced to 33 per cent. So on the City and South London line a generator engine and dynamo will yield, when working at their full load, 78 per cent. of the indicated horse-power as useful electrical power, but at half load the efficiency falls to 65 per cent. Notwithstanding these conditions the generator station of the City and South London line is producing electrical energy at a cost of 1·56*d*. per Board of Trade unit, which is less than the annual average cost of production of any electric station in England, with the single exception of Bradford, which has the advantage both of cheap coal and cheap labour. In output it is the largest of any Electric Generating Station in England, the total electrical energy delivered in 1892 being 1,250,000 Board of Trade units, the second on the list being the St. James and Pall Mall with 1,186,826 units.

Let us pass now to the consideration of the distribution of the electric power along the line. I have equipped the three model tracks before you with three different kinds of conductors. In two of them the rails of the permanent way, which are necessarily uninsulated, are made use of for the return current. This plan, with I believe the almost single exception of the Buda Pesth Tramway, has been universally adopted with the object of saving the cost of a return conductor; but it is doubtful whether such an arrangement can be considered final, for it must necessarily create differences of potential in the earth, which already in some instances have had disturbing effects upon our observatories, or upon our telegraph and telephone systems. It appears to be probable in the more or less distant future that the use of the earth for the passage of large current will be guarded by legislation; and that it will be reserved for the more delicate and widely extended operations of telegraphy and telephony. These disturbances may of course be easily avoided by the use of an insulated conductor for the return circuit. In the case of conductors which are in such a position that contact may be made from them to the ground through the body of a horse or some other animal coming into contact with them, there is another strong argument for an insulated return, as many animals, and notably horses, are far more sensitive to electric shock than man. It is not perhaps well known, but still a fact, that a shock of 250 volts is quite sufficient to kill a horse almost instantaneously.

The first model has a single overhead conductor with return by the rails; but in place of a single fishing-rod collector or trolley to take the current from the overhead wire there are fixed on the car two rigid bars, one at each end, which slide along the under surface of the wire and make a rubbing contact against it. This system, devised by Dr. John Hopkinson, has the advantage that there is less difficulty in maintaining contact on uneven roads or on curves, and that the catenaries of the suspended wire may be hung with greater dip, and therefore with less tension. Again, the double contact obviates the frequent breaks and consequent sparking of a single trolley system. The second model shows the system adopted on the City and South London line, and more recently followed on the Liverpool Overhead line, of a conductor of channel steel, upon which collectors fixed to the locomotives make a sliding contact. The third track shows an overhead system like the first, but with an insulated return in place of return by the rails.

The characteristic feature of an electric motor is that it delivers us the mechanical power we require directly in the form of a couple about an axis instead of in the form of a rectilinear force, as is the case with steam, gas, or air engines, which must be reduced to a rotary form by connecting rod and crank. Thus it is possible to sweep away all intermediate gear, and to arrive at once at the simplest of all forms of a traction motor, consisting of but one pair of wheels fixed on a single axle with the armature constructed directly upon it, with its magnets suspended from it and maintained in their position against the magnetic forces acting upon them by their weight. Such a locomotive is shown in the third model before you. So far as I am aware, a locomotive of such simplicity as this has never been constructed for practical work, but on the City and South London line the armatures of the motors are placed directly on the axles and the magnets, suspended partly from the axles and partly from the frame.

The second model is an exact reproduction of the locomotives on the City and South London line, but with a different arrangement of motors. Here both armatures are included in the same magnetic circuit, and both magnets and armatures carried on the frame of the locomotive and not on the axles. The armatures are geared to the axles by diagonal connecting rods, the axle boxes being inclined, so that their rise and fall in the horn blocks is at right angles to the connecting rods. This design, which is due to the late Mr. Lange, of Messrs. Beyer, Peacock & Co., allows of the motor armature being placed on the floor level of the locomotive, and so more easily accessible.

This model will serve to show some of the characteristic features as well as some of the characteristic defects of an electric motor as such. But in order to show these clearly I may refer for a moment to the general theory of a motor. It is easily shown that in a series wound motor the couple or turning moment on the axle is a function of the current only, and independent of the speed and electro-motive force. Again it follows from Ohm's law that the current passing through the motor multiplied by the resistance of the magnet and armature coils is equal to the difference between the electro-motive force at the terminals of the motor and the electro-motive force which would be generated by the motor, if it were working at the same speed as a generator of electricity, that is to say the difference between the electro-motive force at the terminals and what is called the "back" or "counter" electro-motive force of the motor. Hence if the terminals of the motor be coupled direct to the line at the moment of starting when the motor is still at rest, the current will be very great and its power entirely absorbed in the coils of the armature and magnets, but the turning moment will then be a maximum. The motor then begins to move, part of the power being spent in overcoming frictional resistances and part in accelerating the train. A back electro-motive force is then set up, increasing as the speed increases, and causing the current to diminish until finally a position of equilibrium is established, when the speed is such that the back electro-motive force together with the loss of potential in the coils of the motor is equal to the potential of the line. But in practice the mechanical strength of the motor, and the carrying power of its coils, as well as the limited current available from the generators makes it necessary to introduce resistances in circuit with the motor to throttle the current and to reduce it within proper limits. It is to this point I desire to draw attention, that in traction work when starting the motor resistances must be introduced, which, with the resistance of the motor itself, at the moment of starting, absorb the whole power of the current, reducing the efficiency of the motor to nil, and which continue to absorb a large percentage of the power, until the condition of equilibrium is established. This is the great defect in electric motors for traction work, and its importance can be shown very clearly by reference to the work done on the City and South London line. There the motors when working with their normal current have an efficiency of 90 per cent., but the actual all-round efficiency of the locomotives as a whole is 70 per cent. only, so that the loss in starting is equal to 20 per cent. of the whole power. Of course in some respects the City and South London line is exceptional in that a start is made every two or three minutes. Various devices have been suggested with a view to diminishing this waste of power in starting an electric motor, but none entirely meet the case. Thus if the locomotive or car has two motors, these can be coupled in series at the start, and subsequently thrown into parallel, thereby doubling the tractive force with a given current, or for the same tractive force reducing the loss of power by three-fourths. When through the increase of speed of the motor the back electro-motive force balances the electro-motive force of the line the speed can be increased by diminishing the magnetic field by reducing the effective coils on the magnets, but this device does not give any assistance at the lower speeds, as the magnets ought to be so wound as to be high on the characteristic curve, or nearly saturated, with the normal current, and it is therefore not possible to obtain any increased intensity of field, by increasing the convolutions of the magnet coils. If it were possible to use alternate current motors for traction work the difficulty could at once be met by introducing a transformer in the circuit, and placing the motor in its secondary. The effective convolutions of the secondary circuit on the transformer could then be varied as the speed increases in such wise that the electro-motive force of the line is balanced by the back electro-motive force of the motor and the fall of potential due to the resistance of the motor coils, so avoiding all need for resistances.

The City and South London line has enabled experiments to be made on the efficiency of the railway system as a whole, taking into account the loss of power in the generators, on the line, and in the motors, and in the resistances of the locomotives. The loss in the line is about eleven per cent. of the power generated, and the efficiency of the locomotives as a whole is, as I have shown, 70 per cent.; thus the electrical efficiency of the entire system is 62 per cent. The trains weigh with full load of 100 passengers about forty tons, and the average speed between stations is 13·5 miles per hour. The cost of working, including all charges, during last half year was 7·1*d.* per train mile, of which 4·7*d.* represents the cost of production of the electric power, and 2·4*d.* the cost of utilising it on the locomotives. It is perhaps hardly a fair comparison to compare the cost of working such a line as the South London line with the cost of steam traction on other lines, inasmuch as steam could not possibly be used in the tunnels, only 10′ 6″ diameter, in which this line is constructed, but the comparison is not uninstructive. Take the Mersey Railway, where the gradients and nature of the traffic are similar. On the Mersey Railway the locomotives weigh about 70 tons, and the train, which is capable of carrying about 350 passengers, 150 tons. According to the published returns of the company the cost of locomotive power is 14*d.* per train mile, *i.e.* double the cost on the South London line, but for a train weighing between four and five times as much but capable of carrying only 3½ times the number of passengers; thus the cost of steam traction per ton mile of train is about half that per ton mile of train for electric traction. But it is not on the cost per ton mile that the success of a passenger line depends. The real basis of comparison is the cost per passenger mile, and here electric traction has great advantage over steam, as the dead weight of the electric motor is small compared with the dead weight of steam locomotives of the same power, and with electric motors the trains can be split up into smaller units at but slightly increased cost, so permitting a more frequent service. We cannot expect, therefore, that electric traction with our present knowledge will take the place of steam traction on our trunk lines; but it has its proper function in the working of the underground lines now projected for London, Paris, Berlin, and Brussels, and other large towns, and also I think on other urban lines, for example, on the Liverpool Overhead Railway, where trains of large carrying capacity are not required, but a frequent service is essential; and finally, also on those short lines, whether independent or branches of the great trunk lines where water power is available. When I undertook the construction of the Bessbrook line it was a condition that the cost of working should be less than the cost of working by steam, a condition which the first six months of working showed to be successfully fulfilled. When Messrs. Mather and Platt undertook the construction of the electric plant for the City and South London Railway, they guaranteed that the cost of traction for a service of 8247 miles per week as actually run should not exceed 6·3*d.* per train mile, exclusive of the drivers' wages. Their anticipations have been more than realised, the actual cost being 5·1*d.* per train mile only. There are, however, other projects both in America and on the continent for electric railways on which the special feature is to be an enormously high speed of travel, speeds of 150 and even 200 miles per hour being promised. With a steam locomotive, involving the reciprocating motion of the piston and connecting rod, such speeds are probably unattainable, but they may be realised in the purely rotary motion of an electric motor. But at such high speeds as these the power required to overcome the air resistance is of special consideration. Probably up to speeds of 750 miles per hour, or even to higher limits still, the ordinary law of air resistance holds good, as the rate of disturbance is still less than the velocity of waves in air, but above these limits we leave the regions of ordinary locomotion and enter rather into the field of projectiles. Assuming, however, that the ordinary laws of air resistance do hold good, I calculate that the power required to propel an ordinary train 200 feet long at 200 miles per hour against the resistance of air alone, apart from the frictional resistances, would not be less than 1700 horse power. Though there is nothing to prevent the construction of electric locomotives capable of developing this or even greater power, the strength of the materials at present at command will set a limit to the speeds which may be obtained.

In order that the engineer may realise the imperfection of all his works, it is well for him to be constrained from time to time to contemplate the amount of energy involved in his final purpose compared with the energy of the coal with which he starts. I have endeavoured to put before you to-night the losses that occur and the reasons for them, in some steps of the complex machine which constitutes an electric railway, so in conclusion I will draw your attention to the ultimate efficiency of the machine, starting with the coal and ending with the passenger carried through space. The diagram on the wall, starting with the familiar 12,000,000 foot-pounds, the energy of a pound of coal, shows the loss in each step, supposing it made with the most economical appliances known to the engineer, first in the boiler, then in the steam engine, generator dynamo, conductors, locomotives, in the dead weight of the train, till finally we arrive at the energy expended on the passenger himself, which we find to be 133,000 foot-pounds, or but little more than 1 per cent. of the energy with which we started. It is true indeed that transportation is a more economical process than lighting with incandescent lamps, in which the final efficiency is about one-half per cent., but whether in lighting or in traction, when we consider that ninety-nine parts are now wasted for one part saved, we may realise that the future has greater possibilities than anything accomplished in the past.

HAIL STORMS.[1]

SOME recent thunder and hail storms were so violent that they call for more than a passing notice, not only on account of their severity, but also because they are well marked phenomena in our weather. The district in which they were most severe is that around Narrabri, and the weather map for the day indicated this district as one in which storms would probably manifest great intensity. The places from which the best accounts have reached me are Narrabri, Avondale, thirty miles due north of Narrabri, and Tulcumbah, fifty-seven miles south-east of Narrabri.

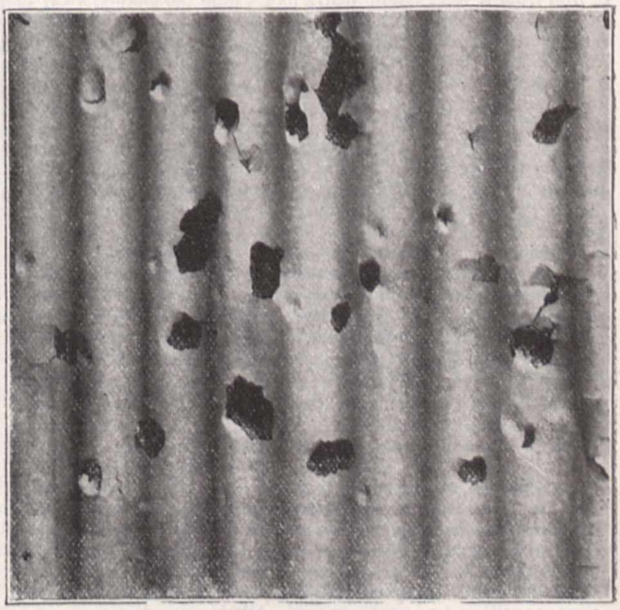
The Sydney weather chart at 9 a.m. on October 13, the day of these storms, shows us that there was but little difference in pressure all over Australia. To the west of the overland telegraph line it was slightly higher, over western New South Wales and Queensland lower, and higher again over the East Coast, in which the isobars clearly outline the area of relatively low pressure, and the kinks in them indicate disturbed conditions, local short-lived storms, and before the day was over the inference from the state of pressure was fully justified, for storms of extreme violence occurred over the area; storms which swept down great forest trees two and three feet in diameter. What this means in wind velocity I am unable to say, the trees are eucalypts, and therefore the wood is hard and very strong, but they were treated as if they were reeds, and their strength was as nothing compared with the force of the wind.

These storms are common enough, but owing to the sparse population they seldom pass over towns or dwellings. In this instance such has been the case, and in the future as population increases similar cases must increase in number, for the storms are abundant, indeed these storms form a well-marked feature of our summer weather. As a rule they are disconnected, and the most violent part of the wind covers but two hundred or three hundred yards wide, and travels along with great rapidity, leaving a narrow line of destruction in its wake.

On the day in question heavy storms were reported at Goodooga, Armidale, two hundred and forty miles south-east of Goodooga, and at Grafton one hundred miles north-east of Armidale. Storms which seem to have been quite disconnected, for the earliest time was at Grafton, and as a rule they come from the west; these are spoken of as severe storms, but were evidently not specially remarkable, nothing to compare with those in the Narrabri district to which I wish to direct your attention. Unfortunately, data for determining the rate of progress is not available, although that as to the intensity of the storms is abundant. I may mention that three days before these storms, that is on October 10, a similar storm passed over from Wilcannia to Sydney, a distance of four hundred and eighty miles, at the rate of fifty-five miles per hour; and I have before traced one over the same part of the colony, the rate being fifty-seven miles per hour, but we have not traced a sufficient number to determine an average rate.

As to the velocity of the wind along the line of damage in these storms, we have no actual anemometer results, so far we have not had one which passed over one of the anemometers, but judging from the damage done to large and solid trees, two and even three feet in diameter, it cannot I think be less than one hundred and forty or one hundred and fifty miles per hour.

We may now turn to the storms in the Narrabri district. The storm reached Narrabri at 6.15 p.m., and the postmaster reports that the storm which approached Narrabri from north-west was accompained by thunder and lightning, but no hail. The wind, however, seems to have been of hurricane violence, trees two feet in diameter were torn up by the roots, limbs twelve inches through were snapped off short, a brick factory completely ruined, roofs, sign-boards, and everything that the wind could move went flying; in the language of the local newspaper, "substantial brick buildings came tumbling in all directions, the



Photograph of iron perforated by hail.

air was full of iron tubs, galvanised iron, and tins of every description."

In the district south of Narrabri the storm was even more severe. At Tulcumbah Station, fifty-seven miles south-east from Narrabri, at 8 p.m. on October 13, a violent thunder and hail storm broke over the homestead. It lasted half an hour, and Mr. A. D. Griffiths, my informant and manager of the station, says, "I measured some of the hailstones, six and a half inches in circumference; this was fifteen or twenty minutes after the storm, and I think I did not get the largest. Next morning I found that nineteen sheep had been killed by the hail, also birds, kangaroo-rats, and other animals were found lying dead in all directions. All the windows exposed to the storm were broken, and the galvanised iron roofing is dented from end to end, and many sheets cut through: in several cases the hailstones went through the iron; in one sheet I found thirty holes, and in another more than sixty. The bark of the trees in the storm track was all battered by the hail, and the fences and buildings bore traces of the impact of these great lumps of ice. The stones were generally triangular or conoidal in form, many having an uneven surface, which looked as if it had been formed from frozen drops of water collected into masses; others had an opaque snow-like centre, perhaps the majority were like this, the remainder being like clear ice. It was only the larger stones that were irregular as described, the smaller ones were generally rounded."

At Avondale, thirty miles north of Narrabri, my informant,

[1] Read by H. C. Russell, F.R.S. before the Royal Society of N.S. Wales, November 2, 1892.

Mr. S. J. Dickson, says, "From the 9th to the 13th of October, the weather was unusually oppressive with threatening storms, and on the evening of the 13th a heavy storm was seen to be working up from the west accompanied by incessant lightning of every description, and about 8 p.m. it broke over the homestead in all its fury, the wind was from south-west and of terrific force, and the rain and hail were very severe. The hailstones were as large as hen-eggs, and in some of the paddocks, one particularly, it pounded the herbage completely out, so that not a vestige of it was left, although before the storm came on it was from six to twelve inches high, and in other places strong variegated thistles three to four feet high were beaten down. Trees some two feet thick, that the wind could not tear up by the roots, were snapped off short as if made of matchwood. In the storm the hail killed birds innumerable, and even domestic fowls roosting on the trees were killed by it, and after the storm a large snake was found cut into two pieces by the hail, so at least it appeared. On the open plain the hail laid four to six inches deep, and the whole country looked as if a heavy snowstorm had passed over it. Trees in the track of the hail were completely denuded of leaves, and the bark knocked off tree trunks and limbs. The storm wind carried away outstations, unroofed the hayshed, damaged the woolshed, and carried away two sides of the house-verandah, and the sheets of iron from it were found nearly half a mile (30 chains) away to the north east, round wall plates in the hayshed six to eight inches thick were broken to pieces, and the iron roofing on all the buildings was battered by the hail as if some one had pounded it with a hammer all over. The storm track was only a mile to a mile and a half wide, at least the hail part. Between 7 and 8 p.m., as the storm came up, there seemed to be a white bow in the sky, like a white rainbow stretching from north to south. I have seen heavy storms before, but I never wish to see another like this. The shearers were completely terrified, and all say that they have never experienced a storm like it, in fact, it beggars description and can hardly be realised. It was an experience that we shall remember as long as we live."

North of Narrabri, and especially between Narrabri and Avondale, the storms were very severe. Midway between these places and at Terry-hi-hi and Berrigal Creek the wind worked great destruction in the forest. How violent it was may be gathered from the fact that great trees twelve feet in circumference at three feet from the ground, were snapped off short ten feet above the ground, or entirely stripped of their limbs.

SCIENTIFIC SERIAL.

American Meteorological Journal, March.—Exploration of the free air, by Prof. M. W. Harrington. The author considers that the conclusions to be drawn from weather maps are nearly exhausted, and that the reason of the imperfection of meteorology is the want of knowledge of what is going on in the free air. Mountain observations give most important results, but they are still surface observations. We know what goes on at the base of a cyclone, but not what occurs at the top. Theories are deduced from cloud observations, but we lack actual knowledge of what is going on above, and the only means available at present is systematic balloon observations. Prof. Harrington thinks that such observations should be provided for by funds from private sources.—The general winds of the Atlantic Ocean, by Prof. W. M. Davis. The basis of this discussion is the "Sailing Directory of the Atlantic Ocean," published by the Deutsche Seewarte, and especially two generalised wind charts contained in the atlas accompanying that work. The author classifies the winds as planetary (due to the earth's rotation and the influence of the sun), terrestrial (the annual migration of the wind belts north and south, and the seasonal variations of velocity and direction), including the interruptions of continents and mountain ranges.—The colours of cloudy condensation, by Prof. C. Barus. The author considers the problems connected with the condensation of water from moist air, and reviews the labours of Mr. Aitken and Mr. Bidwell with reference to the particles of an opaque steam-jet. He also gives a minute description of the apparatus employed in his own investigations.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 24.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Several excellent photographs of flying bullets and of the air waves produced by vibrating hammers, were exhibited, the originals of which had been taken by Prof. Mach.—A paper on the differential equation of electric flow was read by Mr. T. H. Blakesley. The object of the paper is to show that the ordinary mathematical expressions for electric flow fail to explain all known facts, and to point out that in order to interpret these facts certain properties of matter not usually recognised must be admitted. The subject is treated both algebraically and geometrically, in the latter case the magnitudes being represented by the projections of the sides of a triangle revolving in its own plane on a fixed line in that plane. Taking the ordinary differential equation for a simple circuit having resistance and self-induction, viz., $V - L\frac{dC}{dt} = RC$, it is shown that this takes no account of any energy except that spent in heating the conductor, and that where radiation into space is concerned, it is necessary to introduce another term λC, where λ is a quantity of the nature of resistance. It is further pointed out that if work be done outside the circuit, the line which geometrically represents the induced E.M.F. cannot be perpendicular to that indicating the current and "effective" E.M.F., the latter term being defined to mean the value of the quantity which is numerically equal to the product of the current into the resistance. A magnetic phase-lag must therefore exist. The author also shows that a magnetic field induced in phase with the magnetic induction would not result in a loss of energy, and no hysteresis could exist. Under the same circumstances there could be no radiation of energy from an alternating magnet. A Leyden jar discharging through a circuit having self-induction is next considered. Taking the ordinary premises, it is shown that no provision is there made for energy radiated into space, and that magnetic lag is necessary for the existence of such phenomena. The differential equations for the variables in condenser discharges according to ordinary assumptions are shown to be of the same form, and the variables can be represented by the projection of the sides of a triangle which is simultaneously undergoing uniform rotation and linear logarithmic shrinking. The rate of shrinking is the same as that of the radius vector of an equiangular spiral of characteristic angle β, where $\cos\beta = \sqrt{\frac{K}{L}} \cdot \frac{R}{2}$; K, L, and R representing capacity, self-induction, and resistance respectively. The equations and their consequences are considered at some length, and several important properties brought out. To allow for radiated energy, R must be virtually increased from R to $R+\lambda$, and the total energy is divided between the circuit and the field in the ratio of R to λ. If, therefore, the circumstances be such that λ is large compared with R, say by having high frequency, the heating of the circuit may only be a small part of the total energy. In this direction the author thinks the true explanation of some of Tesla's experiments is to be found, the energy being expended chiefly in radiation and not in current through the experimenter's body. Prof. Perry thought the C^2R term would not represent the heating of the wire when the oscillations were rapid, owing to the distribution of current not being uniform over the section of the conductor. Maxwell had shown that certain throttling terms had to be considered. In condenser discharges the complete equation would have many terms. Prof. O. J. Lodge said the best definition of R in such case. was that derived from Joule's law rather than that of Ohms Frequency was very important in the radiation of energy, but even at ordinary frequencies of alternators some energy was radiated. Referring to Tesla's experiments, he said the reason why no serious consequences followed, was that there was not much energy behind them. High frequency might be instrumental in preventing injury, but this he thought remained to be proved. Dr. Sumpner pointed out that losses other than C^2R (R being the ordinary resistance of the conductor) had to be taken into account. In some cases, such as transformers on open circuit, the effective resistance might be 1000 times that of the coil. To discuss completely the problem taken up by Mr. Blakesley, it would be necessary to take account of non-uniform distribution of current, both across and along the conductor, as well as the character of the magnetic and electric fields surrounding the circuit. Mr. Swinburne thought there was a tendency to over-estimate the rate of high-frequency currents, for unless the coils of transformers were assumed geometrically coincident, calculations were difficult. Errors of hundreds per cent. were quite possible. In Tesla's experiments no great power was involved, for the transformer could not give out any large power. Mr. Blakesley, in reply, said the term R was such that C^2R represented the whole waste loss in the conductor, whilst λ included everything wasted outside the conductor.—A paper on the viscosity of liquids, by Prof. J. Perry, F.R.S., assisted by J. Graham and C. W. Heath, was read by Prof. Perry. The viscosity was tested by suspending a hollow cylinder within an annular trough containing the liquid, and measuring the torque exerted on the cylinder when the trough rotated at various speeds about its axis. In the paper the equation of motion under the conditions of the experiment is discussed, the error introduced by assuming that the liquid moves in plane layers being shown to be about 0·5 per cent. By measuring the viscous torques exerted with different depths of liquid in the trough, the correction for the edge of the suspended cylinder was found to be 0·8 c.m. On plotting the results obtained with sperm oil at different temperatures and constant speed, a discontinuity was noticed about 40°. For a speed of nine revolutions a minute the viscosity (μ) could be very approximately calculated from the formula $\mu = 2{\cdot}06 (\theta - 4{\cdot}2)^{-{\cdot}686}$ below 40° C. and $\mu = 21{\cdot}67 (\theta - 4{\cdot}2)^{-1{\cdot}349}$ above 40° C., θ being the temperature. Experiments on the change of density of sperm oil with temperature, made by Mr. J. B. Knight, indicated a minimum density about 40°. Subsequent experiments with other samples had not confirmed these observations. The paper contains several tables of the results obtained in various experiments. Those performed at constant temperatures show that for slow speeds the torque is strictly proportional to speed, but afterwards increases more rapidly, probably owing to the critical speed having been exceeded. After concluding the paper Prof. Perry read a letter he had received from Prof. Osborne Reynolds on the subject, who doubted whether the true critical velocities had been reached in the experiments. In the particular arrangement employed, he would expect no critical velocity in the outer ring of liquid, whilst in the inner ring the motion would be unstable from the first. Mr. Rogers pointed out that experiments which corroborated those of Prof. Perry had been made by M. Couette and published in *Ann. de Chim. et de Phys.* [6] xxi.

Geological Society, March 22.—W. H. Hudleston, F.R.S., President, in the chair.—The following communications were read:—On the jaw of a new carnivorous dinosaur from the Oxford clay of Peterborough, by R. Lydekker. The author describes a fragment of the left side of a lower jaw of a carnivorous dinosaur from the Oxford clay of Peterborough, indicating a new genus and species, which he names *Sarcolestes Leedsi.* Some remarks were made on this paper by the President and Prof. Seeley.—On a mammalian incisor from the Wealden of Hastings, by R. Lydekker. In this paper a small rodent-like tooth from the Wealden of Hastings, belonging to Sir John Evans, K.C.B., is described. It is probably the front tooth of one of the mammalian genera found in the Purbeck Beds, as may be gathered from American specimens. The reading of this paper was followed by a discussion, in which the President, Sir John Evans, Mr. C. Dawson, Mr. Oldfield Thomas, Dr. Forsyth-Major, Dr. H. Woodward, and the author took part.—On an intrusion of Muscovite-biotite-gneiss in the south-eastern Highlands, and its accompanying thermo-metamorphism, by George Barrow, of the Geological Survey. (Communicated by permission of the Director-General of the Geological Survey.) The area to which this paper refers lies in the north-eastern part of Forfarshire, and is drained by the two Esks. The author first describes the distribution, mode of occurrence, and petrological characters of the intrusive masses. In the north-western portion of the area the intrusive rock is always a gneiss, and occurs in thin tongues which permeate the surrounding rocks. Towards the south-east these tongues amalgamate and form large masses, in which the foliation is less marked. Moreover, in this direction the large masses are often fringed with pegmatite, especially on their southern and eastern edges. Where the rock is a gneiss, it is composed of oligoclase, muscovite, biotite, and quartz, but contains no microcline. As the gneissose character becomes less marked, the oligoclase diminishes in amount, and microcline begins to appear, especially towards the margins of the masses. In the most south-easterly of these microcline is greatly in excess of oligoclase. The differences in structure and composition of these masses are believed by the author to be due to the straining off of the crystals of earlier consolidation during intrusion under great pressure. The still liquid potash-bearing portion of the magma was squeezed out and forced into every plane of weakness in the surrounding rocks; and that portion of it which contained the highest percentage of potash finally consolidated as pegmatite. Special attention is directed to the distribution of pegmatite. This rock is widely distributed in the Southern Highlands, and cuts across every known system of folding. It is consequently newer than any member of the metamorphic series. The surrounding metamorphic schists are next dealt with. These are remarkable for their highly crystalline condition, and also on account of the presence of many minerals known to occur in regions where thermo-metamorphism has taken place. The characters of the more important minerals are described in detail. The rocks of the metamphoric area become less and less crystalline as they are followed towards the Highland border. Three zones, characterised respectively by the minerals sillimanite, cyanite, and staurolite, have been roughly mapped. The more important rocks found in these zones are described in detail, and evidence is given to show that the boundaries between the zones do not in all cases coincide with the strike of the rocks. Thus, a thin bed of quartzite, which retains its character in consequence of the simplicity of its chemical composition, may be followed through all the zones; whereas the bed adjacent to it is in the outer zone a staurolite-schist, in the intermediate zone a cyanite-gneiss, and near the contact with the igneous rock a coarse sillimanite-gneiss. Evidence is given to show that the original rocks formed a sedimentary series. The phenomena are compared with those of other areas where thermo-metamorphism has taken place; and the conclusion is reached that the differences are of *degree* rather than of *kind*. The special features of the area in question are attributed to the depth at which the change was produced. The paper is illustrated by a map of the district and a table of original analyses. This paper gave rise to a discussion, in which the president, Prof. Judd, Mr. Rutley, General McMahon, Dr. Hicks, Mr. Marr, Dr. Du Riche Preller, Mr. Teall, and the author took part.

Zoological Society, March 28.—Sir W. H. Flower, K.C.B., LL.D., F.R.S., President, in the chair.—A report was read, drawn up by Mr. A. Thomson, the Society's head-keeper, on the insects bred in the insect-house during the past season.—A communication was read from Mr. Herbert Druce, giving an account of some new species of Lepidoptera Heterocera, chiefly from Central and South America.—Mr. F. E. Beddard, F.R.S., read a paper on the brain of the African elephant. The author gave reasons for disagreeing with some of the conclusions of Dr. Krueg, but confirmed others. The outline is more like that of the carnivorous than the ungulate brain, but the principal furrows appear to be arranged on a plan characteristic of the elephantidæ.—Mr. W. T. Blanford showed that the various names hitherto employed in systematic works for the bird called by Jerdon the Himalayan cuckoo (*Cuculus himalayanus*, *C. striatus*, and *C. intermedius*) belonged to other species. He also gave reasons for not adopting S. Müller's *C. canoroides*, and accepted the term *C. saturatus*, Hodgson, as the correct scientific name.—A communication was read from Mr. F. M. Woodward, entitled "Further observations on the genitalia of British earthworms." This paper chiefly dealt with supplementary gonads which were found to be much more common than had been supposed; in one specimen an hermaphrodite gland was discovered in addition to testes and ovaries.

Entomological Society, March 29.—Henry John Elwes, President, in the chair.—Mr. G. C. Champion exhibited a living specimen of a luminous species of *Pyrophorus*, which had been found in an orchid house in Dorking. It was supposed to have emerged from the roots of a species of *Cattleya* from Colombia.—Mr. A. H. Jones exhibited living full-grown larvæ of *Charaxes jasius*, found by Mr. Frederic Raine, at Hyères, feeding on *Arbutus unedo.*—Surgeon-Captain Manders exhibited a series of *Lycæna theophrastus* from Rawal Pindi, showing climatal variations, the rainy-season form being of darker coloration, and larger than that occurring in the dry season. The ground colour of the former on the under surface was markedly white with deep black striæ; in the latter form the ground colour was distinctly reddish, and the marking reduced to reddish lines. He said that the latter form had been described as *L. alteratus.*—Mr. S. G. C. Russell exhibited a beautiful variety of *Argynnis selene*, taken near Fleet, Hants; two varieties of *A. selene* from Abbot's Wood, Sussex; typical specimens of *A. selene* and *A. euphrosyne* for comparison; and a remarkable variety of *Pieris napi* from Woking.—Mr. C. J. Gahan exhibited a microscopic preparation of the antenna of the larva of a beetle (*Pterostichus*), for the purpose of demonstrating the sensory nature of the so-called "appendix" of the antenna. Since he wrote a note describing this structure, a short time ago, he found that Prof. Beauregard had already suggested its sensory character, and was inclined to believe that it was an auditory organ.—Mr. H. Goss exhibited a specimen of *Trogus lapidator*, Grav., believed to have been bred from a larva of *Papilio machaon*, taken in Norfolk by Major-General Carden. Mr. Goss stated that he sent the specimen to the Rev. T. A. Marshall, who said it was a well-known parasite of *P. machaon* on the Continent, but not proved to exist in the United Kingdom.—Mr. F. Merrifield said he knew this parasite, and had bred several specimens of it from pupæ of *P. machaon* received from Spain.—Colonel Swinhoe read a paper, entitled "The Lepidoptera of the Khasia Hills. Part I." A long and interesting discussion ensued, in which Mr. Elwes, Mr. Hampson, Colonel Swinhoe and others took part.—Mr. W. Bartlett-Calvert communicated a paper entitled "New Chilian Lepidoptera."—Mr. J. W. Shipp communicated a paper entitled "On a New Species of the Genus *Phalacrognathus*."

PARIS.

Academy of Sciences, April 4.—M. Lœwy in the chair.—On the construction of the chart of the heavens; numerical application of the method of attaching neighbouring negatives, by M. Maurice Lœwy.—Remarks on M. Joubin's note relating to the measurement of large differences of phase in white light, by M. A. Cornu.—On the approximate representation of experimental functions between given limits, by M. Vallier.—On the benzeneazocyanacetic ethers and their analogues, by MM. A. Haller and E. Brancovici.—Measurement of the parallel of 47° 30′ in Russia, by M. Venukoff. The parallel was measured from the meridian of Kichinev, near the Roumanian frontier, to that of Astrakhan, on the Lower Volga, the difference of longitude being 19° 11′ 55″·11. The measurements gave 1,446,462 m. for the length of the arc, or 75,336 m. per degree of longitude. But this mean value is not everywhere attained. Between Rostov-on-the-Don and Sarepta the geodetic arc exceeds the astronomical one by 15″·26, whilst between Sarepta and Astrakhan the astronomical arc is the larger by 9″·82. This deviation shows a remarkable agreement with that obtained in the measurement of the 52nd parallel and indicates that the plains of Eastern Russia are formed according to the same geometrical law over a vast area. A comparison of the results for the two arcs, with reference to the length of the meridian measured from the North Cape to Dorpat and the Lower Danube, indicates a polar depression of 1 in 299·65, which agrees closely with that found by Bessel for Germany in 1841 (1 in 299·26), but differs from that of Clarke (1 in 293·46).—Condensation experiments of the acetylcyanacetic acids with the phenols, by M. A. Held.—Synthesis of erythrite, by M. G. Griner.—Action of temperature upon the rotatory power of liquids, by M. A. Aignan. Reasoning from the fact that the oxide of isobutylamyl presents a rotatory power which changes its sign at −30°, M. Colson has concluded that "chemical constitution does not appear to be the preponderating factor in the value or the sign of the rotatory power." But the fact referred to can be explained as the effect of the mixture of a negative and a positive rotating substance respectively. A mixture of essence of terebenthine (left-handed) and camphor (right-handed) was dissolved in benzene, and observed through the 20 cm. tube of the polarimeter in different kinds of light. This mixture changed from negative to positive at a temperature between 61° and 73°C. for red light, between 13° and 33° C. for yellow light, and was positive for all the temperatures for green light, the angle of rotation being 2° 24′ at 13°, and 6° 43′ at 90° C. To explain M. Colson's observation, it is not even necessary to assume that the oxide contains two substances of rotatory powers of different signs. It suffices to admit, as has been done in the case of solutions of tartaric acid, that the molecules of isobutylamyl are susceptible of polymerisation in the liquid state, so that the sign of the rotatory power characterising the molecule of the substance is that observed at the higher temperatures.—Neolithic village of the Roche-au-Diable, near Tesnières, canton of Lorez-le-Bocage (Seine-et-Marne), by M. Armand Viré. In the course of excavations in the valley of Lunain a village was discovered of a type not met with up to now. It consists of a series of ground-works of square huts touching each other, and arranged in a line nearly east and west, forming a very regular street. At the end was a sort of square enclosure of stone, measuring about 2·5 by 3 m., with a door towards the south. Inside it presented a circular cavity, 30 cm. in diameter and 20 cm. deep, which still appeared to contain ashes, and whose clay walls were baked to a depth of about 4 cm. Similar hearths have been found among the Kabyles of Algiers. Near this structure was another, of circular form, built of rough blocks of limestone and sandstone, with a triangular door built of two enormous blocks of sandstone, joining at the top, and leaving a space of 50 cm. at the bottom. This hut also showed traces of cooking operations. A little further on came a series of seven similar huts, followed by two larger ones without hearths, and finally two more like the first. The total length of the village was 114 m. All the masonry consisted of blocks of limestone or sandstone, cemented with clay. A large number of stone and flint implements was found, including half a dozen sandstone hatchets, polished or prepared for polishing. The village is, curiously enough, situated at the very bottom of the valley.

BOOKS AND PAMPHLETS RECEIVED.

Books.—Exercises in Euclid: W. Weeks (Macmillan).—Electrical Tables and Memoranda: S. P. Thompson and E. Thomas (Spon).—Popular Lectures on Scientific Subjects: H. von Helmholtz, 2 vols. new edition, translated by E. Atkinson (Longmans).—Aids to Biology: J. W. Williams (Baillière).—Statics and Dynamics: E. Geldard (Longmans).—Map of River Basins: C. E. De Rance (Manchester, J. E. Cornish).—Telephone Lines and their Properties: W. J. Hopkins (Longmans).—The Birds of Derbyshire: F. B. Whitlock (Bemrose).—Theory of Functions of a Complex Variable: Dr. A. R. Forsyth (Cambridge University Press).—Theory of Structures and Strength of Materials: H. T. Bovey (K. Paul).—Die Thermodynamik in der Chemie: J. J. Van Laar (Leipzig, Engelmann).—Polarisation Rotatoire: G. Foussereau (Paris, G. Carré).—Traité Pratique d'Analyse Chimique et de Recherches Toxicologiques: G. Guérin (Paris, G. Carré).—Forest Tithes, &c.: A Son of the Marshes (Smith, Elder).—Technology for Schools: J. Hassell (Blackie).—A Practical Treatise on Bridge Construction, 2 vols.: T. C. Fidler (Griffin).—The Steam-Engine, 2 vols: D. K. Clark (Blackie).

Pamphlets.—Sulla Distribuzione del Potenziale Nell'Aria Rarefatta percorsa dalla Corrente Elettrica: Prof. A. Righi (Bologna).—The Fundamental Theorems of Analysis Generalised for Space: Prof. A. Macfarlane (Boston).—The Imaginary of Algebra: Prof. A. Macfarlane (Salem).—Australian Museum, Sydney; Catalogue of Australian Mammals, &c. (Sydney).—Catalogue of the Michigan Mining School, Houghton, Michigan, 1891-92 (Houghton).

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