THURSDAY, JUNE 21, 1888.

THE STEAM-ENGINE.

The Steam-Engine. By G. C. V. Holmes. (London: Longmans, 1887.)

THIS treatise is intended as an elementary text-book for technical students. In many respects it fulfils its purpose, at least better than any book of moderate size with which we are acquainted. It is clearly written; its arrangement, if not the best possible, is orderly; it is so far practical that problems arising in the actual design and use of steam-engines are not ignored, but attacked in a sufficiently elementary way; and the *rationale* of processes involved in the use of steam is explained adequately and correctly on the whole. The woodcuts represent fairly good examples of construction, with the exception of one or two, like those of the injector and exhaust-ejector, which are antiquated, and one or two others so bad that they are obviously mere imaginary sketches. Nevertheless the book fails of being what a really good elementary text-book of the steam-engine might easily be—what, indeed, anyone of Mr. Holmes's competence would make it, if some experience in teaching had shown him the needs and difficulties of engineering students. It is a little to be feared that Mr. Holmes's book is marred by an attempt in part to adapt it to the requirements of some existing examinations on the steam-engine, which are more scrappy and less scientific than the worst of existing text-books. If only a really adequate practical and elementary text-book were written, it would control the examinations instead of needing to be adapted to them.

The treatise includes the mechanics, the thermodynamics, and rules for the design of steam-engines. The portions included under the last head are by far the weakest portions of the book. The scattered discussions of the strength of some portions of engines and boilers are too vague and general to be of practical value. The rules for the strength of fly-wheels at p. 246, and that for area of steam passages at p. 204, are examples of the kind of useless rules which stop short of encountering any one of the actual difficulties of ordinary designing. It is just these portions of the book which seem designed to meet the exigencies of a student cramming for an examination, and the book would be improved by their omission. An elementary treatise on the steam-engine might well leave questions of design on one side, and confine itself to a descriptive account of engines and boilers, with theory enough to explain the actions involved. But then it is neither necessary nor useful in such a treatise to introduce elementary physics and mechanics. A technical student may be assumed to know elementary science. "I have not assumed," says the author, "the slightest acquaintance on the part of the reader with the sciences of heat and motion, and have consequently devoted many pages to the explanation of such parts of these sciences as are necessary for the proper understanding of the working of engines." Hence we find a chapter on the nature of heat, including a discussion of the melting of ice, and the graduation of thermometers. There are definitions of mass, weight, force, and velocity, and arithmetical examples of the laws of motion. Surely all this would only be justifiable in an age when elementary books were scarce and dear. An ordinary student finds it a tiresome obstruction, when the way to the subject of the book is barred by such repetition. On the other hand, a brief but clear and critical account of the methods by which Regnault determined the fundamental constants for steam would have been very useful. It would have shown both the meaning of the terms used, and the probable trustworthiness of the determinations. In place of this, we find only verbal definitions and formulæ.

The thermodynamical portion of the book is probably its best and clearest part, and that in which it is most in advance of any quite elementary book of a similar kind. It must be understood that in criticizing this portion we do not ignore the fact that the author has done a service to elementary technical students.

On p. 67 a diagram is copied from Maxwell, and called a diagram of isothermals of dry saturated steam. It has escaped the author that for dry saturated steam there is no isothermal. At a point in the curve, say at 212°, the steam is saturated: on one side of this it is a mixture of steam and water, or conventionally wet steam; on the other side it is superheated steam. The saturation curve so useful in steam-engine calculations is nowhere mentioned. Further, in any modern treatment of the steam-engine it ought to be recognized that the engineer is always or almost always dealing not with dry saturated steam but with wet steam. The algebraical expressions for the total heat, &c., of wet steam should be introduced along with those for dry steam. Curiously, nowhere in this book can we find an expression for the latent heat of steam, though no quantity is so often required. The total heat is given, and so the latent heat can be inferred, but surely the ordinary approximate expression for latent heat is also useful.

In Chapter III. the theory of perfect engines is given. Following the precedent of treatises of wider scope, the author begins with the laws of expansion of permanent gases. Next the theorem about a reversible engine is given, but in a form in which it is restricted to the case of an air-engine. The efficiency of the reversible engine so obtained is afterwards spoken of as the efficiency of perfect heat-engines in general. But the independence of the result on the nature of the fluid employed is nowhere indicated. The diagram for a perfect steam-engine is given on p. 113. But no elementary student will perceive why the efficiency of this is the same as that of the air-engine, at least without explanation. The only idea ordinary students get from the theorem about the Carnot engine is that the efficiency of *any* engine is proportional to the range of temperature in the cylinder. In the case of the actual steam-engine this is so wrong as to be nearly the reverse of the truth, and the misconception is hardly anywhere adequately guarded against. It is very doubtful whether the Carnot engine ought to be introduced into the elementary theory of the steam-engine. An ordinary indicator-diagram can be taken, and the relation of the heat expended to the heat utilized determined. From the feed measurement and indicator-diagram the steam liquefied at the end of admission and at exhaust can be ascertained. The heat expenditure corresponding to work of admission, expansion, and expulsion can be calculated. From the condenser measurement the heat abandoned can be found, and an estimate formed of the loss by radiation. Repeating the calculation for different degrees of expansion, and perhaps for cases of a jacketed and unjacketed cylinder, really clear notions will be formed of the relative importance of the processes going on in the engine. All this can be done in a perfectly elementary way, and the student will soon perceive that it is in the direct study of the losses of heat, and not in attempts to realize the conditions of a Carnot engine, that improvement is to be sought.

We fail to see the use of reviving the antiquated empirical treatment of Navier and de Pambour given in Chapter IV. De Pambour's equations involve so many assumed quantities that they are practically useless. The author might have remembered that contrary to de Pambour's view the friction of an engine is not proportional to the load, but very nearly independent of it.

Chapter V. deals with the mechanics of the engine. But the simplest graphic methods for finding curves of crank pin effort and acceleration are not given. The next chapter, on slide-valve diagrams, is one of the clearest and most useful in the book.

In Chapter XI. the very difficult question of cylinder condensation is treated on the whole clearly and with insight. But the obscurities of this difficult part of the explanation of the steam-engine are, as might be expected, not quite removed. The author probably attaches much too great importance to radiation from the cylinder sides to the steam, and too little to conduction from the cylinder sides to the water lying on its surface. The following passage will certainly puzzle a student:—

"The second cause—excess of condensation over re-evaporation—is a most fruitful source of waste, and should be most carefully guarded against. It results in the continuous accumulation of water in the cylinder, and consequently causes an amount of waste which goes on increasing with each stroke."

Of course, if the accumulation is continuous the cylinder must get full, which is impossible. In steady working, initial condensation must exactly equal re-evaporation and water carried mechanically to the condenser. Priming and condensation during expansion may for the argument be neglected. What is prejudicial is not excess of condensation over re-evaporation, but retention of water in the cylinder after exhaust.

THE ANIMAL ALKALOIDS.

On the Animal Alkaloids, the Ptomaïnes, Leucomaïnes, and Extractives in their Pathological Relations. By Sir William Aitken, Knt., M.D., F.R.S., Professor of Pathology in the Army Medical School. (London: H. K. Lewis, 1887.)

A Treatise on the Animal Alkaloids, Cadaveric and Vital; or, The Ptomaïnes and Leucomaïnes chemically, physiologically, and pathologically considered in Relation to Scientific Medicine. By A. M. Brown, M.D. With an Introduction by Prof. Armand Gautier, of the Faculté de Médecine of Paris, &c. (London: Baillière, Tindall, and Cox, 1887.)

THE advancement of modern chemistry has increased our knowledge of the alkaloids occurring in the vegetable kingdom—bodies which are of great importance both in a therapeutical and a toxicological aspect. Since the year 1872, a new mode of natural origin of alkaloids has been discovered, viz. from animal sources, and the knowledge and investigation of these bodies have proved of great service in the study of both physiological and pathological chemical processes.

Ptomaïnes were first discovered in decomposing animal tissues, as their pseudonym of "cadaveric alkaloids" implies. Their presence in these dead tissues introduced a new factor in the *post-mortem* search for poisons in suspected cases—a factor, however, the importance of which has been somewhat exaggerated. A more important result of their discovery has been the explanation of the cases of poisoning by decayed animal foods, such as sausages, tinned and putrid meats, in which they have been found.

Further researches have, moreover, brought to light the fact that similar bodies of an alkaloidal nature may be produced within, and by, the living organism. In this case they may be considered as of "vital" origin, the products, that is, of the metabolism of protoplasm; or they may, in some cases, be the result of the decomposition of albuminoid bodies: in both cases, the term "leucomaïnes" has been used to designate them. A leucomaïne—peptotoxin—has, for example, been found by Brieger as a product of artificial peptic digestion; another has been discovered in the body of the sea-mussel (*Mytilus edulis*), and to its presence were ascribed the symptoms of poisoning which occurred in Wilhelmshaven, in many people who had eaten the shell-fish. These facts, of the origin of poisonous alkaloids by the decomposition of albuminoid bodies, and also in the living animal tissues, open out a wide field of research in pathology, and have perhaps led to more speculation than our present knowledge warrants.

The two books before us deal with the whole subject of poisonous alkaloids. Sir W. Aitken's small work owes its origin to an introductory lecture delivered by him at the Army Medical School at Netley. It is chiefly a short *résumé* of the work done on the subject. The second part of the *brochure* will be found of interest to medical men, as it gives the direction in which modern thought is tending with regard to the part played by poisonous alkaloids in the production of disease. The conclusions drawn can, in the present state of our knowledge, be considered merely as suggestions: many more facts must come to light before the *rôle* played by the "vital" alkaloids in pathological processes can be adequately, or even reasonably, discussed.

Dr. Brown's work is of a more ambitious nature, and purports to be a treatise on the subject of animal alkaloids generally. After commencing with a short history of the subject, the author proceeds to give an account of the methods for extraction of the alkaloids, and of the chemical and physiological properties of ptomaïnes; the "vital" alkaloids, leucomaïnes, being treated in a similar manner. The account of the methods of extraction might, we think, be made more practical by being considered a little more fully, as it is to this part of the book that workers in this field will turn for information.

Of the chemical and physiological properties of these alkaloids, a fairly complete account is given: our knowledge of these properties is, however, up to the present so imperfect, that the researches carried on during the last sixteen years only serve as a basis for future work. Much has yet to be done regarding the physiological action of these bodies; and no progress can be made in this respect until the alkaloids have been extracted in a pure state. It is almost useless, in the interests of science, to speak of the action of alkaloids extracted by various reagents; though, in certain cases of poisoning, the investigation of such an action may be of immediate utility. Dr. Brown has devoted much space to the consideration of the part played by the vital alkaloids in physiological or pathological conditions. In his account he has closely followed the views of M. Gautier, whose researches have thrown great light on the subject.

Dr. Brown's work may be recommended as giving a general account of the present state of our knowledge regarding these alkaloids. S. H. C. M.

PRACTICAL FORESTRY.

Practical Forestry: its Bearing on the Improvement of Estates. By Charles E. Curtis, F.S.T., F.S.S., Professor of Forestry, Surveying, and General Estate Management at the College of Agriculture, &c. (London: *Land Agent's Record* Office, 1888.)

THE present work is described as a reprint of a series of papers on "Practical Forestry," which appeared in the *Land Agent's Record*, and the author's object in republishing his ideas on practical forestry is to promote and encourage the study of true forestry among the British land-owners and land agents, and especially to impress upon students the necessity of acquiring a sound practical knowledge of a branch of land economy so long neglected and ignored. So far so good; but when the author says, "I trust this publication will be the means of spreading this object more widely" (*sic*), we fear that he will be grievously disappointed.

To begin with: the book is written in doubtful English. Though the correct use of the English language is not absolutely essential, yet in order to be a really useful work, a book should be written in language which complies with the ordinary grammatical rules, and which is also intelligible to the class of readers expected to profit by its perusal. The whole book is conceived in a very narrow spirit, and the expressed views of the author are frequently open to question. Take for instance the following passage (p. 40):—

"The great and true principle of thinning is to encourage the growth of those trees which are left, and not to secure a financial present return. This, though important, is quite a secondary consideration, and should at all times be ignored."

We beg to say that the great and true principle of thinning is nothing of the kind. In every instance the owner, or his manager, must consider what the objects of his management are. They may be:—

(1) To produce material of a certain description.

(2) To produce the greatest possible number of cubic feet per acre and year.

(3) To secure the highest possible money return from the property.

(4) To secure the highest possible interest on the invested capital.

(5) To improve the landscape, or to affect the climate, &c.

In each of these cases the method of thinning will be different.

Again, the description given of a true forester (p. 12) is somewhat illusory. If the author thinks that a man who has studied botany, vegetable physiology, geology, entomology, &c., is also able to wield the axe, and use with skill the pruning saw or knife, he is likely to be disappointed in nine cases out of ten. Such ideas are theoretical speculations, and not the result of practical experience.

The chapter on "Soil and Site" is of a very hazy description whenever the author attempts to rise above ordinary platitudes. He promises to describe clearly in future sections the nature of the soils and sites in which the individual trees most delight, but, as far as we can see, he has got over the difficulty by omitting to redeem his promise.

To sum up, the book is not likely to further the object which the author seems to have at heart. The experienced forester will find nothing new in it, and the beginner will only meet with badly arranged statements which are frequently not in accordance with the teaching of science or of practice. Sw.

OUR BOOK SHELF.

Tropical Africa. By Henry Drummond. (London: Hodder and Stoughton, 1888.)

THIS is a brightly-written and most interesting sketch of Mr. Drummond's experiences during a recent journey in East Central Africa. He has no very surprising or exciting adventures to describe, but in the course of his narrative, which is written with a vigour and grace unusual in books of travel, he contrives to convey a remarkably vivid impression of the country through which he passed. Going up the valley of the Shiré River, he visited Lake Shirwa, of which little has hitherto been known; then he went on to Lake Nyassa, and to the plateau between Lake Nyassa and Lake Tanganyika. During the whole of his journey he was a close observer, not only of the physical features of the districts he visited, but of the various classes of phenomena which interested him as a geologist, an ethnographer, and a student of natural history. In one admirable chapter he gives a full and striking account of the white ant, which he had frequent opportunities of studying; in another he brings together many curious illustrations of the well-known fact that among numerous species of animals mimicry is one of the means of self-protection. Before going to Africa, Mr. Drummond had mentally resolved not to be taken in by "mimetic frauds," yet he was "completely stultified and beaten" by the first mimetic form he met. This was an insect—one of the family of the *Phasmidæ*—exactly like a wisp of hay. Another insect, which he often saw, closely resembles a bird-dropping, and the consequence is that "it lies fearlessly exposed on the bare stones, during the brightest hours of the tropical day, a time when almost every other animal is skulking out of sight." Mr. Drummond has of course much to say about the chances of a great future for Africa, and in this connection he presents a good deal of valuable information as to the capacity of the natives for work and as to the wrongs inflicted upon them by vile gangs of slave-traders.

Plotting, or Graphic Mathematics. By R. Wormell, D.Sc., M.A. (London: Waterlow and Sons, Limited, 1888.)

THIS book is intended chiefly for those who have mastered the beginnings of algebra and Euclid, and so is very elementary. The method employed throughout is that of using squares, and preparatory exercises are first given to show the student the different purposes to which they may be applied with facility. Proportion and the determination of areas are the subjects of the first two chapters, followed by a chapter on the tracing of paths of projectiles, with various data. The sections of the cone, such as the parabola, ellipse, and hyperbola, are next described, with various methods of tracing them. The book contains a great number of numerical examples, and concludes with a chapter on the higher graphs and curves of observation.

The Elements of Logarithms. By W. Gallatly, M.A. (London: F. Hodgson, 1888.)

IN this little book of thirty-one pages the various rules and methods of treating logarithms are stated and explained in a simple and precise way, and those beginning the subject would do well to read through these few pages. Numerous examples are put in here and there, and at the end the author has added a collection of questions taken from the Woolwich and Sandhurst examination papers for the years 1880–87.

LETTERS TO THE EDITOR.

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Thunderstorms and Lightning Accidents.

As the season of thunderstorms and lightning accidents is now approaching, I hope you will kindly allow me to make known through your columns the fact that, in the interests of science, the Institute of Medical Electricity is very desirous of obtaining authentic information concerning lightning accidents, whether fatal or otherwise. I should therefore esteem it a favour if some of the many friends of humanity among your readers will assist us to investigate these phenomena by sending me such particulars of accidents of this nature as they may have personal or trustworthy knowledge of as soon after they occur as possible.

Of course, electrical and physiological details are what we most require, but trustworthy general information is often valuable, and will be gratefully received.

24 Regent Street, S.W. H. NEWMAN LAWRENCE.

Nose-Blackening as Preventive of Snow-Blindness.

I ONLY read Prof. Ray Lankester's letter the other day on the above, which appeared in NATURE of May 3 (p. 7). I have made inquiries among travellers in the snow regions of North America, and find the practice to be quite common and well known, but have met with no one who can explain it. I may say, however, that when I visited New Zealand in 1884 there were in one of the canoes which came off to our ship several naked natives, who had disfigured their faces by blackening their noses and eyes, and running a black fillet round the face, which gave them a villainous aspect; and I, in that insolent ignorance which seems to prevail with all pious people who have dealings with "the heathen of the isles," believed they had got themselves up in this way in order to frighten us. But it may well have been for other reasons. Certainly the sun's heat, reflected from the still waters of the sea, was quite as painful as any I ever felt in the regions of the silver snow. I subsequently found that the black used by these people, who are of a pale complexion, was the oxide of manganese, called in their tongue *labán.*

A. J. DUFFIELD.

The Delaware, Keweenaw Michigan, U.S.A., June 4.

The *Lethrus cephalotes.*

THE beetle which is described in your issue of June 7 (p. 134), by the British Consul at Varna, is probably the *Lethrus cephalotes,* which has proved so destructive to vineyards in East and South-East Europe. It is a dull black beetle, easily recognized by the swollen truncated ends of the antennæ; its length is about 21 mm. It lives chiefly in dry and sandy soil, and during dry weather the beetles leave their holes generally between nine and eleven in the morning and after three in the afternoon, to attack the tender parts of the vine, as Mr. Brophy describes.

Taschenberg is of the opinion that the buds, &c., of the vine which are dragged back to the holes of the beetles serve as food for the larvæ. As the beetles show a marked aversion to water, it is possible that the pest might be lessened by copiously watering the infected areas. ARTHUR E. SHIPLEY.

Christ's College, Cambridge, June 16.

Proposed Fuel-testing Station for London.

WILL you allow me to put before your readers the following proposition for the establishment of such a station, the desirability of which has been much impressed upon me within the last few years? So far as I know, there does not exist anything of the kind in this country where, as on the Continent, coals can be tested for their evaporative power, the gases of combustion analyzed, and all the results carefully reported on by experts. I subjoin a few details of the proposed station, with probable cost. It should, I consider, be placed on a perfectly independent footing, and managed by experts, under a small committee appointed by those who assist with money or otherwise. It might follow generally the lines of existing coal-testing stations, but with all modern improvements.

In this country it is remarkable that neither the sellers of coal take the trouble to find out how much heat they are offering, nor the purchasers how much they are getting for their money, and this notwithstanding the hundreds of millions of tons of coal changing hands yearly. Colliery-owners and coal-merchants, as well as the large consumers, know very little about coal calorimeters, although the former sell so much heat, and the latter try to utilize it to the best advantage. How few of the latter weigh their coal regularly, or keep any weekly record of the quantities of ashes and clinkers, to find out how much dirt and incombustible matter they are paying for! How few know what it costs them in fuel to evaporate one thousand gallons of water into steam, which is one of the best standards of comparison in a given district!

Locality.—The station might be in close proximity to a river, canal, or railway-station, so that the coals could be delivered easily and cheaply, and the steam allowed to escape under pressure without causing annoyance. A small piece of land doubtless could be obtained in such a situation at a low rent. The boiler-shed should be about 35 × 20 feet, with a small additional shed for storing the fuel.

Cost.—It would be desirable to allow at least £700 for a start, to cover the cost of the boiler-shed, chimney, 20 horse-power boiler (if such were considered large enough), and the special arrangements for measuring the feed-water with tanks, scales, feed-pump, injector, gas and coal analyzing apparatus, calorimeters, &c. Seeing that until the objects of the station become known it would probably not pay expenses, the help of guarantors would no doubt be necessary.

Yearly Expenses.—The charge for testing and reporting upon each combustible would probably more than cover eventually the salaries of a technical manager, his assistant, and the stoker. Some arrangement might possibly be made by which the manager and his assistant should only attend when required, at any rate at first, in order to diminish expenses.

The station would require to be advertised and made known in various ways. Colliery-owners would no doubt find it to their advantage to have their different kinds of coal tested and reported upon, so as to offer them to their customers with their ascertained heating value or evaporative power. Large consumers of coal (railway companies, water-works, and others) should know the heating value of the coal they are paying for, and the percentage of incombustibles.

I add a few notes on the temporary and permanent experimental heat stations known to me.

(1) The earliest fuel-testing station was established in 1847 at Brix, in Germany.

(2) Sir H. de la Beche and Dr. Lyon Playfair made a series of

experiments before the year 1851 with different coals suitable for the Navy. These trials were conducted near London, under a small marine boiler at atmospheric pressure.

(3) At the English Government dockyards, various interesting experiments have been made under small marine boilers, and the results published in Blue-books.

(4) Messrs. Armstrong, Longridge, and Richardson published in 1858 an account of some valuable experiments they had made with the steam-coals of the Hartley district of Northumberland, under a small marine boiler, for the Local Steam Colliery Association.

(5) At Wigan many excellent experiments were made by Messrs. Richardson and Fletcher about 1867, to test the value of Lancashire and Cheshire steam-coals for use in marine boilers. The water was evaporated under atmospheric pressure from a small marine boiler. This station was afterwards abolished.

In none of the above do the gases of combustion appear to have been analyzed.

(6) A fuel-testing station was worked at Dantzig in 1863.

(7) An important station was opened at Brieg, on the Oder, by the colliery-owners of Lower Silesia in April 1878, with the primary object of testing the value as fuel of the important coal-seams of that province. After working with the most satisfactory results for two years, and establishing the superiority of the Lower Silesian coal, the experiments terminated in 1880. The testing boilers had each 40 square metres of heating surface. Gases and coals were analyzed.

Existing Continental Stations.—(8) The Imperial Naval Administration Coal-testing Station at Wilhelmshaven, Germany, was established in 1877.

(9) Dr. Bunte's coal-testing station, erected at Munich about 1878, particulars of which have been published in the Proceedings of the Institution of Civil Engineers, vol. lxxiii. Here some hundreds of trials have been reported on and published; much valuable work has been done, and many fuels tested, including coals of the Ruhr valley, Saar basin, Saxon and Bohemian coal-fields, and those of Silesia and Upper Bavaria. The boiler of the station has about 450 square feet of heating surface. The gases and coals are analyzed, and all particulars carefully noted. It is one of the most complete stations I have seen.

(10) In Belgium, near Brussels, there is a Government station for testing fuels, under the administration of the Belgium State railways; locomotive boilers are used. The establishment has been at work for the last two years, but no results are published, as they are considered the property of the Government. Private firms can, however, have their coals tested and reported upon.

(11) The Imperial Marine Station, Dantzig.

(12) Boiler Insurance Company at Magdeburg.

The above is a slight outline of the work already done in this direction.

With the view of obtaining the opinions of those interested in starting a fuel-testing station, I ask you kindly to give this letter publicity. If the necessary sum can be raised, we may hope to have before long a practical and useful establishment in London, and to gain from it many interesting practical results respecting the combustion of fuels. BRYAN DONKIN, JUN.

Bermondsey, S.E., June 11.

The Geometric Interpretation of Monge's Differential Equation to all Conics—the Sought Found.

THE question of the true geometric interpretation of the Mongian equation has been often considered by mathematicians. In the first place, we have the late Dr. Boole's statement that "here our powers of geometrical interpretation fail, and results such as this can scarcely be otherwise useful than as a registry of integrable forms" ("Diff. Equ.," pp. 19–20). We have next two attempts to interpret the equation geometrically. The first of these propositions, by Lieut.-Colonel Cunningham, is that "the eccentricity of the osculating conic of a given conic is constant all round the latter" (*Quarterly Journal*, vol. xiv. 229); the second, by Prof. Sylvester, is that "the differential equation of a conic is satisfied at the sextactic points of any curve" (*Amer. Journ. Math.*, vol. ix. p. 19). I have elsewhere considered both these interpretations in detail, and I have pointed out that both of them are irrelevant; the first of them is, in fact, the geometric interpretation, not of the Mongian equation, but of one of its five first integrals which I have actually calculated (Proc. Asiatic Soc. Bengal, 1888, pp. 74–86); the second is out of mark as failing to furnish such a property of the conic as would lead to a geometrical quantity which vanishes at every point of every conic (Journal Asiatic Soc. Bengal, 1887, Part 2, p. 143). In this note I will briefly mention the true geometric interpretation which I have recently discovered.

Consider the osculating conic at any point, P, of a given curve; the centre, O, of the conic is the centre of aberrancy at P, and as P travels along the given curve, the locus of O will be another curve, which we may conveniently call the *aberrancy curve*. Take rectangular axes through any origin; let (x, y) be the given point P, and α, β the co-ordinates of the centre of aberrancy. Then it can be shown without much difficulty that

$$\alpha = x - \frac{3qr}{3qs - 5r^2},$$

$$\beta = y - \frac{3q(pr - 3q^2)}{3qs - 5r^2},$$

whence

$$\frac{d\alpha}{dx} = \lambda T, \quad \frac{d\beta}{dx} = \mu T,$$

where

$$\lambda = \frac{r}{(3qs - 5r^2)^2}, \quad \mu = \frac{pr - 3q^2}{(3qs - 5r^2)^2},$$

$$T \equiv 9q^2t - 45qrs + 40r^3,$$

p, q, r, s, t being, as usual, the successive differential coefficients of y with respect to x.

If $d\psi$ be the angle between two consecutive axes of aberrancy, ds the element of arc, and ρ the radius of curvature of the aberrancy curve, we have

$$\rho = \frac{ds}{d\psi}, \quad ds^2 = d\alpha^2 + d\beta^2,$$

whence

$$\rho = (\lambda^2 + \mu^2)^{\frac{1}{2}} \,.\, T \,.\, \frac{dx}{d\psi}.$$

But it is easy to show that

$$\frac{d\psi}{dx} = \frac{q(3qs - 5r^2)}{r^2 + (rp - 3q^2)^2},$$

so that

$$\rho = T \,.\, \frac{\{r^2 + (rp - 3q^2)^2\}^{\frac{3}{2}}}{q(3qs - 5r^2)^3}.$$

Now, $T = 0$ is Monge's differential equation to all conics, and when $T = 0$ we have $\rho = 0$. Hence, clearly, the true geometric interpretation of the Mongian equation is:

The radius of curvature of the aberrancy curve vanishes at every point of every conic.[1]

This geometrical interpretation will be found to satisfy all the tests which every true geometrical interpretation ought to satisfy, and I believe that this is the interpretation which, during the last thirty years, has been sought for by mathematicians, ever since Dr. Boole wrote his now famous lines. I will not take up the valuable space of these columns with the details of calculation: they will be found fully set forth in two of my papers which will be read next month before the Asiatic Society of Bengal, and will in due course be published in the Journal.

Calcutta, May 18. ASUTOSH MUKHOPADHYAY.

PERSONAL IDENTIFICATION AND DESCRIPTION.[2]

I.

IT is strange that we should not have acquired more power of describing form and personal features than we actually possess. For my own part I have

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[1] The differential equation of all parabolas,

$$3qs - 5r^2 = 0,$$

is also easily interpreted, viz. calling the distance OP between the given point and the centre of aberrancy the *radius of aberrancy*, and the reciprocal of this (= I) the *index of aberrancy*, we have, easily,

$$I = \frac{3qs - 5r^2}{3q\{r^2 + (rp - 3q^2)^2\}^{\frac{1}{2}}},$$

so that the interpretation is that *the index of aberrancy vanishes at every point of every parabola.*

[2] The substance of a Lecture given by Francis Galton, F R.S., at the Royal Institution on Friday evening, May 25, 1888.

frequently chafed under the sense of inability to verbally explain hereditary resemblances and types of features, and to describe irregular outlines of many different kinds, which I will not now particularize. At last I tried to relieve myself as far as might be from this embarrasment, and took considerable trouble, and made many experiments. The net result is that while there appear to be many ways of approximately effecting what is wanted, it is difficult as yet to select the best of them with enough assurance to justify a plunge into a rather serious undertaking. According to the French proverb, the better has thus far proved an enemy to the passably good, so I cannot go much into detail at present, but will chiefly dwell on general principles.

Measure of Resemblance.—We recognize different degrees of likeness and unlikeness, though I am not aware that attempts have been as yet made to measure them. This can be done if we take for our unit the *least discernible difference.* The application of this principle to irregular contours is particularly easy. Fig. 1 shows two such contours, A and B, which might be meteorological, geographical, or anything else. They are drawn with firm lines, but of different strengths for the sake of distinction. They contain the same area, and are so superimposed as to lie as fairly one over the other as may be. Now draw a broken contour which we will call C, equally subdividing the intervals between A and B; then C will be more like A than B was. Again draw a dotted contour, D, equally subdividing the intervals between C and A; the likeness of D to A will be again closer. Continue to act on the same

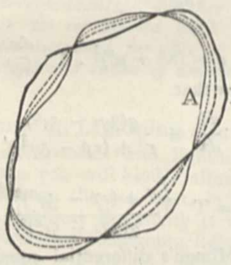

FIG. 1.

principle until a stage is reached when the contour last drawn is undistinguishable from A. Suppose it to be the fourth stage; then as $2^4 = 16$, there are 16 grades of least-discernible differences between A and B. If one of the contours differs greatly in a single or few respects from the other, reservation may be made of those peculiarities. Thus, if A has a deep notch in its lower right-hand border, we might either state that fact, and say that in other respects it differed from B by only 16 grades of unlikeness, or we might make no reservation, and continue subdividing until all trace of the notch was smoothed away. It is purely a matter of convenience which course should be adopted in any given case. The measurement of resemblance by units of least-discernible differences is applicable to shades, colours, sounds, tastes, and to sense-indications generally. There is no such thing as infinite unlikeness. A point as perceived by the sense of sight is not a mathematical point, but an object so small that its shape ceases to be discernible. Mathematically, it requires an infinitude of points to make a short line; sensibly, it requires a finite and not a large number of what the vision reckons as points, to do so. If from thirty to forty points were dotted in a row across the disk of the moon, they would appear to the naked eyes of most persons as a continous line.

Description within Specified Limits.—It is impossible to verbally define an irregular contour with such precision that a drawing made from the description shall be undistinguishable from the original, but we may be content with a lower achievement. Much would be gained if we could refer to a standard collection of contours drawn with double lines, and say that the contour in question falls between the double lines of the contour catalogued as number so-and-so. This would at least tell us that none of the very many contours that fell outside the specified limits could be the one to which the description applied. It is an approximate and a negative method of identification. Suppose the contour to be a profile, and for simplicity's sake let us suppose it to be only the portion of a profile that lies below the notch that separates the brow from the nose and above the parting between the lips, and such as is afforded by a shadow sharply cast upon the wall by a single source of light, such as is excellently seen when a person stands side-ways between the electric lantern and the screen in a lecture-room. All human profiles of this kind, when they have been reduced to a uniform vertical

FIG. 2.

scale, fall within a small space. I have taken those given by Lavater, which are in many cases of extreme shapes, and have added others of English faces, and find that they all fall within the space shown in Fig. 2. The outer and inner limits of the space are of course not the profiles of any real faces, but the limits of many profiles, some of which are exceptional at one point and others at another. We can classify the great majority of profiles so that the whole of each class shall be included between the double borders of one, two, or some small number of standard portraits such as Fig. 3. I am as yet unprepared to say how near together the double borders of such standard portraits should be; in other words, what is the smallest number of grades of unlikeness that we can satisfactorily deal with. The process of sorting profiles into their proper classes and of gradually

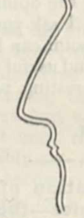

FIG. 3.

building up a well-selected standard collection, is a laborious undertaking if attempted by any obvious way, but I believe it can be effected with comparative ease on the basis of measurements, as will be explained later on, and by an apparatus that will be described.

Classification of Sets of Measures.—Prisoners are now identified in France by the measures of their heads and limbs, the set of measures of each suspected person being compared with the sets that severally refer to each of many thousands of convicts. This idea, and the practical application of it, is due to M. Alphonse Bertillon. The actual method by which this is done is not all that could be theoretically desired, but it is said to be effective in action, and enables the authorities quickly to assure themselves whether the suspected person is or is not an old malefactor. The primary measures in the classification are four—

namely, the head length, head breadth, foot length, and middle-finger length of the left foot and hand respectively. Each of these is classified according as it is large, medium, or small. There are thus three, and only three, divisions of head lengths, each of which is subdivided into three divisions of head breadth ; again, each of these is further subdivided into three of foot length, and these again into three of middle-finger length ; thus the number of primary classes is equal to three multiplied into itself four times—that is to say, their number is eighty-one, and a separate pigeon-hole is assigned to each. All the exact measures and other notes on each criminal are written on the same card, and this card is stored in its appropriate pigeon-hole. The contents of each pigeon-hole are themselves sub-sorted on the same principle of three-fold classification in respect to other measures. This process can, of course, be extended indefinitely, but how far it admits of being carried on advantageously is another question. The fault of all hard-and-fast lines of classification, when variability is continuous, is the doubt where to find values that are near the limits between two adjacent classes. Let us take the case of stature, for

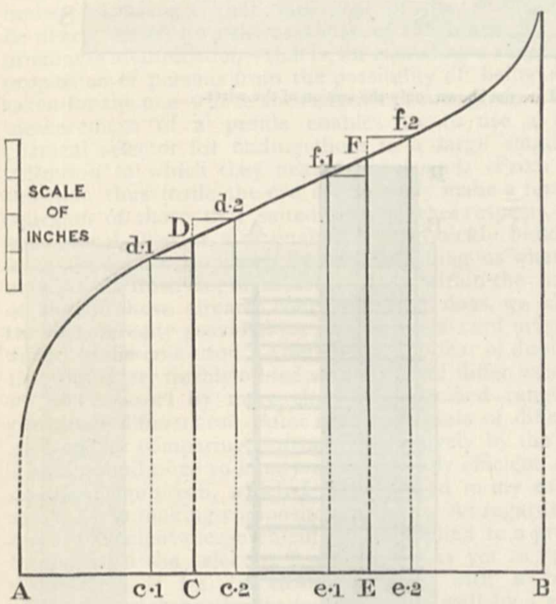

FIG. 4.

illustration of what must occur in every case, representing its distribution by what I have called a " scheme," as shown in Fig. 4.

Here the statures of any large group of persons are represented by lines of proportionate length. The lines are arranged side by side at equal distances apart on a base, A B, of convenient length. A curve drawn through their tops gives the upper boundary of the scheme ; the lines themselves are then wiped out, having served their purpose. If the base A B be divided into three equal parts, and perpendiculars, C D, E F, be erected at the divisions between them, reaching from the base up to the curve, then the lengths of those perpendiculars are proportionate to the limiting values between the small and the medium group, and the medium and the large group, respectively. The difference between these perpendiculars in the case of stature is about 2·3 inches. In other words, the shortest and tallest men in the medium class differ only by that amount. We have next to consider how much ought reasonably to be allowed for error of measurement. Considering that a man differs in height by a full third of an inch between the time of getting up in the morning and lying down at night ; considering also that measures are recorded to the nearest tenth of an inch at the closest, also the many uncertainties connected with the measurement of stature, it would be rash not to allow for a possible error of at least ± half an inch. Prolong C D, and note the points upon it at the distance of half an inch above and below D ; draw horizontal lines from those points to meet the curve at *d*.1, *d*.2, and from the points of intersection drop perpendiculars reaching the base at *c*.1, *c*.2. A similar figure is drawn at F. Then the ratio borne by the uncertain entries to the whole number of entries is as $c_1c_2 + e_1e_2$ to AB. This, as seen by the diagram, is a very serious proportion. There is a dilemma which those who adopt hard-and-fast lines of classification cannot avoid : either the fringe of uncertainty is dangerously wide, or else the delicacy with which measures are made is not turned to anything like its full account. If the delicacy is small, the fringe of uncertainty must be very wide ; if the delicacy is great, the fringe will be narrow ; but then the other advantages of possessing delicate observations are wasted through employing only a few classes. The bodily measurements are so dependent on one another that we cannot afford to neglect small distinctions. Thus long feet and long middle-fingers usually go together. We therefore want to know whether the long feet in some particular person are accompanied by particularly long, or moderately long, or relatively short fingers, though the fingers may in the two last cases be long as compared with those of the general population, and will be treated as long in M. Bertillon's system of classes. Certainly his eighty-one combinations are far from being equally probable. The more numerous the measures the greater would be their interdependence, and the more unequal would be the distribution of cases among the various possible combinations of large, small, and medium values. No attempt has yet been made to estimate the degree of their interdependence. I am therefore having the above measurements (with slight necessary variation) recorded at my anthropometric laboratory for the purpose of doing so. This laboraiory, I may add, is now open to public use under reasonable restrictions. It is entered from the Science Collections in the Western Galleries at South Kensington.

Mechanical Selector.—Feeling the advantage of possessing a method of classification that did not proceed upon hard-and-fast lines, I contrived an apparatus that is quite independent of them, and which I call a mechanical selector. Its object is to find which set out of a standard collection of many sets of measures, resembles any one given set within specified degrees of unlikeness. No one measure in any of the sets selected by the instrument can differ from the corresponding measure in the given set, by more than a specified value. The apparatus is very simple, it applies to sets of measures of every description, and ought to act on a large scale with great rapidity, and as well as it does on a small one, testing several hundred sets by each movement. It relieves the eye and brain from the intolerable strain of tediously comparing a set of many measures with each successive set of a large series, in doing which a mental allowance has to be made for a *plus* or *minus* deviation of a specified amount in every entry. It is not my business to look after prisoners, and I do not fully know what need may really exist for new methods of quickly identifying suspected persons. If there be any real need, I should think that this apparatus, which is contrived for other purposes, might, after obvious modifications, supply it.

The apparatus consists of a large number of strips of card or metal, *c*1, *c*2 (Fig. 5), say 8 or 9 inches long, and having a common axis, A, passing through all their smaller ends. A tilting-frame, T, which turns on the same axis, has a front cross-bar, F, on which the tips of the larger ends of all the cards rest whenever the machine is left alone. In this condition a counterpoise at the other end of T suffices to overcome the weight of all the cards, and this heavy end of T lies on the base-board S. When the heavy end of T is lifted, as in Fig. 5, its front-bar is of course depressed, and the cards being individually acted on by their own weights are free to descend with the cross-bar unless they are otherwise prevented. The lower edge of each card is variously notched to indicate the measures of the person it represents. Only four notches are shown in the figure, but six could easily be employed in a card of eight or nine inches long, allowing compartments of 1 inch in length, to each of six different measures. The position of the notch in the compartment allotted to it, indicates the corresponding measure according to a suitable scale. When the notch is in the middle of a compartment, it means that the measure is of mediocre amount; when at one end of it, the measure is of some specified large value or of any other value above that; when at the other end, the measure is of some specified small value or of any other value below it. Intermediate positions represent intermediate values according to the scale. Each of the cards corresponds to one of the sets of measures in the standard collection. The set of measures of the given person are indicated by the positions of parallel strings or wires, one for each measure, that are stretched

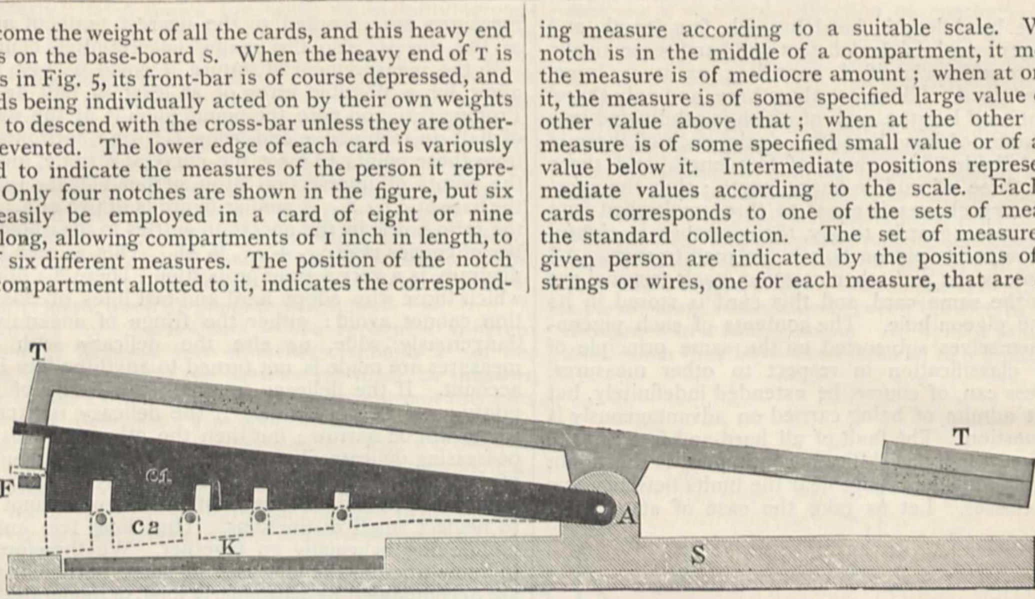

FIG. 5.—Section of the apparatus, but the bridge and rod are not shown, only the section of the wires.

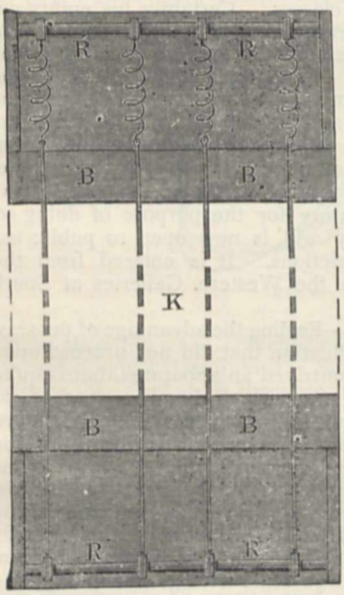

FIG. 6a.

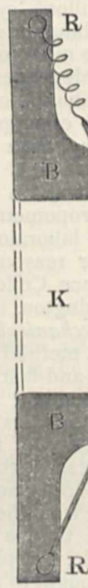

FIG. 6b.

Plan and section of the key-board K.

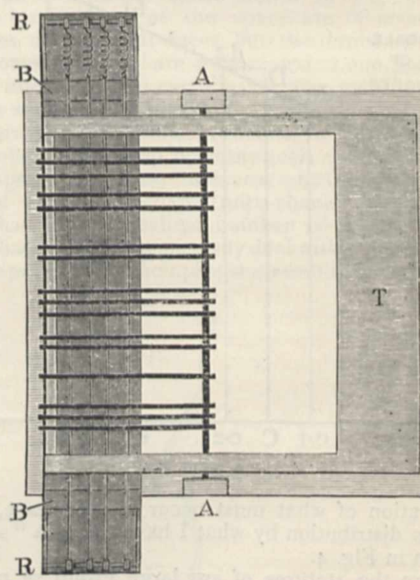

FIG. 7.—Reduced plan of complete apparatus.

Explanation:—A, the common axis; c_1, c_2, the cards; T, tilting-frame, turning on A (the cards rest by their front ends on F, the front cross-bar of T, at the time when the heavy hinder end of T rests on the base-board S); K, key-board, in which R, R are the rods between which the wires stretch; B, B, are the bridges over which the wires pass.

across bridges at either end of a long board set crossways to the cards. Their positions on the bridges are adjusted by the same scale as that by which the notches were cut in the cards. Figs. 6*a* and 6*b* are views of this portion of the apparatus, which acts as a key, and is of about 30 inches in effective length. The whole is shown in working position in Fig. 7. When the key is slid into its place, and the heavy end of the tilting-frame T is raised, all the cards are free to descend so far as the tilting-frame is concerned, but they are checked by one or more of the wires from descending below a particular level, except those few, if any, whose notches correspond throughout to the positions of the underlying wires. This is the case with the card c_2, drawn with a dotted outline, but not with c_1, which rests upon the third wire, counting from the axis. As the wires have to sustain the weight of all or nearly all the cards, frequent narrow bridges must be interposed between the main bridges to sustain the wires from point to point. The cards should be divided into batches by partitions corresponding to these interposed bridges, else they may press sideways with enough friction to interfere with their free independent action. Neither these interposed bridges nor the partitions are drawn in the figure. The method of adjusting the wires there shown is simply by sliding the rings to which they are attached at either end, along the rod which passes through them. It is easy to arrange a more delicate method of effecting this if desired. Hitherto I have snipped out the notches in the cards with a cutter made on the same principle as that used by railway guards in marking the tickets of travellers. The width of the notch is greater than the width of the wire by an amount proportionate to the allowance intended to be made for error of measurement, and also for that due to mechanical misfit. There is room for 500 cards or metal strips to be arranged in sufficiently loose order within the width of 30 inches, and a key of that effective length would test all these by a single movement. It could also be applied in quick succession to any number of other collections of 500 in each.

Measurement of Profiles.—The sharp outline of a photograph in profile admits of more easy and precise measurement than the yielding outline of the face itself. The measurable differences between the profiles of different persons are small, but they are much more numerous than might have been expected, and they are more independent of one another than those of the limbs. I suspect that measures of the profile may be nearly as trustworthy as those of the limbs for approximate identification—that is, for excluding a very large proportion of persons from the possibility of being mistaken for the one whose measurements are given. The measurement of a profile enables us to use a mechanical selector for finding those in a large standard collection to which they nearly correspond. From the selection thus made the eye could easily make a further selection of those that suited best in other respects. A mechanical selector also enables us to quickly build up a standard collection step by step, by telling us whether or no each fresh set of measures falls within the limits of any of those already collected. If it does, we know that it is already provided for; if not, a new card must be added to the collection. There will be no fear of duplications, as every freshly-added standard will differ from all its predecessors by more than the specified range of permitted differences. After numerous trials of different methods for comparing portraits successively by the eye, I have found none so handy and generally efficient as a double-image prism, which I largely used in my earlier attempts in making composite portraits. As regards the most convenient measurements to be applied to a profile for use with the selector, I am unable as yet to speak decidedly. If we are dealing merely with a black silhouette, such as the shadow cast on a wall by a small or brilliant light, the best line from which to measure seems to be B C in Fig. 8; namely, that which touches both the concavity of the notch between the brow and nose, and the convexity of the chin. I have taken a considerable number of measures from the line that touches the brow and chin, but am now inclined to prefer the former line. A sharp unit of measurement is given by the distance between the above line and another drawn parallel to it just touching the nose, as at N in the figure. A small uncertainty in the direction of B C has but a very trifling effect on this distance. By dividing the interval between these parallel lines into four parts, and drawing a line through the third of the divisions, parallel to B C, we obtain the two important points of reference, M and R. M is a particularly well-defined point, from which O is determined by dropping a perpendicular from M upon B C. O seems the best of all points from which to measure. It is excellently placed for defining the shape and position of the notch between the nose and the upper lip, which is perhaps the most distinctive feature in the profile. O L can be determined with some precision; O B and O C are but coarse measurements. In addition to these and other obvious measures, such as one or more to define the projection of the lips, it would be well to measure the radius of the circle of curvature of the depression at B, also of that between the nose and the lip, for they are both very variable and very distinctive. So is the general slope of the base of the nose. The difficulty lies not in selecting a few measures that will go far towards negatively identifying a face, but in selecting the best—namely, those that can be most precisely determined, are most independent of each other, most variable, and most expressive of the general form of the profile. I have tried many different sets, and found all to be more or less efficient, but have not yet decided to my own satisfaction which to adopt.

A closer definition of a profile or other curve, can be based upon the standard to which it is referred. Short cross-lines may be drawn at critical positions between the two outlines of the standard, and be each divided into eight equal parts. The intersection of the cross-lines with the outer border would always count as 0, that with the inner border as 8, and the intermediate divisions would count from 1 to 7. As the cross-lines are very short, a single numeral would thus define the position of a point in any one of them, with perhaps as much precision as the naked eye could utilize. By employing as

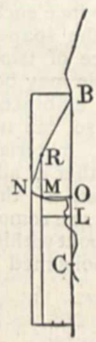

Fig. 8.

many figures as there are cross-lines in the standard, each successive figure for each successive cross-line, a corresponding number of points in the profile would be accurately fixed. Suppose a total of nine figures to be given, together with a standard collection of under a thousand doubly outlined portraits, each with six cross-lines. The first three figures would specify the catalogue number of the portrait to be referred to, and the remaining six figures would determine with much accuracy, six points in the outline of the portrait that it is desired to describe.

I have not succeeded in contriving an instrument that shall directly compare a given profile with those in a standard collection, and which shall at the same time act with anything like the simplicity of the above, and with the same quick decision in acceptance or rejection. Still, I recognize some waste of opportunity in not utilizing the power of varying the depths of the notches in the cards, independently of their longitudinal position.

I shall have next to speak of other data that may serve for personal identification, and especially on the marks left by blackened finger-tips upon paper.

(*To be continued.*)

SOAP-BUBBLES.

SOAP-BUBBLES fill the same happy position as do those charming books in which Lewis Carroll describes the adventures of Alice, in that they serve equally to delight the young and to attract the old. Clerk-Maxwell has mentioned the fact that on an Etruscan vase in the Louvre are seen the figures of children amusing themselves with bubbles, while to-day the same subject is being forced on the attention of the world by a strange development of modern enterprise. On the other hand, the bubble has occupied the minds of scientific men of all times. Sir Isaac Newton, Sir David Brewster, and Faraday, not to mention many others, devoted themselves to the soap-bubble as a means for investigating the subtleties of light. Plateau a few years ago delighted men of science with that wonderful book in which he, a blind man, expounded, in the clearest and most elegant manner, the result of years of labour on this one subject. Lately, Profs. Reinold and Rücker have employed the soap-film in investigations which tend to throw more light on the molecular constitution of bodies. These experiments will be remembered by all who saw them as being no less beautiful than instructive. The latest experiments with bubbles, which were shown by Mr. C. V. Boys to the Physical Society and at the Royal Society *conversazione*, and of which a full account is to be found in the May number of the *Philosophical Magazine*, depend upon no property which is not well known, and, unlike those referred to above, are not intended to increase our scientific knowledge; and yet no one would have ventured to predict that bubbles would submit to the treatment described in the paper, or would have expected such simple means to produce such beautiful results.

The first property of the soap-film turned to account is that strange reluctance of two bubbles to touch one another. Just as a bubble may be danced on the sleeve of a serge coat, or even embraced, without wetting the sleeve or being broken, so can two bubbles be pressed together until they are materially deformed without really touching one another at all. One bubble may be blown inside another, and if the heavy drops which accumulate at the bottom are removed, the inner one may be detached and rolled about within the outer one; or the outer one, held by two moistened rings of wire (Fig. 1),

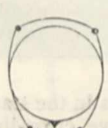

Fig. 1.

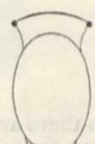

Fig. 2.

may be pulled out so as to squeeze the inner one into an oval form (Fig. 2), or may even be swung round and round, and yet the inner one remains free and independent, and when the outer is broken it floats gently away. If the inner one is coloured with the fluorescent material uranine, it shines with a green light, while the outer one remains clear as at first, showing that there is no mixture and no contact.

When the inner bubble is blown with coal gas, it rests against the upper side of the outer one (Fig. 3), pulling it

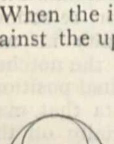

Fig. 3.

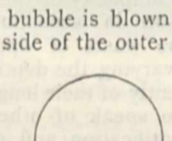

Fig. 4.

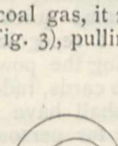

Fig. 5.

more and more out of shape as its size increases (Fig. 4). It can even be made to tear the outer one off the ring to which it was attached, after which the two bubbles rise in the air one inside the other. The outer bubble may be held by a light ring of thin wire to which thread and paper are attached, and then when an inner bubble of coal gas is blown, it will carry up the outer bubble, ring, paper, and all; and yet, in spite of this weight pressing them together, the inner bubble refuses to touch the outer one. If a little gas is let into the outer of two bubbles, the inner one will remain suspended like Mahomet's coffin (Fig. 5).

Diffusion of gas through a soap-film is shown by lowering a bell-jar of coal-gas over a bubble in which a second one is floating (Fig. 6). By degrees the gas penetrates the outer bubble, until the inner one, insufficiently buoyed up, gently sinks down.

The heavy and inflammable vapour of ether is made use of to show the rapidity with which the vapour of a liquid which will mix with the soap solution will penetrate through the walls of a bubble. A large

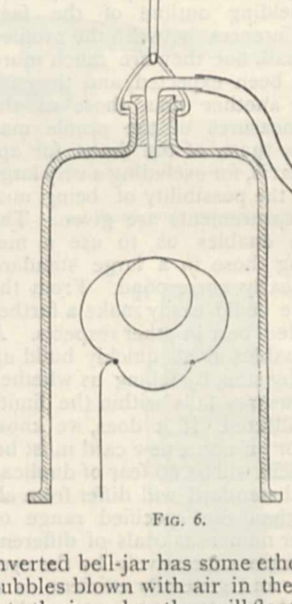

Fig. 6.

Fig. 7.

inverted bell-jar has some ether poured into it, after which bubbles blown with air in the usual way may be dropped into the jar, when they will float upon the vapour. They are then taken out and carried to a flame, when a blaze of light shows that the inflammable vapour has penetrated through the film. A bubble blown at the end of a wide tube and lowered into the vapour hangs like a heavy drop when removed; and if held in the beam of an electric light the vapour is seen oozing through the film and falling away in a heavy stream, while a light applied to the

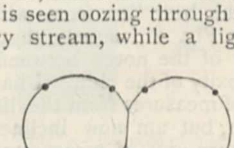

Fig. 8.

mouth of the tube fires the issuing inflammable vapour, and a large flame like that of a bunsen burner is the result (Fig. 7).

A variety of experiments are described in which bubbles are rolled along troughs made of soap-film—either straight, circular, or spiral—the prominent feature being that bubbles will roll upon or within one another as if they were made of india-rubber; they will even, where apparently in contact, take up the vibrations of a tuning-fork, and this will not force them to touch. There is one influence, however, which they cannot resist, and that is electrification. When two bubbles which are resting against one another (Fig. 8), provided that one is not within the other, are exposed to the influence of an even feebly electrified body, they instantly coalesce and become one (Fig. 9), and so act as a delicate electroscope. When one bubble is within the other, the outer one may be pulled out of shape by electrical action, and yet the inner one is perfectly screened from the electrical influence, thus showing in a striking manner that there is no electrical force within a conductor not even as near the surface as one side of a soap-film is near the other; for though the force outside is so great that the bubble is deformed, yet the fact that the inner one remains separate shows that the force within is too small to be detected. One of the experiments described shows at the same time the difference between the behaviour of two bubbles, one blown inside a third, and the other brought to rest against the third from the outside. Under these conditions, if electricity is produced

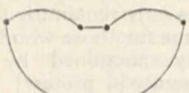

FIG. 9.

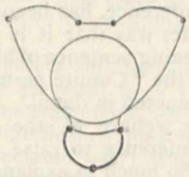

FIG. 10.

in the neighbourhood, the two outer bubbles become one, and the inner one, unharmed, rolls down and rests at the bottom of the now enlarged outer bubble (Fig. 10).

One experiment is described in which a cylindrical bubble is blown with oxygen gas between the poles of an electro-magnet. If the length is properly adjusted, the bubble breaks into two directly the exciting current is turned on, though the force due to the magnetic nature of oxygen is so feeble that not the slightest change of shape can be detected in a spherical bubble under the same conditions.

For other experiments and for details, readers are referred to the original paper in the *Philosophical Magazine*, the editor of which has kindly allowed us to reproduce the illustrations used in this article.

THE PARIS OBSERVATORY.

THE Annual Report of the Paris Observatory, which has recently appeared, draws special attention to the two events which have rendered the past year memorable, not merely in the history of the Observatory, but in that of astronomical science as a whole. The first of these was, of course, the meeting at Paris of the International Congress for the execution of the photographic chart of the heavens, and Admiral Mouchez gives the names of the members of the Congress, and the resolutions adopted by them. Of the Permanent Committee appointed by the Congress, Admiral Mouchez is himself the President, and he has already issued the first number of the *Bulletin de la Carte du Ciel*, future numbers of which will be brought out by the Committee as occasion may require. Twelve Observatories, including that of Paris, had definitely pledged themselves to join in the scheme, and five or six more expected to be able to do so shortly, so that there should be no difficulty in completing the chart within three or four years. The International Exhibition to be held at Paris next year would furnish a good opportunity for the reassembling of the Permanent Committee in order that the final decisions relating to the carrying out of this great scheme might be formed.

The other great event was the publication of the first two volumes of the great Paris Catalogue, the revision of the Catalogue of Lalande. This last work, which has already been referred to in NATURE (vol. xxxvii. p. 569), was commenced in 1855, but owing to many unfavourable circumstances has only been pushed forward vigorously during the last ten years, and now is all but completed. As the stars which still require observation have become fewer and more scattered, it has been found no longer necessary to devote more than one instrument to the work; the great meridian instrument has therefore been set apart for this work, and for the observation of minor planets and comparison stars, whilst the other meridian instruments have been left free for the careful study of the places of fundamental stars and for special researches. The "garden" circle has accordingly been used for the observation of circumpolars after M. Lœwy's plan, and the Gambey mural circle by M. Perigaud for the redetermination of the latitude of the Observatory. The value found for this latter by a series of *consecutive* observations of Polaris at upper and lower transit is 48° 50′ 12″·0, but Admiral Mouchez considers that despite the care and skill of M. Perigaud this determination falls short of the desired accuracy on account of the uncertainty of the corrections for refraction. This is partly due to the observations having all been made during midsummer, but chiefly to the bad position of the Observatory at the extreme south of Paris, the observations of Polaris therefore being made with the telescope pointed over the entire breadth of the city. It is hoped that the great Eiffel tower may render assistance to the study of refraction by affording much information as to inversions of the usual law of the variation of temperature with the height. The above value for the latitude still remains to be corrected for flexure of the instrument, and M. Perigaud is now undertaking the study of this error. The total number of meridian observations obtained during the year was 16,318, the highest monthly number having been secured in February, a most unusual circumstance. The observations of sun, moon, and planets amounted to 545.

The observations with the equatorials have been of the usual kind. M. Bigourdan has made 400 measures of nebulæ with that of the West Tower; and M. Obrecht, with the equatorial *coudé*, has made 720 measures of lunar craters referred to different points of the limb, in order to secure a better determination of the form of our satellite. But a yet more important work with this latter instrument has been the thorough examination of its theory by MM. Lœwy and Puiseux. In view of the success of the Paris telescope, of the number of similar instruments now under construction, and of the still wider popularity which the same form will probably have in the future, this was a work much to be desired.

The results, however, achieved in the field of astronomical photography are those in which, in view of the proposed chart, the greatest interest will be felt just now, and here the MM. Henry have further evidences of progress to present. Saturn and the moon have been photographed with a direct enlargement of 20 diameters. The phases of the lunar eclipse of August 3 have been recorded by the same means. With the smaller photographic instrument, aperture 4·3 inches, negatives have been obtained, one of which showed more than 30,000 stars on the single plate. Several curious new nebulæ have been discovered, one 1° in length near ζ Orionis; but the most remarkable have been those in the Pleiades. Two plates of this group, each with an exposure of four hours, have not only added much to our knowledge of the nebulæ round Electra, Merope, Maia, and Alcyone, these no longer appearing as mere faint clouds, but as well-marked nebulosities of intricate and complicated forms, but two new nebulæ are shown, both very narrow and straight, the longer one being some 40′ in length and but 2″ or 3″ in breadth, and threading together as it were no fewer than seven stars. The plate representing this photograph of the Pleiades, which is attached to the Report, shows 2326 stars, and comprises stars of the 18th magnitude, instead of the 1421 stars contained in the earlier photograph. MM. Henry have been likewise engaged in the study of the new instrument they have devised for the measurement of the stellar photographs, and in the preparation of tables of instrumental corrections, and of corrections for the effect of refraction; whilst M. Thiele has been inquiring into the degree of accuracy of which the measures are capable, with most encouraging results, and Admiral Mouchez considers that the precision thus attainable "will permit the carrying out under good conditions of the Catalogue of all the stars down to the 11th magnitude as decided by the Congress." It should be noted, however, that this interpretation of the resolution of the Congress has been challenged, and it has been urged that the Catalogue to be formed was to contain simply as many suitably placed stars as would be necessary as reference points for the great photographic chart, and that stars down to the 11th magnitude might be used for this purpose.

As to the publications of the Observatory, the first volume of the Catalogue, 0h.–6h. of R.A., is shortly to be followed by the second, 6h.–12h., the first sheets of which were already in the printers' hands. The volume of Observations for 1882 was published last August, that for 1883 was passing through the press, whilst the reduction of apparent to mean places was completely finished for 1884. The nineteenth volume of the Memoirs was in course of publication, and would contain, besides the works mentioned in the Report for 1886, a memoir on the theory of the figure of the planets, by M. Callandreau, and another on an allied subject, by M. Hamy. Amongst the works published by the individual members of the Observatory, the most important have been M. Lœwy's new method for the determination of the constant of aberration, and a work by M. Wolf, on the pendulum. M. Leveau is still engaged in his work upon Vesta, and M. Bossert is preparing for the determination of a definitive orbit of the Pons-Brooks comet. Under the head of "Matériel" the progress of the new equatorial *coudé* of 2 feet aperture and 60 feet focal length is referred to. Its completion is expected during the present year, but the building for it has not yet been begun.

The chief exception to the record of progress which Admiral Mouchez's Report supplies is found in the short paragraph which records the closing of the astronomical school, on financial grounds. The necessity for this step is to be most deeply regretted.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.

WE lately reprinted from the *Observatory* (NATURE, May 10, p. 38) an article by the editors of that periodical on Dr. Gill's proposal that two million stars should be catalogued. The following is the reply of the editors, printed in the June number of the *Observatory*, to letters addressed to them on the subject by Admiral Mouchez and Mr. E. B. Knobel:—

We print above letters from Admiral Mouchez and from Mr. Knobel, concerning the remarks we made last month on Dr. Gill's proposition to catalogue 2,000,000 stars. There is a somewhat personal implication in both letters, to which we must at once reply before proceeding to treat of the real question at issue—a suggestion that we have been so emphatic in our disapproval of the scheme as to be discourteous to its supporters. We may perhaps venture to doubt whether either writer has done us the honour to read our remarks carefully enough. Admiral Mouchez "nous trouve bien sévère pour un projet aussi bien étudié et venant d'un savant aussi habile et compétent que le Directeur de l'Observatoire du Cap." We have not said a single word in disparagement of the skill and care with which Dr. Gill's paper has been written; we have vehemently objected to the question being raised at all; and that we have objected so vehemently may be taken as a full recognition of Dr. Gill's prominent position, which makes it a matter of necessity to bring all our forces to bear against a scheme which he chooses to advance. Mr. Knobel is perhaps more unjust to us. We have not in an unqualified manner characterized a catalogue of 2,000,000 stars as "an utter waste of time, labour, and money"; but we did use even stronger language about cataloguing stars "for the purpose only of getting their places written down," in order to call attention to the *reductio ad absurdum* of cataloguing towards which we very much fear there is some apparent tendency. And, finally, if we have been so emphatic as to be accused of exaggeration, let us again point out that a scheme, which we contend has not been assented to or even considered by the members of the Astrophotographic Conference, has been quietly launched, and is now so far under way that it is referred to by the President in the opening sentence of his letter as a matter already accepted by the "Comité permanent," and as only remaining to be discussed in detail. Surely it is time for those who have the welfare of the scheme really sanctioned by the Conference to raise their voices loudly in protest!

So much in explanation of the tone we have adopted in speaking of this proposal, and we now return to the letters. The main point of both is that this scheme of a catalogue of 2,000,000 stars has not been originated by Dr. Gill, but was really considered and approved by the Conference. As we have stated above, we hold the opposite opinion,—that although two resolutions of the Conference do mention *a* catalogue, this term cannot be supposed to sanction a catalogue of 2,000,000 stars without further specification. The Conference met to discuss the advisability of making a chart. With the invitations sent out to the various astronomers to attend this Conference there was sent a "programme provisoire" (which, it is to be very much regretted, was not that considered by the Congress). This first "programme provisoire" was dropped, and at the first *séance* of the Congress another was produced. In the first, in article 19 a *catalogue of reference stars* was mentioned, and properly so, but in the second there was no mention of any such catalogue. Mention was made in section 4 of a means of publishing the chart and the form of publication, but up to this time there was absolutely no question before the Conference of publication of a catalogue either of 2,000,000 or any other number of stars. There was no doubt a feeling amongst some astronomers present that a catalogue would be as useful, in their judgment, as the chart; and they took the opportunity of putting forward their views when the question of a second series of plates was brought forward. The taking of this second series of plates was proposed to meet an anticipated difficulty in photographing parts of the heavens where the stars differed greatly in magnitude. It was decided (Resolution 17) that a second series of plates should be taken, in order to insure the greatest precision in the micrometrical measurement of the stars of reference, and to render possible the construction of a catalogue. Here we have the first mention of a catalogue in the resolutions noted. A reference to the minutes of the Congress will show that this resolution was a compromise, for there had already been before the Congress a direct proposition (that of M. Tacchini) for a catalogue, which, however, was not voted upon. The resolution was in fact an endeavour to settle a question that was before the Congress, viz. whether the plates should be so taken as to be capable of accurate measurement; and this is decided by the specification that they shall render possible the construction of a catalogue. The next two resolutions speak of the second series of plates as *destinés à la construction du catalogue*, but nowhere is any direct resolution to be found as to the construction of a catalogue of all the stars.

If these resolutions need interpretation by the light of subsequent consideration at all, we may suggest a very different direction in which they might be modified in actual fact, and in which their spirit would yet be even better represented than by a literal fulfilment. It was pointed out that in taking the photographic plates of stars down to the 14th magnitude in parts of the sky where brighter stars existed, these with the exposure necessary to obtain the 14th magnitude would be very much over-exposed. And it was suggested that it would be advisable to take a second series of plates, as already mentioned (see Resolution 17). Now in some parts of the sky no second series of plates are, from this point of view, at all necessary; whilst in others not one or two, but many series of plates would be necessary in order to do justice to the various magnitudes in that particular part of the sky. For the present this is not the point at issue, but it may serve as an illustration of the sort of interpretation of the resolutions which we should consider legitimate.

In order to come to a proper judgment on the legitimacy of the derivation of Dr. Gill's proposal from the resolutions it is necessary to make some statements, which are not new, but of which the true significance does not seem to have been universally appreciated:—(1) When the plates are obtained they are actual representations of the stars as existing at a given time, and for every purpose except spectrum analysis are as good, if not better, than the visible heavens. If with these plates we have the absolute places of a certain small number of known stars, we have then all the data to make them valuable, either in the present or in the future. (2) The many questions concerning the stars which it is hoped a photographic chart of the heavens would do a great deal towards settling, such as their distribution, their proper motions, their changes of magnitude, and the presence of minor planets, of new stars and the like, can all be best treated by a direct comparison of plate with plate, in any of the various ways in which this can be done. (3) In order to obtain the best results from such an agent as photography it is necessary to use it in its own proper way; and astronomers must recollect that old methods of procedure adapted to other instrumental means may most probably be out of place. We might considerably enlarge on these statements, but for our present purpose it is sufficient to call attention to them.

Now, if Dr. Gill's catalogue were successfully constructed—and there are, alas! many difficulties in the way—its utility in the direction of comparison of our sky with that of the future is wholly limited by one condition, that in the future another exactly similar catalogue be constructed, occupying a similar time. Even then, if any changes were found by means of this comparison of catalogues which might very well be made in the course of fifty or one hundred years, the natural and indeed the proper thing to do would be to immediately compare the original plates. But can it be possible that any man or number of men really think of dealing with such a subject in such a way? If, on the other hand, the object of a catalogue be merely to allow of comets, minor planets, and other bodies being located, surely it would be better to measure the plates as occasion arises, and not to catalogue 2,000,000 stars on the off-chance of having some twenty or thirty positions to settle in the course of a year. And, further, such a catalogue would have this enormous disadvantage, that whilst in some parts of the sky stars of the 11th magnitude would be fairly well spread, in the Milky Way we should have stars clustered in such enormous quantities that it would be an extremely difficult thing to even identify them: in fact, speaking roundly, we should say that if such a catalogue were made, two-thirds of the stars catalogued would lie in the Milky Way. If, contrary to the opinion we have expressed, it is decided to form a very large catalogue, surely it would be better to determine the places of a certain number of stars, of such magnitudes as are found available, in each square degree, and make these the reference stars from which the positions of the other stars on the plate could be obtained.

We are therefore of opinion that, supposing limitless time and money available for such a purpose, the advantages of constructing this catalogue would be doubtful; but even if we waived all these objections and agreed that such a catalogue would be a "nice thing to have," or admitted that since men of the ability and reputation of Admiral Mouchez and Dr. Gill consider such a catalogue necessary it is heresy to inquire the why and wherefore, there would still be left the serious objection that to form a chart of the heavens is the first thing to do, and, take it in as simple a form as possible, it will quite possibly tax the energies of astronomers to their utmost; and that stellar photography being as yet in its infancy it is suicidal to attempt anything which will commit us to a course of action extending over more than a very few years. We could not give a better illustration of the dangers of the opposite procedure than has been supplied by Admiral Mouchez himself. In a recent article he has suggested that there have lately been such improvements in the sensitiveness of plates that we could now go to the 15th magnitude instead of the 14th. With a little ingenuity and less arithmetic it could easily be shown that the whole plan of operations would have become hopelessly futile and obsolete before half the time allowed by Dr. Gill for its completion had elapsed.

But not for one moment do we wish to appear lacking in sympathy with those who have spent and are spending so much time and thought on this subject; it is our great anxiety for the success of the work in which they are co-operating which makes us eager to protest as far as we can against the grand mistake of attempting too much.

THE INCURVATURE OF THE WINDS IN TROPICAL CYCLONES.

THE question of the incurvature of the winds in tropical cyclones is one of such importance to mariners, to enable them to judge their position in a storm, and to escape the hurricane around the central calm, that no apology is needed for adding my independent testimony to that of Prof. Loomis, whose conclusions, given at length in his recent well-known memoir, "Contributions to Meteorology," are quoted in Mr. Douglas Archibald's paper on M. Faye's work "Sur les Tempêtes" in last week's NATURE (p. 149).

In the preparation of a forthcoming work on the weather and climates of India and the storms of Indian seas, I have lately had occasion to re-investigate the above question in the case of cyclones in the Bay of Bengal, on the evidence afforded by the numerous original memoirs and reports prepared by Messrs. Willson, Eliot, Pedler, and other officers of the Indian and Bengal Meteorological Departments; my object being the practical one of determining directly the bearing of the storm-centre from a ship's position; and instead, therefore, of measuring the angle between the wind direction and the nearest isobar, as was done by Prof. Loomis, I have measured with a protractor the angle included between the former and its radius vector, in all cases in which the position of the storm's centre has been ascertained on sufficient evidence. In one other important condition I have also departed from the method pursued by Prof. Loomis. I have restricted the measurements to wind observations of ships at sea, within the influence of the storm, and to those of good observatories on the coast, subject to the same proviso; and have taken no account of those of inland observatories. This difference of procedure is probably the reason that the amount of the incurvature shown by these measurements is somewhat different from that obtained by Prof. Loomis, though the general fact of a great incurvature is thoroughly confirmed. My results are as follow:—

(1) The mean of 132 observations between lats. 15° and 22°, within 500 miles of the storm-centre, gives the angle 122° between the wind direction and its radius vector.

(2) The mean of 12 observations between the same latitudes, within 50 miles of the storm-centre, gives the angle 123°.

(3) The mean of 68 observations between N. lats. 8° and 15°, within 500 miles of the storm-centre, gives the angle 129°.

The observations within 50 miles of the storm-centre in the south of the Bay are too few to afford any trustworthy result.

For seamen's guidance, the following practical rules may be formulated:—

(1) In the north of the Bay of Bengal, standing with the back to the wind, the centre of the cyclone bears about five points on the left hand, or three points before the beam.

(2) In the south of the Bay, it bears about four points on the left hand, or four points before the beam.

(3) These rules hold good for all positions *within the influence of the storm*, up to 500 miles from the storm-centre. On the north and west the influence of the storm rarely extends to anything like this distance, but it does to the east and south.

Since much of this evidence, afforded by the Bay of Bengal cyclones, has been before the public for many years, it is incomprehensible to me how a man of M. Faye's scientific eminence can still assert that in the tropics "the wind arrows display an almost rigorous circularity." If, as may possibly be the case, he relies on the evidence of Mr. Piddington's memoirs, ignoring all subsequent work, it is only necessary to examine those memoirs to find that his data do not bear out that author's conclusions. In the charts which accompany Mr. Piddington's later memoirs, the wind observations are, as a rule, not shown, but only the ships' courses, and the author's interpretation of the positions and tracks of the storms. But the evidence is always fully given in the text, and it will be found that when the wind arrows are plotted therefrom, and are sufficiently numerous to allow of the position of the storm's centre being determined, which is far from being generally the case, they are reconcilable only with spiral courses, having a considerable incurvature.

I do not propose now to enter on a formal criticism of Mr. Piddington's work, the great merit of which, as that of a pioneer in the field of storm-science, no one more fully recognizes than myself; but so much seems necessary in explanation of the apparent glaring discrepancy between his results and those of modern workers in the same field.

The evidence of the cyclones of the Bay of Bengal, those tropical cyclones to which M. Faye appeals as authoritative on the validity of his views, is, then, conclusive against him. There is a strong influx of the lower atmospheric strata into a tropical cyclone, proving, in the most unquestionable manner, the existence of an ascending current over the vortex. This fact is quite independent of any views that may be entertained as to any theory of cyclone origin and movement of translation, but any such theory must harmonize with the fact, and hence I conceive that it is fatal to M. Faye's views. With these, in so far as they are theoretical merely, I have no present concern, but it is obviously a matter of high importance to seamen that they should not be misled as to the facts of the wind's movement in cyclones, and it is because the promulgation of such views as M. Faye's tends to perpetuate an old and now exploded error of fact, that I have to put in my protest against them.

HENRY F. BLANFORD.

Folkestone, June 15.

NOTES.

IT should have been stated in our paragraph last week relative to the opening of the Laboratory of the Marine Biological Association at Plymouth that the President, Prof. Huxley, who has given unremitting care to the affairs of the Association during the last three years, would be present if he were not prevented from taking part in any public proceedings by the state of his health. In the absence of the President, one of the Vice-Presidents of the Association, Prof. Flower, will preside. The Honorary Secretary, Prof. Ray Lankester, who founded the Association, and has conducted its affairs to the present issue, will also be present.

MR. J. J. H. TEALL, who now holds a foremost place among the petrographers of this country, has just been appointed to the Geological Survey. We understand that he will be specially charged with the study of the crystalline schists and the problems of regional metamorphism, and that he will be closely associated with the field officers who are mapping these rocks in different parts of Scotland. The Survey is to be heartily congratulated on this appointment. The staff is now remarkably strong, but the problems with which it is confronted are among the most difficult in geology. These problems have never been attacked by such a united force of field geologists and microscopists, who, working together with one common aim, will no doubt raise still higher the scientific reputation of the Survey, increase our knowledge of the history of the most ancient rocks, and throw light on some of the most puzzling questions in geological science.

THE electors to the Mastership of Downing College, Cambridge, have, by a unanimous vote, chosen Dr. Alexander Hill, Fellow of the College, to succeed Prof. Birkbeck. Dr. Hill's claim to the appointment sprang from his success as a teacher and worker in biology. No appointment to a Headship has been made on this ground alone since the revival of natural science at the Universities.

ON the 4th inst., Dr. Maxwell T. Masters was elected a corresponding member of the Institute of France, in the Botanical Section, in place of the late Prof. Asa Gray. Besides Dr. Masters, the following names appeared on the list of presentation: M. Treub, of Batavia; Mr. Triana, of Paris; M. Warming, of Lund; M. Wiesener, of Vienna. Dr. Masters obtained 39 votes; M. Triana, 5; M. Treub, 1.

THE Sorbonne, consulted as to the proposed creation of a Chair for the teaching of Darwinian theories, has not expressed disapproval of the scheme suggested by the Municipal Council of Paris. It has appointed a committee to report on the matter; and it is expected that no serious opposition will be offered to the proposal.

WE are glad to learn that a pension of £50 has been granted to Mrs. Balfour Stewart from the Civil List.

ON May 25, a complimentary dinner was given at the Queen's Hotel, Manchester, to Prof. Schorlemmer, of the Owens College, by his former pupils, to celebrate the occasion of the conferring of LL.D. upon him by the Senate of the Glasgow University, and to offer their congratulations. In the absence of Sir Henry Roscoe, who had been expected to take the chair, Mr. R. S. Dale, one of Prof. Schorlemmer's eldest pupils and friends, presided. Numerous congratulatory telegrams and letters were received by Dr. Schorlemmer, and early in the evening a letter was read from Sir Henry Roscoe, expressing regret that he could not be present, and testifying to his high appreciation of the ability of his old friend and colleague. Among those from whom congratulatory telegrams were received were Dr. Pauli, Director of the firm of Meister, Lucius, and Brüning, in Hoechst; Prof. Bernthsen, of the Badische Anilin und Sodafabrik, in Ludwigshafen; and Prof. Hermann Kopp, of Heidelberg, the historian of chemistry, who spoke of Prof. Schorlemmer's position as one of the principal pioneers of the science of organic chemistry and one of its foremost exponents, both as a teacher and a writer. Prof. Thorpe, F.R.S., proposed the health, long life, and prosperity of Dr. Schorlemmer, and referred to the fact that Glasgow, which had conferred honour on him, had produced such men as Black and Thomson, names familiar to all chemists.

Dr. Asa Gray left Harvard College in trust, to aid in the support of the Gray Herbarium of Harvard University, the copyrights of all his books, upon condition that proper provision should be made for the renewal and extension of these copyrights by new editions, continuations, and supplements, such as might be needed in the study of botany, and as might best enhance and prolong the pecuniary value of the bequest.

Prof. Lovering has resigned the Chair of Mathematics and Natural Philosophy which he has held at Harvard for fifty years. In accepting his resignation, which takes effect in the autumn, the President and Fellows of the College have expressed warm appreciation of his services. Prof. Lovering has been President of the American Association, and still presides over the American Academy.

Prof. McNab, Swiney Lecturer on Geology in connection with the British Museum, will begin a course of twelve lectures on the fossil plants of the Palæozoic epoch on Monday next, at the Natural History Museum, Cromwell Road.

Last night the *conversazione* of the Society of Arts took place at the South Kensington Museum.

A *conversazione* will be given by the Royal College of Surgeons, at the College, on Wednesday, June 27; and by the Royal Geographical Society, at Willis's Rooms, on Friday, June 29.

An International Horticultural Exhibition is to be held at Cologne from August 4 to September 19.

We have received from Messrs. West, Newman, and Co., samples of two kinds of botanical drying paper. One of the kinds differs but little from that which they have supplied for many years, which was originally manufactured, purposely for drying plants, by a paper-maker of the name of Bentall, who lived at Halstead in Essex, and contributed, a generation ago, to the distributions of the London Botanical Society. This paper has been largely used for the last thirty years, and combines in a very satisfactory manner the merits of a high degree of absorbence with a reasonable toughness. No doubt, for drying plants, it is the best paper that can be got, but yet, excepting grasses, Cyperaceæ, and mosses, one or more changes are required in the first few days to make satisfactory specimens in a climate like that of England. The new paper is quite without glaze, and seems a little more absorbent than the old "Bentall." The other kind is copied from an American model, a paper not made expressly for botanical use, sent to England by the late Dr. Asa Gray. It is twice as thick as the "Bentall," much more rigid, and very absorbent; a serviceable paper to mix with the lighter kind for home use, but too heavy to carry about in large quantities.

According to *La Nature*, an immense terrestrial globe, constructed on the scale of one-millionth, will be shown at the Paris Exhibition of 1889. A place will be set apart for it at the centre of the Champ de Mars. The globe will measure nearly 13 metres in diameter, and will give some idea of real dimensions, since the conception of the meaning of a million is not beyond the powers of the human mind. Visitors to the Exhibition will see for the first time on this globe the place really occupied by certain known spaces, such as those of great towns. Paris, for instance, will barely cover a square centimetre. The globe will turn on its axis, and thus represent the movement of rotation of the earth. The scheme was originated by MM. T. Villard and C. Cotard, and *La Nature* says that it has been placed under the patronage of several eminent French men of science.

We have received a sample of tobacco grown by Messrs. James Carter and Co., at a farm in Kent, and cured by Messrs. Cope Brothers and Co. It represents one of the first experimental crops brought to maturity, and passed through the various processes of manufacture, in this country, since the time of Charles II. The packet is accompanied by a card, on which we find the somewhat discouraging counsel: "Examine leisurely—use warily—smoke sparingly." Mr. Goschen was asked the other evening in the House of Commons whether he would cause an inquiry by experts into the results attending the experiment made by Messrs. Cope, with the view, if possible, of relaxing the fiscal restrictions upon the culture of tobacco in Great Britain. The Chancellor of the Exchequer cautiously replied that "only experience would show the value to smokers of this tobacco, and no inquiry by experts would be so valuable as that practical test. If any hon. member wished to try it, samples would be placed in the smoking-room. It was impossible to give any form of relaxation in the fiscal regulations which would injure the revenue."

According to the *Kavkaz* newspaper, a shock of earthquake was felt at Julfa, in the Armenian province of Erivan, on May 15, about midday. The first shock was followed by a stronger one, which lasted for about three seconds, and seemed to have a direction from east to west.

The Council of the Italian Meteorological Society held its first annual meeting at Turin on Sunday, April 15, under the presidency of Padre Denza. It was decided to hold the third general assembly of the Society at Venice, in September next, just before or after the Congress of the Alpine Club at Bologna. The establishment by the Society of a new Observatory in the Argentine Republic was notified, and also of four new meteorological stations in Italy. The arrangements being made with respect to the hygienic stations at five large cities were explained, as well as the proposed method of publication of the observations. The President submitted the Report of the Geodynamic Committee, nominated at the meeting at Aquila (Nature, vol. xxxvi. p. 614), with reference to seismological observations and the protection of buildings. The Report, which is printed in the monthly Bulletin of the Italian Meteorological Society for May, consists of nine articles, and will be distributed to the Prefects and Mayors of districts liable to earthquake-shocks.

The Hydrographer of the Admiralty has issued notices of the recent establishment of the following storm-signals:—(1) By the Japanese Government, at forty-seven stations on the coasts of Japan. A red ball, or one red light, to indicate that strong winds are probable from any direction. A red cone, or three red lights in the shape of a triangle, to indicate that strong winds are probable, at first from the northward or southward, according as the apex is upwards or downwards. (2) By the harbour authorities at Chittagong, relative to the signals at that port. A ball, or three lights placed vertically, to indicate that a severe cyclone is near Akyab, and will probably advance towards Chittagong. A drum, or two lights placed vertically, to indicate the early approach of a severe cyclone, with its attendant storm-wave. We take this opportunity of suggesting the desirability of introducing more uniformity in these signals in different countries, wherever practicable.

The atomic weight of the element osmium has been re-determined by Prof. Seubert. The necessity for this re-determination has been felt ever since the principle of periodicity began to take firm root in the minds of chemists; and the more recent values arrived at for the atomic weights of iridium, platinum, and gold have tended to render this necessity even more imperative. The natural sequence, according to their chemical and physical properties, of the metals of the platinum group is generally accepted as—osmium, iridium, platinum, gold. Now the atomic weight of iridium as determined in 1878 by Seubert is 192·5, that of platinum as fixed by the same chemist in 1881 is 194·3, and that of gold as estimated last year by Thorpe and Laurie, and by Krüss, is 196·7, while the recognized atomic weight of osmium as given by Berzelius in 1828 is so high as 198·6. Obviously, if the grand conception of Newlands, Mendelejeff, and Lothar Meyer is correct, the atomic value of osmium required most careful revision. Such an undertaking, however, is endowed with peculiar interest owing to the dangerous nature of work with the osmium compounds, and many chemists who have been interested in this subject have been deterred by the knowledge that accidental contact with the fumes of the tetroxide, which are so frequently evolved by the spontaneous decomposition of many osmium compounds, might deprive them of the use of their eyes for ever. Prof. Seubert has happily succeeded without accident in establishing the validity of our "natural classification" by means of the analysis of the pure double chlorides of osmium with ammonium and potassium, $(NH_4)_2OsCl_6$ and K_2OsCl_6. Both these salts were obtained in well-formed octahedral crystals, of deep red colour while immersed in their solutions, but appearing deep black with a bluish reflection when dry, and yielding bright red powders on pulverization. The method of analysis consisted in reducing the double chlorides in a current of hydrogen: in case of the ammonium salt the spongy osmium which remained after reduction was weighed, and the expelled ammonium chloride and hydrochloric acid caught in absorption apparatus, and the total chlorine estimated by precipitation with silver nitrate. In case of the potassium salt the expelled hydrochloric acid was absorbed and determined, and the metallic osmium left after removal of the potassium chloride by washing was weighed. The mean value yielded by all these various estimations is 191·1, thus placing osmium in its proper place before iridium, and removing the last striking exception to the "law of periodicity."

AT a recent meeting of the Washington Society of Anthropology, Mr. H. M. Reynolds read a paper on Algonquin metal-smiths. He expressed the opinion that the working of the copper-mines of Lake Superior is not of such high antiquity as has been supposed, and that it may have been continued until comparatively modern Indian times.

SOME time ago the Smithsonian Institution issued inquiries as to the existence and geographical distribution of "rude and unfinished implements of the Palæolithic type." The *American Naturalist* says that responses have been received from thirty States and Territories. The implements already noted amount to between six and seven thousand, and their distribution extends nearly all over the United States. Several hundreds of implements—none of which seem to have been found in the mounds—have been sent to the Institution. The object of the Institution in undertaking this investigation was to determine whether there was in America a Palæolithic Age, and, if so, whether it had any extended existence.

THE Free Public Libraries and Museum of Sheffield seem to be in a most flourishing condition. According to the last Report, which has just been sent to us, there has been a steady increase in the number of books issued. The number issued during the year ending August 31, 1887, was 410,395. The number issued during the previous year was 399,653, so that there was an increase of 10,742.

MESSRS. LONGMANS, GREEN, AND CO. have sent us a series of their test cards in mechanics, packed in neat little card-board cases. The questions on the many and various branches of the subject are arranged in three stages. Each stage consists of about thirty cards with six questions on each, and is supplemented by cards containing the answers to all the numerical questions. The questions are excellently chosen, and are arranged in an intelligible and progressive order.

A CAREFUL and very valuable bibliography of the works of Sir Isaac Newton, with a list of books illustrating his life and works, by G. J. Gray, has just been issued by Messrs. Macmillan and Bowes, Cambridge. The bibliography is divided into ten sections: (1) collected editions of works; (2) the "Principia"; (3) "Optics"; (4) "Fluxions"; (5) "Arithmetica Universalis"; (6) minor works; (7) theological and miscellaneous works; (8) works edited by Newton; (9) memoirs, &c.; (10) index.

A NEW edition of the late Prof. Humpidge's translation of Dr. Hermann Kolbe's "Short Text-book of Inorganic Chemistry" (Longmans) has been issued. The greater part of this edition was prepared by Dr. Humpidge last summer. Being unable, owing to failing health, to complete the task of revision, he asked Prof. D. E. Jones, of the University College, Aberystwith, to undertake it, and to see the book through the press.

A REPORT, with admirable illustrative maps, on the geology and natural resources of part of Northern Alberta, and the western parts of the districts of Assiniboia and Saskatchewan, by Mr. J. B. Tyrrell, Field Geologist of the Geological Survey of Canada, has just been published at Montreal. The Report is, to a certain degree, preliminary, but the author hopes that, for the present at all events, it may suffice as a guide to the extent, position, and character of the mineral wealth of the district.

AN interesting paper by Mr. Tyrrell, giving an account of the journeys of David Thompson in North-Western America, has been issued at Toronto. It was read lately before the Canadian Institute, and is published in advance of the Proceedings by permission of the Council. The materials for this narrative are contained in Mr. Thompson's field note-books and journals, which are preserved in the office of the Crown Land Department of Ontario. Mr. Thompson died in 1857 at the age of eighty-seven.

MR. LELAND will shortly send to the printer his work on "Americanisms," which will follow on the "Dictionary of Slang, Jargon, and Cant" now in the press. It will contain much folk-lore in the form of proverbs, songs, and popular phrases, and also the etymology and history of the words, as far as they could be traced. The work will include an account of American dialects, such as Pennsylvanian Dutch, Chinook, Creole, and Gumbo. A number of American scholars will deal with special subjects.

WE have received a copy of the *Tōyō Gakugei Zasshi* (the *Eastern Science Journal*), printed in Japanese characters. This magazine is published monthly, and is edited by a committee, most of whose members are Professors of the Imperial University at Tokio. Nearly 3000 copies of each number are sold.

THE first part of the second volume of the Journal of the College of Science, Imperial University, Japan, has been sent to us. The contents include, besides a mathematical paper, in German, by Dr. P. R. Fujisawa, the following articles in English: on the composition of bird-lime, by Dr. E. Drivers, F.R.S., and Michitada Kawakita; on anorthite from Miyakejima, by Yasushi Kikuchi; the source of *Bothriocephalus latus* in Japan, by Dr. Isao Ijima; and earthquake-measurements of recent years, especially relating to vertical motion, by S. Sekiya.

MESSRS. D. C. HEATH AND CO. (Boston) will publish at once Compayre's "Lectures on Pedagogy: Theoretical and Practical," a companion volume to their Compayre's "History of Pedagogy." It is translated and annotated by Prof. Payne, of the University of Michigan.

PROF. J. VIOLLE has just issued the first part of the second volume of his "Cours de Physique." The present part relates to acoustics.

WE reprint from *Science* of June 1, 1888, the following suggestive paragraph:—"The Committee of the House of Representatives on acoustics and ventilation has actually reported favourably a Bill appropriating seventy-five thousand dollars to subsidize a man who thinks he can construct a steel 'vacuum' balloon of great power. He is to be allowed to use the facilities of one of the navy-yards for the building of his machine, and is to have the money as soon as he has expended seventy-five thousand dollars of private capital upon his air-ship. One of the mathematical physicists of Washington was asked by a member of Congress whether such a balloon could be successfully floated. He set to work upon the problem, and here are some of his results, which are rather curious:—A common balloon is filled with hydrogen gas, which, being lighter than air, causes the balloon to rise and take up a load with it. But, as the pressure of the gas within is equal to the pressure of the atmosphere without, no provision other than a moderately strong silk bag is required to prevent collapse. The inventor of the proposed steel balloon hopes to gain greater lifting-power by using a vacuum instead of gas, the absence of substance of any kind being lighter than even hydrogen gas. But he has to contend with the tendency of the shell to collapse from the enormous pressure of the atmosphere on the outside, which would not be counterbalanced by anything inside of it. The first question which presented itself was, How thick could the metal of the shell be made, so that the buoyancy of the sphere, which would be the most economical and the strongest form in which it could be constructed, would just float it without lifting any load? The computations showed that the thickness of the metal might be ·000055 of the radius of the shell. For example: if the spherical shell was one hundred feet in diameter, the thickness of the metal composing it could not be more than than one-thirtieth of an inch, provided it had no braces. If it was thicker, it would be too heavy to float. Now, if it had no tendency to buckle, which of course it would, the strength of the steel would have to be equivalent to a resistance of more than 130,000 pounds to a square inch to resist absolute crushing from the pressure of the air on a cross-section of the metal. Steel of such high crushing-strength is not ductile, and cannot be made into such a shell. If the balloon is to be braced inside, as the inventor suggests, just as much metal as would be used in constructing the braces would have to be subtracted from the thickness of that composing the shell. Of course, such a shell would buckle long before the thickness of the metal of which it was composed was reduced to ·000055 of its radius. In other words, it is mathematically demonstrated that no steel vacuum balloon could be constructed which could raise even its own weight. This is an illustration of how intelligently Congress would be likely to legislate on scientific matters unguided by intelligent scientific advice."

THE additions to the Zoological Society's Gardens during the past week include two Pig-tailed Monkeys (*Macacus nemestrinus* ♂ ♀) from Java, presented by Mr. C. W. Ellacott; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mr. J. Wiltshire; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mrs. Gleig; two Spotted Cavys (*Cœlogenys paca* ♂ ♀) from South America, presented by Mr. W. H. Stather; a Mauge's Dasyure (*Dasyurus maugæi*) from Australia, presented by Mr. H. R. Brame; three Abyssinian Sheep (*Ovis aries*, var.) from Abyssinia, presented by Mr. A. J. Baker; two Pallas's Sand Grouse (*Syrrhaptes paradoxus*) from the Island of Tiree, Argyllshire, presented by Lieut.-Colonel Irby and Captain Savile Reid, F.Z.S.; a Wapiti Deer (*Cervus canadensis* ♂), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE CONSTANT OF ABERRATION.—In the year 1862, Prof. J. S. Hubbard commenced a series of observations of α Lyræ with the prime vertical instrument of the Washington Naval Observatory, which was continued by either Profs. Newcomb, Harkness, or Hall until 1867. The purpose of these observations had been to obtain corrections to the assumed values of the constants of nutation and aberration, and to afford an absolute determination of the annual parallax of the star. The series was not continued for a sufficient period for the first purpose; and Prof. Asaph Hall, when engaged on the determination of the parallax of α Lyræ by another method, found that these observations would give it a small negative value. From this and other circumstances he was at that time induced to think the observations would not repay the trouble of a careful discussion; but recently, reflecting that they had been skilfully designed, and carried out with care, he resolved to ascertain the result they would furnish for the constant of aberration. The observations commenced 1862 March 25, and extended to 1867 April 25, and were 436 in number. The mean resulting value of the parallax is—

$$\pi = -0''\cdot079 \pm 0''\cdot0134,$$

whilst

$$\text{Constant of aberration} = 20''\cdot4506 \pm 0''\cdot0142,$$

with an average probable error for a single observation of $\pm 0''\cdot174$.

Adopting a parallax of $+0''\cdot15$, the result would be—

$$\text{Constant of aberration} = 20''\cdot4542 \pm 0''\cdot0144.$$

Prof. Hall prefers this latter result, notwithstanding the uncertainty as to the true parallax of the star. The negative result obtained for the parallax may probably be due to the fact that the coefficient of parallax obtains its extreme values in January and July, when the mean temperature is likewise at its extreme points; the January observations also are made in daylight, but the July at night, which would tend to produce a systematic difference in the method of observing. The coefficient of aberration, on the other hand, has its greatest values in April and October, when the conditions of observation will be nearly the same.

The above value of the constant of aberration gives, for the solar parallax—

$$\pi = 8''\cdot810 \pm 0''\cdot0062,$$

Hansen's values of the mean anomaly of the earth, and eccentricity of its orbit being assumed, together with Clarke's value for the equatorial radius, and Michelson and Newcomb's determination of the velocity of light, viz. 186,325 miles per second.

THE MARKINGS ON MARS.—The observations of M. Perrotin at Nice, and M. Terby at Louvain, and, in England, of Mr. Denning at Bristol, have confirmed the presence on the planet of most of the "canals" or narrow dark lines which were discovered by M. Schiaparelli in 1877, and at subsequent oppositions. M. Perrotin has also been able to detect, in several cases, the gemination or doubling of the canals, and M. Terby has observed the same phenomenon in one or two cases, but with much greater difficulty than in the opposition of 1881-82. But some curious changes of appearance have been noted. An entire district (Schiaparelli's *Lybia*) has been merged in the adjoining "sea," *i.e.* its colour has changed from the reddish hue of the Martial "continents" to the sombre tint of the "seas." The district in question is larger than France. To the north of this district a new canal has become visible, and again another new canal has appeared to traverse the white North Polar cap, or, according to M. Terby, to divide the true Polar cap from a white spot of similar appearance a little to the south of it. With the exception of these changes, the principal markings, both light and dark, are those which former oppositions have rendered familiar.

COMET 1888 *a* (SAWERTHAL).—The following ephemeris for Berlin midnight is by Herr Berberich (*Astr. Nach.*, No. 2838), from elliptic elements which he has found for it, and which closely resemble those of Prof. Boss given in NATURE of May 24 (p. 88):—

1888.	R.A. h. m. s.	Decl. ° ′	Log *r*.	Log Δ.	Brightness.
June 23	0 55 11	46 11·5 N.	0·2760	0·3129	0·042
25	0 57 1	46 40·5			
27	0 58 42	47 8·9	0·2887	0·3173	0·039
29	1 0 16	47 36·6			
July 1	1 1 42	48 3·7	0·3009	0·3212	0·036
3	1 3 0	48 30·2			
5	1 4 9	48 56·0	0·3127	0·3247	0·033
7	1 5 9	49 21·2			
9	1 6 1	49 45·7	0·3241	0·3278	0·031
11	1 6 44	50 9·6			
13	1 7 18	50 32·8 N.	0·3352	0·3306	0·029

The brightness at discovery is taken as unity.

THE Kazan Observatory has celebrated its "Jubilee" by publishing an interesting report about its activity since it was founded by Littrow fifty years ago. The mapping of the stars between 75° and 80°, which was begun by Prof. Kovalsky, was continued and extended by his successor, Prof. Dubyago.

THE Tashkend Observatory has just issued the second volume of its "Works."

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1888 *JUNE* 24–30.

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on June 24

Sun rises, 3h. 46m.; souths, 12h. 2m. 13·7s.; sets, 20h. 19m.: right asc. on meridian, 6h. 14·5m.; decl. 23° 25′ N. Sidereal Time at Sunset, 14h. 33m.

Moon (Full, June 23, 21h.) rises, 19h. 57m.*; souths, 0h. 9m.; sets, 4h. 20m.: right asc. on meridian, 18h. 19·6m.; decl. 21° 5′ S.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury	5 33	13 25	21 17	7 37·2	19 52 N.
Venus	3 23	11 41	19 59	5 53·7	23 36 N.
Mars	13 28	18 53	0 18*	13 6·5	7 39 S.
Jupiter	17 6	21 29	1 52*	15 42·7	18 47 S.
Saturn	6 29	14 19	22 9	8 31·3	19 34 N.
Uranus	12 56	18 36	0 16*	12 49·3	4 35 S.
Neptune	1 59	9 45	17 31	3 56·9	18 47 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Comet Sawerthal.

June.	h.	Right Ascension. h. m.	Declination. ° ′
24	0	0 55·2	46 12 N.
28	0	0 58·7	47 9

Occultations of Stars by the Moon (visible at Greenwich).

June.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
24	50 Sagittarii	6	22 6	23 16	65 250
28	50 Aquarii	6	2 28	2 59	163 215

June.	h.	
25	9	Mercury stationary.
27	23	Mercury at greatest distance from the Sun.

Meteor-Showers.

	R.A. °	Decl. °		
Near 52 Herculis	253	47 N.	June 25–30.	Swift.
,, δ Cygni	295	40 N.		Slow.
,, ε Delphini	305	9 N.	June 28.	

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·4	81 16 N.	June 25,	22 54	*m*
			,, 30,	22 33	*m*
R Geminorum	7 0·6	22 53 N.	,, 27,		*M*
δ Libræ	14 55·0	8 4 S.	,, 29,	2 2	*m*
U Ophiuchi	17 10·9	1 20 N.	,, 28,	2 52	*m*
			,, 28,	23 0	*m*
W Sagittarii	17 57·9	29 35 S.	,, 24,	2 0	*m*
T Herculis	18 4·9	31 0 N.	,, 27,		*M*
U Sagittarii	18 25·3	19 12 S.	,, 30,	2 0	*m*
β Lyræ	18 46·0	33 14 N.	,, 28,	22 0	*m*
S Vulpeculæ	19 43·6	27 1 N.	,, 26,		*M*
η Aquilæ	19 46·8	0 43 N.	,, 24,	21 0	*m*
R Sagittæ	20 9·0	16 23 N.	,, 27,		*m*
X Cygni	20 39·0	35 11 N.	,, 26,	22 0	*M*
δ Cephei	22 25·0	57 51 N.	,, 27,	21 0	*M*

M signifies maximum; *m* minimum.

GEOGRAPHICAL NOTES.

LIEUTENANTS KUND AND TAPPENBECK have been conducting an expedition into the Cameroons interior during the latter part of 1887 and the beginning of the present year. Starting from Batanga they succeeded in penetrating as far as 12° 30′ W. long., when, being attacked by Soudan Negro traders they were forced to retreat, both of them seriously wounded. They succeeded in tracing the course of the Beundo or Njong River far into the interior, and brought back much information concerning the people and the products of the country. With regard to general results, they found that the water-parting between the rivers that discharge in the Cameroons region and those that flow into the Congo Basin lies not near the coast as has hitherto been supposed, and therefore it is hoped that a navigable route may be discovered that will lead well into the interior. The water-parting between the left tributaries of the Binué and the rivers in the German Cameroons also lies far in the interior. The division between the Soudan Negroes and the Bantus is not to be looked for in the direction of Adamawa, but southwards is formed by the Zannaga River and eastwards lies at a distance of 150 miles from the coast. Lieutenants Kund and Tappenbeck assert that the area of Mohammedan influence extends much farther south than has hitherto been thought. No signs of volcanic action have been met with as far as the Zannaga River or in the mountains to the north. The profile which accompanies the report shows a coast plain about 70 feet high, succeeded by a sharp slope rising to a height of from 3000 to 4000 feet, beyond which the country slopes gradually to the inner African plateau, about 2500 feet above the sea.

THE June number of Petermann's *Mitteilungen* is mostly occupied with a memoir by Dr. Supan on "A Century of African Exploration," written in commemoration of the centenary of the British African Association, founded in June 1788. Dr. Supan traces the gradual opening up of the continent and its various regions, the text being illustrated by a series of most instructive maps. In indicating what yet remains to be done, Dr. Supan maintains that it is a mistake to assert that the days of pioneer exploration are over. He shows that while a few patches have been surveyed with some care, while of others we have a general knowledge, and while in other regions lines of travel have been run through, there are great regions that still remain absolutely blank. In the north, in the region of the Sahara, which has been so long known to Europe, the blanks are almost greater than elsewhere, leaving ample room for pioneer work, which may very well be carried on alongside of more minute exploration.

TECHNICAL INSTRUCTION.[1]

IN celebrating as we are now doing the fifty-first annual meeting of the Yorkshire Union of Institutes, one's thoughts naturally revert to the foundation of that Union and to the educational progress which our country has made since the earlier years of the century; and round these thoughts will gravitate recollections of the life and labours of your revered President,

[1] Address delivered by Sir Henry Roscoe, M.P., F.R.S., at Castleford, on Wednesday, June 20, on the occasion of the fifty-first annual meeting of the Yorkshire Union of Mechanics' Institutes.

Sir Edward Baines, for in him we have a living picture of the history of the educational progress of the century. Truly, he has been a witness, and an active witness, of English educational reform from his earliest years, nor have his efforts in the great cause from that time forward ever ceased. Was he not even as a boy in Leeds so long ago as 1809 an earnest listener to the expositions of one who may be justly regarded as the founder of our present system of national education, I mean Joseph Lancaster? The name of Baines, again, is intimately connected with those of Birkbeck and Brougham in the great work of founding mechanics' institutes.

The English character is ever prone to consecutive action, sudden revolutions are contrary to its spirit, and this characteristic is evidenced by the present phase of interest in so-called technical education, for this is doing nothing more than carrying out in accordance with the necessities of the hour the old principle enunciated by Birkbeck, Brougham, and Baines in 1825 in the founding of mechanics' institutions, which have for their object the teaching to our workmen the principles of art and science which underlie the trades they practise. This, too, is our definition of technical instruction. We do not attempt to teach trades, but the principles, artistic or scientific, upon which these trades depend. The school can teach how to make the best article, how to apply the principles which lie at the foundation of the manufacture. The workshop, on the other hand, teaches what the workshop alone can teach—how to produce the article most economically. This I take to be the essential distinction between school teaching and workshop practice. The boy at school learns how to do the work well, the man at the factory or shop must learn to do it not only well but most cheaply. If we keep these two parts of the question separate, give to the school what belongs to the school, and to the workshop what belongs to the workshop, we shall avoid all conflict between the so called theorist and the practical man, we shall preserve what is greatly to be prized, our English workshop experience, but add thereto a knowledge of principles which have hitherto been greatly wanting. Each does necessary work; what we desire and need to develop and to foster is the proper union of theory and practice, without which the supremacy in manufacturing industry, the chief glory and mainstay of our country, will be endangered in the industrial warfare in which all civilized nations are now engaged.

This, then, is the problem which Baines sought to solve, and which your Union and all ardent educationists of the present day are striving to accomplish. For this end we now seek Government aid, and are asking for national recognition of a national necessity. What else is the meaning of the Bills for the promotion of technical education now before Parliament? We ask simply for powers to develop and to strengthen the work which mechanics' institutes were founded to accomplish. We desire to carry on that work on sound lines; that, whilst asking for Imperial aid and for the imprimatur of a national system, we shall be left to decide for ourselves the exact mode of carrying out that system which each locality and each special industry knows is best adapted to satisfy its peculiar requirements. These should be the main objects of any Technical Bill. Are these objects properly put forward, and are these conditions properly safe-guarded in the Government Technical Bill now before Parliament? This is the pressing question of the hour. It is for you, and for similar associations throughout the length and breadth of the land, to say whether this is so or not, to satisfy yourselves on this point, and to urge your representative in Parliament—than whom none is more willing or more able to assist you—to see that your claims and opinions on this subject are made known to the Government which is responsible for bringing this great subject forward. For, gentlemen, it is a great question, one which lies at the foundation of the future welfare—I had almost said the future existence—of the nation.

May I, then, venture to call your attention to one or two of the salient points in this Bill, and to point out to you what I consider some of its valuable provisions as well as some of its defects? In the first place, then, the chief and leading principle of the Bill is the recognition that the time has arrived for giving national aid, whether from local rates or from Imperial sources, for the promotion of technical instruction. The establishment of this principle is one, I venture to think, of the highest possible importance, which if once admitted may well cover a multitude of minor defects. Still, every benefit may be purchased too dear, and it is well to look at the conditions with which this concession to public opinion is coupled. Here I am speaking to educationists, but I am also speaking in Yorkshire and to Yorkshiremen, who have always upheld, and especially at the present moment do uphold, the standard of Liberal opinion in political as well as in educational matters, and I therefore feel that in expressing my opinion against certain conditions attached to the Bill—conditions which are diametrically opposed to the ideas and principles upon which the Liberal party has always acted—I say in expressing these objections I may claim your support as well as your attention.

Clause 2 of the Bill makes it compulsory on every School Board adopting its provisions as to technical instruction—that is, upon every School Board undertaking to rate its district to the limited penny in the pound—to aid the supply of technical instruction in any other public elementary school not under its management in like manner as it aids the supply of such instruction in its own schools. This clause, which as you all will see may be most sweeping in its effects, must be entirely rejected; indeed, it could not stand one hour's scrutiny in the House of Commons, for it offends against the cardinal principle that those who pay the rates should have a voice, either directly or indirectly, in the spending of them, and this is not provided for. But whilst strongly objecting to this compulsory clause—the only compulsory one in the Bill—I, for one, am willing to consider, and to deal fairly with, the just claims of the voluntary schools; for although I am a believer in the Liberal creed, I am before all things an educationist, and I cannot forget that if we are to have our children made more fit for succeeding in the modern battle of life, we must endeavour to bring to bear upon them all, without distinction of creed or of party, the lever which will raise them in the social scale and enable them to use their heads and their hands to their own benefit, and therefore to that of the nation of which they form the units.

Hence, remembering that more than one-half of our population are educated in voluntary schools, and that in many localities these schools are the only ones in existence, and moreover that they are doing excellent educational work, I, speaking for myself, whilst strongly opposed to any compulsory powers, do not feel the same difficulty in admitting the provisions of the first clause in the Bill by which "any School Board in England may from time to time supply, or aid the supply of, such manual or technical instruction or both, as may be required, for supplementing the instruction in any public elementary school in its district, whether under its own management or not." This clause, you will perceive, enables School Boards if they think fit to assist voluntary schools in their districts by aid from the rates for the special purposes of technical instruction, and through the School Board the ratepayers have a voice as to whether their rates shall or shall not be thus spent. But here comes in the limiting clause that not more than 1*d.* in the pound shall be spent. I object to this limit. It will obviously be very difficult for any School Board to ascertain how far the expenses of giving technical instruction can be accurately defined, and I should prefer to leave the amount spent on this object to the good sense and judgment of the locality as represented by the School Board. But how about districts which possess no School Board? Are they to be left out in the cold? No. Provision is made in a further clause by which any local authority having adopted the Free Libraries Acts may hand over to the voluntary schools in its district a sum not exceeding 1*d.* in the pound for the purpose of supplying technical education to be given in its district public elementary schools. Here again the clause is a permissive one only, and the local authority as representing the ratepayers is the judge of whether and how far such aid is to be given. I do not like the plan of mixing up the vexed question of free libraries with that of technical education, and should much prefer the names of the authorities to be simply scheduled, as I see grave objections to the necessary *plébiscite* in districts which have not already adopted the Acts. Still I do not know that on this account I should wish to see the Bill rejected.

Another grave defect in the Bill is a limit is placed on the teaching of technical subjects in Board schools at the seventh standard. This deals a fatal blow at the higher elementary schools. Thus in the Central School in Manchester at the present moment no fewer than 500 scholars who have passed Standard VII. are now learning the sciences—subjects included within the term technical instruction. These scholars cannot continue thus to be taught under the Bill. We must have a similar provision introduced to that in the Scotch Bill, by which the Boards are empowered to use the rates for the maintenance of higher-grade schools; and these matters must be attended to if we are to have a Technical Bill worthy of the name. The higher technical education, as that given in the Colleges, may be assisted by rates levied by local authorities or by Imperial grants, in addition to those made now by the Department. All acknowledge the importance of this higher training. If the head is not educated, the hands are apt to get into mischief. Hence, as these University Colleges can never be self-supporting, it is greatly to be hoped that they will receive that national aid which their importance to the State demands.

But we have a second Bill before the House of Commons—one introduced by myself on behalf of the National Association for the Promotion of Technical Education. I naturally prefer the provisions of my own Bill to those of the Government. They are much simpler, less clogged and hampered by conditions, and confer the same benefits as the Government Bill proposes to confer, with one exception only, viz. aid from the rates to voluntary schools, for to this many of my friends are strongly opposed; but, so far as I am myself concerned, I am free to admit that I should not object to see the difficulty settled by permissive powers being given to the School Boards to aid voluntary schools in their district, just as it is proposed that local authorities shall have power to do the same where no School Boards exist; for, as I have pointed out, the ratepayers have it in their power to refuse such payments by electing members who will oppose such an application of the rates.

Now, to turn to the more immediate question relating to your Union, you may, I think, be gratified with the results of your fifty-one years' work. You can look back upon half a century of admirable endeavour. You have now 260 institutions in union, containing upwards of 500,000 members and 14,000 technical students. You have spent half a million of money in buildings contributed by voluntary subscriptions, with the exception of 1 per cent. derived from S.K. grants for building. All the members of your committees are unpaid, and many of them have been at work for you all their lives. Your claims for national aid are therefore high, and such aid is much needed, for, though the progress you have made is great, you have not nearly accomplished all that has to be done. We want continuation evening schools established on a new and generous basis. We want a new and more elastic evening school code. We want to emancipate from the rigid lines and requirements of payment on individual results. We want an attendance and merit grant for evening continuation schools—say 12*s*. per head for attendance of sixty nights to insure good and continuous teaching. Above all, we wish that existing institutions should be rendered effective. The 260 institutes are in existence, but need help.

When we look abroad we see that both Governments and municipalities vie with each other in aiding technical schools. They are proud to do so, for they know their value. "Do you suppose," said an intelligent German to me, "that we, weighted as we are with heavy taxation for our military and civil services, would willingly further tax ourselves for the purposes of technical schools unless we were convinced that the outlay will repay us over and over again?" This is German opinion, and it is the opinion which we need to inculcate in the minds of our own people, for then we shall get what we want.

Nor need we be ashamed of the beginnings which we have already made; many of our existing institutions will bear favourable comparison with Continental models. Take Huddersfield for example; the school there exactly meets the requirements of the district, and it has already exerted a very marked and beneficial influence on the trades of the district, especially as concerns dyeing and design. This school cost £20,000, all raised by voluntary effort, but though doing excellent work it is heavily in debt, and its friends have difficulty in raising funds to keep it going—not for lack of pupils, for the school is largely attended, but for the reason that such higher schools cannot be self-supporting, and the greater the number of pupils the greater the cost. Surely, if our people understood their true interests as well as our neighbours and competitors do, they would not rest until such an institution is placed in a position to do all it can to raise the condition of their industries by supplanting the too common and worn-out rule of thumb by scientific knowledge always new and always productive. Then again at Yeadon, a small place, you have a school which cost £7000 to build, and in which 350 students are being instructed. But here, too, funds are urgently needed to carry on the work. Surely there ought not to be many who grudge spending a penny in the pound on such objects. In Castleford itself, your Mechanics' Institute has done during its forty years of life, and is now doing, good work. The building is, however, too small for the requirements of the day; your numbers have increased from 80 to 210, and the necessary appliances for teaching science and technology are deficient. Let us hope that when the Technical Bill becomes an Act, Castleford will be one of the first to take advantage of its provisions.

But you may ask, What good will come to our leading industries here—coal and glass—by your technical education? How shall the employers and employed benefit therefrom? In the first place, then, there is no industry in which the value of even a little scientific training is so important for both masters and men as in that of coal-getting. Such a training may, for instance, be, and indeed has often been, the means of saving hundreds of valuable lives. One ignorant man may place in jeopardy or even sacrifice by a single careless act the lives of his comrades, an act which no one acquainted with the properties of explosive gases would dare to commit. In a thousand other ways scientific knowledge—which after all is only organized common-sense—will help all concerned in this great industry. So again in glass-making, how great is the aid given by scientific and artistic knowledge. What a step was the introduction of the Siemens regenerative tank furnace, and how much more remains to be achieved. Then your bottle trade might, by the application of artistic knowledge, be made the foundation of a higher and more tasteful industry which might successfully compete with the wares of Bohemia and Venice. Why not? Are not our workmen both mentally and physically superior to the foreigner? I believe them to be so. They only need teaching, and that we have hitherto withheld from them.

It has been well said that whilst we have confined our attention to improving our machines, the Germans have devoted themselves to educating their men. Let us lose no time in following their lead. "What we fear," said one of the masters to me, "is not either free trade or protection. What we fear is that some day you English will wake up to the necessity of educating your manufacturing population as we do, and then with your racial and physical advantages it will become difficult, if not impossible, for us to compete with you." Let us, then, take to heart the old adage that victory comes to the strong, but remember that it is not to the bodily strong, but only to the strong mentally and morally that the victory comes. Let us see that in this struggle for existence our people are healthy and vigorous in all these three essentials, and act upon the true and eloquent words of Huxley, "You may develop the intellectual side of a people as far as you like, and you may confer upon them all the skill that training and instruction can give, but if there is not underneath all that outside form and superficial polish the firm fibre of healthy manhood and earnest desire to do well, your labour is absolutely in vain."

THE INTERNATIONAL GEOLOGICAL CONGRESS.

ADMIRABLE arrangements have been made for the London meeting of the International Geological Congress, from September 17 to 22 next. The following details are taken from a printed letter signed by the General Secretaries, Mr. J. W. Hulke and Mr. W. Topley. The meetings will be held in the rooms of the University of London, Burlington Gardens, where accommodation for the Council, Committees, Exhibition, &c., has been granted by the Senate of the University. There is a refreshment-room in the building, and there are several restaurants and hotels in the immediate neighbourhood. Arrangements will be made at one of these restaurants for a room to be set apart for the social meetings of members of the Congress. The opening meeting of the Congress will take place on Monday evening, September 17, at 8 p.m., when the Council will be appointed, and the general order of business for the session will be determined. The ordinary meetings of the Congress will be held on the mornings of Tuesday, the 18th, and succeeding days, beginning at 10 a.m. In the afternoons there will be visits to Museums, or to places of interest in the neighbourhood of London. Arrangements for the evenings will be made at a later date. The ordinary business of the Congress will include the discussion of questions not considered at Berlin, or adjourned thence for fuller discussion at the London meeting. Amongst these are: the geological map of Europe; the classification of the Cambrian and Silurian rocks, and of the Tertiary strata; and some points of nomenclature, &c., referred to the Congress by the International Commission. Miscellaneous business will also be considered. In addition to these questions, the Organizing Committee proposes to devote a special sitting to a discussion on the Crystalline Schists. An Exhibition will be held during the week of the Congress, to which geologists are invited to send maps, recent memoirs, rocks, fossils, &c. Foreign members of the Congress are invited by the Council of the British Association to attend the meeting of that Association at Bath. During the week when the Association meets, there will be short excursions in the neighbourhood of Bath, and longer excursions will be made after the meeting. At these excursions excellent sections of the Lower Secondary and Upper Palæozoic rocks will be visited. Excursions will take place in the week after the meeting of the Congress (September 24 to 30). The number of these will depend upon the number of members desirous of attending, and upon the districts which they most wish to visit. The excursions at present suggested are:—(1) The Isle of Wight (visiting the Ordnance Survey Office at Southampton on the way)—Cretaceous, Eocene, Oligocene. (2) North Wales—Pre-Cambrian and the older Palæozoic rocks; West Yorkshire (Ingleborough, &c.)—Silurian and Carboniferous Limestone. (3) East Yorkshire (Scarborough, Whitby, &c.)—Jurassic and Cretaceous. Should the number of members be so large as to make additional excursions necessary, they will probably be:—(4) Norfolk and Suffolk—Pliocene (Crag) and Glacial beds. (5) To the Jurassic rocks of Central England. The short excursions during the week of the Congress will probably be to Windsor and Eton, to St. Albans, to Watford, to Brighton, to the Royal Gardens at Kew, and to other places of interest. Brief descriptions of the districts to be visited in these excursions will be prepared (with illustrative sections, &c.), and will, if possible, be sent to members before the meeting. The full Report of the London meeting will be issued soon after the close of the session. It will contain, in addition to reports of the ordinary business of the Congress, the Report of the American Committee on Nomenclature (about 230 pp.); the Memoirs on the Crystalline Schists (about 150 pp.), and reports of discussion on the same; and probably a reprint, with additions, of the Report of the English Committee on Nomenclature (about 150 pp.).

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The Burdett-Coutts Scholarship in Geology has been awarded to Mr. M. Hunter, B.A., Queen's College.

The degree of M.A. *honoris causâ* has been conferred on Dr. S. J. Hickson, the Deputy Linacre Professor, and on Mr. Wyndham R. Dunstan.

Scholarships in Natural Science are announced for competition, at Merton and Corpus jointly on June 26, at Magdalen on October 9, and at Balliol, Christ Church, and Trinity jointly on November 20. Information may be had from the science tutors of the various Colleges.

A statute is being discussed by Congregation, which will place the biological sciences on the same footing as the physical sciences so far as the examinations for pass degrees are concerned, and it is hoped that the changes to be introduced will increase the numbers of the biological and medical schools.

Mr. F. J. Smith, of the Millard Laboratory at Trinity, has been appointed University Lecturer in Mechanics and Experimental Physics.

CAMBRIDGE.—An amended report on the Natural Science Examinerships has just appeared, but the scheme proposed is very complex. It having been found difficult to get examiners to undertake the honours, and ordinary degree, and M.B. examinations combined, it is proposed to separate the elementary examination work, and appoint two examiners each in elementary chemistry, in elementary physics, and in elementary biology, while two examiners in each subject of the Natural Sciences Tripos are to be appointed as before, and two in pharmaceutical chemistry, for the second M.B. Thus there will be twenty-four examiners in all. The examiners are to be paid a minimum of fifteen, twenty, or thirty pounds each, with a payment of five shillings for each Tripos candidate in their subject, or one, two, and four shillings per candidate in other examinations. Moreover, it is required that all papers and all practical work in honours shall be examined by both examiners in a subject. Both examiners are to be present at all oral work in their subject; and all examiners must be present at the meeting for arranging the class-list for any examination. We prognosticate that the list of examiners, if at all worthy of the University, will not largely consist of non-residents, under the new scheme. The worst mistake perhaps that the University makes is in continuing the one-sided ordinary degree examinations in single subjects, such as geology, botany, and zoology; for all combined there were only four candidates in the last academical year; and for these there were six separate examinations provided, though two were not held. The chemistry "special" attracts a number of candidates, who might be much better employed in preparing for the First Part of the Natural Sciences Tripos. It would be far easier to work the Natural Science Examinations if these were abolished. It is absurd to keep up a machinery of examination which is tabooed even by candidates. The Tripos is a success, which the specials are not, and still more liberal payments and regulations ought to be made. It ought to be remembered that the graduates pay heavy degree fees in addition to examination fees.

The examiners for 1888 in the Second Part of the Mathematical Tripos were Edward John Routh, Sc.D., Peterhouse; James Whitbread Lee Glaisher, Sc.D., Trinity College; Joseph John Thomson, M.A., Trinity College; Andrew Russell Forsyth, M.A., Trinity College. The names, in each class and in each division, are arranged in alphabetical order, and not in order of merit. All the candidates passed the Mathematical Tripos, Part I., in June 1887.

Class I.—Division 1.—Baker, B.A., Joh.; Berry, B.A., Trin.; Flux, B.A., Joh.; Mitchell, B.A., Trin. Division 2.—Brown, B.A., Christ's; Clay, B.A., Trin.; Iles, B.A., Trin.

Class II.—Little, B.A., Trin.; Norris, B.A., Joh.; Peace, B.A., Emman.; Soper, B.A., Trin.

Class III.—None.

The faint hope that there was till lately that a Geological Museum might soon be begun has been dissipated by the Financial Board having reported that the University has no funds available at present, although the Sedgwick Fund has £19,000 in hand to supplement the University contribution.

The late Sir Charles Bunbury's valuable herbaria have been presented to the University by Lady Bunbury.

At the Annual Scholarship Election at St. John's College, on June 18, the following awards in Natural Science were made:—Foundation Scholarships continued or augmented—Seward, Rolleston, Rendle. Turpin, Groom, d'Albuquerque; Foundation Scholarships awarded—Hankin, Horton-Smith, Locke, Baily, Simpson; Exhibitions awarded—d'Albuquerque, Hankin, Horton-Smith, Blackman, Schmitz. In Mathematics, the following awards were made:—Foundation Scholarships continued or augmented—Baker, Flux, Norris, Orr, Sampson, Harris, Rudd, Bennett; Foundation Scholarships awarded—Palmer, Carlisle, Burstall, Monro, Cooke, Lawrenson; Exhibitions awarded—Sampson, Harris, Monro, Dobbs, Reeves, Bennett, Burstall, Cooke, Lawrenson, Brown, Finn, Kahn, Salisbury, Schmitz, Shawcross; Proper Sizarship awarded—Finn. Wright's Prizes to Simpson, Hankin, Blackman, for Science; and Orr, Burstall, Reeves, for Mathematics. The Herschel Prize to Salisbury, for Astronomy; the Hockin Prize for Electricity not awarded. The Hutchinson Studentship of £60 a year for two years is awarded to Mr. G. S. Turpin for research in Organic Chemistry; and the Hughes Prize to Orr (Senior Wrangler) and Brooks (Senior Classic).

SCIENTIFIC SERIALS.

American Journal of Science, June.—Note on earthquake-intensity in San Francisco, by Edward S. Holden. The object of this paper is to obtain an estimate of the absolute value of the earthquake-intensity developed at San Francisco during the American historic period, based on the very complete records collected by Thomas Tennant. The intensity of each separate shock (417 altogether) is assigned on the arbitrary scale of Rossi and Forel. The total average intensity during the 80 years from 1808 to 1888 is found to be nearly equal to the intensity of 28 separate shocks as severe as that of 1868, and the 417 shocks of known intensities correspond to 33,360 units of acceleration.—On the relations of the Laramie Group to earlier and later formations, by Charles A. White. The author's further studies of this group, by some geologists referred to the Tertiary, by others to the Cretaceous ages, lead to the conclusion that the upper strata form a gradual transition from the latter to the former, while there is strong presumptive evidence of the Cretaceous age of the greater part of it.—The gabbros and diorites of the "Cortlandt Series" on the Hudson River near Peekskill;

New York, by George H. Williams. With this paper the author concludes for the present his elaborate petrographic studies of the extremely varied massive rocks of the "Cortlandt Series," as it has been designated by Prof. J. D. Dana. He treats in detail the gabbro, diorite, and mica-diorite varieties of norite occurring chiefly in the south-western portion of the area. —Three formations of the Middle Atlantic slope (continued), by W. J. McGee. In this concluding paper the whole subject of the Columbia formation is recapitulated, the general conclusion being that it is much older than the moraine-fringed drift-sheet of the North-Eastern States, and that while th evertebrates of its correlatives suggest a Pliocene origin, both stratigraphy and the invertebrate fossils prove that it is Quaternary. Thus the Columbia formation not only enlarges current conceptions of Quaternary time, and opens a hitherto sealed chapter in geology, but at the same time bridges over an important break in geological history, between the Tertiary and Quaternary epochs.—A comparison of the elastic and the electrical theories of light with respect to the law of double refraction and the dispersion of colours, by J. Willard Gibbs. The main object of this paper is to show the great superiority of the electric over the elastic theories of light as applied to the case of plane waves propagated in transparent and sensibly homogeneous media. The phenomena of dispersion here studied corroborate the conclusion which seemed to follow inevitably from the law of double refraction alone.—Mr. Henry J. Biddle contributes some valuable notes on the surface geology of Southern Oregon, visited by him during the summer of 1887.

SOCIETIES AND ACADEMIES.

London.

Royal Society, June 7.—"An Additional Contribution to the Placentation of the Lemurs." By Prof. Sir Wm. Turner, Knt., M.B., LL.D., F.R.S.

In 1876 the author contributed to the Royal Society a memoir "On the Placentation of the Lemurs," which was published in the Philosophical Transactions of that year (vol. clxvi. Part 2). The gravid uteri which he examined and described were from specimens of *Propithecus diadema*, *Lemur rufipes*, and *Indris brevicaudatus.*

In April of the present year he received from Mr. F. E. Beddard, Prosector to the Zoological Society of London, the gravid uterus of a Lemur, which was *Lemur xanthomystax*.

The examination of this gravid uterus confirmed the conclusions to which both Alphonse Milne Edwards[1] and the author had arrived independently from previous investigations, that the placenta in this important group of animals is diffused and non-deciduate, and that the sac of the allantois is large and persistent up to the time of parturition. In these important respects, therefore, the Lemurs, are, in their placental characters, as far removed from man and apes as it is possible for them to be.

Although the author is not disposed to attach too much weight to the placenta as furnishing a dominant character for purposes of classification, yet he cannot but think that animals which are megallantoid, non-deciduate, and with the villi diffused generally over the surface of the chorion, ought no longer to be associated in the same order with animals in which, as in the apes, the sac of the allantois early disappears, and the villi are concentrated into a special placental area, in which the fœtal and maternal structures are so intermingled that the placenta is highly deciduate. Hence he is of opinion that the Lemurs ought to be grouped apart from the Apes in a special order, which may be named either with Alphonse Milne Edwards *Lemuria*, or with Victor Carus and others *Prosimii.*

The fœtus possessed an imperfect covering, external to the hairy coat, and quite independent of the amnion, composed of a cuticular membrane. It corresponded with the envelope named by Welcker *epitrichium*, and described both by him and by the author as present in *Bradypus* and *Cholopus.* But it occurred in the fœtus both of *Lemur xanthomystax* and *Propithecus diadema* in flakes and patches, and not as a continuous envelope as in the Sloths.

[1] "Histoire Naturelle des Mammifères de Madagascar," forming vol. vi. chap. ix. of Grandidier's "Histoire de Madagascar."

Physical Society, May 26.—Mr. Shelford Bidwell, F.R.S., Vice-President, in the chair.—The following communications were read:—Note on the governing of electromotors, by Profs. W. E. Ayrton and J. Perry. In a paper read before the Society of Telegraph-Engineers in 1882 the authors deduced the conditions of self-regulation of electromotors for varying load when supplied either at constant potential or with constant current. The conditions involved "differential winding," *i.e.* the use of a shunt motor with series demagnetizing coils. With this arrangement fairly good regulation has been obtained, but owing to want of economy the methods have not been developed further. Since then another arrangement, in which a simple shunt motor is used, and a few accumulators placed in series with the armature, has been devised for working in a constant current system. By means of a suitable switch, the accumulators can be charged when the motor is at rest. On the assumption that the E.M.F. of motors is given by $E = n(p + tZ)$, where n = speed, Z = number of turns on magnets, and p and t are constants, it is shown that the speed at which a motor will govern is given by

$$n = \frac{z + a + a'}{t},$$

and the constant current

$$C = \frac{e - np}{a + a'},$$

where z and a are the resistances of the shunt and armature respectively, and e and a' the E.M.F. and resistance of the accumulators. Since a and a' may be small and np not large, the value of e need not be great to give a considerable value for C, and thus only a small number of accumulators will be required. —On the formulæ of Bernoulli and Haecker for the lifting-power of magnets, by Prof. S. P. Thompson, read by Prof. Perry. The formulæ referred to are $P \propto \sqrt[3]{W^2}$ and $P = a\sqrt[3]{W^2}$ respectively, where P = lifting-power, W = mass of magnet, and a a constant depending on the material and shape of the magnet. These formulæ, the author shows, are equivalent to saying that the lifting-power of magnets in which the magnetic induction, B, has been carried to an equal degree, is proportional to the polar surface, and that Haecker's coefficient a is proportional to B^2 through the surface. Assuming the induction uniform over the surface, it is shown that

$$P = \frac{1}{8\pi} B^2 A,$$

where A = area of surface, and this gives a very convenient method of determining B from measurements made upon the pull exerted at a given polar surface. If P be measured in kilogrammes and A in square centimetres, the formula for B becomes

$$B = 5000 \sqrt{\frac{P}{A}};$$

and if the measurements be made in pounds and inches, the constant becomes 1317. It will be readily seen that the greater power of small magnets in proportion to weight does not require for its explanation the sometimes alleged fact that small pieces of steel can be more highly magnetized than large ones, for if B be the same, the lifting-power will be proportional to the polar surface, and not to weight, and hence must necessarily be greater relatively to weight in small magnets. In the case of electromagnets for inductions between 6000 and 16,000, between which the permeability, μ, is approximately given by

$$\mu = \frac{16{,}000 - B}{3 \cdot 2},$$

the lifting-power is shown to be

$$P = A\left(\frac{3 \cdot 2\, Si}{Si + 2 \cdot 56 l}\right)^2,$$

where P is in kilogrammes, A in square centimetres, Si = ampere turns, and l = mean length of the magnetic circuit.—Experiments on Electrolysis; Part ii., Irreciprocal Conduction,[1] by Mr. W. W. Haldane Gee and Mr. H. Holden. An abstract was read by the Secretary. The authors have observed, when strong sulphuric acid is used as an electrolyte, the electrodes being of platinum, that the decomposition nearly ceases, if, by decreasing the resistance in circuit, it is attempted to increase the current beyond a certain maximum. When this condition (called the insulating condition) is arrived at, reversing the current immediately restores the conductivity. Experiment shows that the current density is an important factor, and that the composition,

[1] Irreciprocal conduction is said to occur if a reversal of the direction of a current causes any change in its magnitude.

viscosity, and temperature of the electrolyte, as well as the previous history of the electrode, have considerable influence on the current density at which the insulating condition occurs. The seat of the insulating layer is found to be at the anode; and the authors believe it due to very concentrated acid formed around the electrode, whose specific resistance is very high. Experiments were also made with carbon and gold electrodes, and phosphoric acid, caustic potash, soap, and sodium benzoate were used as electrolytes, the results of which seem compatible with the concentration hypothesis above stated. The paper contains an historical and critical account of allied phenomena, and tables expressing the numerical results obtained by the authors are given.

Linnean Society, June 7.—Mr. Carruthers, President, in the chair.—The following were nominated Vice-Presidents: Mr. F. Crisp, Dr. Maxwell Masters, Dr. John Anderson, Mr. C. B. Clarke.—An exhibition under the microscope of decalcified and stained portions of the test of *Laganum depressum* was then given by Prof. Martin Duncan, who made some very instructive remarks on the structural characters to be relied on for discriminating the species.—Mr. D. Morris, of Kew, exhibited some drawings of a Fungus (*Exobasidium*) causing a singular distortion of the leaves of *Lyonia*, from Jamaica.—A paper was then read, by Mr. H. N. Ridley, on the natural history of Fernando Noronha, in which he gave the general results of his investigations into the geology, botany, and zoology of this hitherto little-explored island.

Royal Meteorological Society, May 16.—Dr. W. Marcet, F.R.S., President, in the chair.—The following communications were read:—Report of the Wind Force Committee on experiments with anemometers conducted at Hersham, by Mr. G. M. Whipple and Mr. W. H. Dines. A whirling apparatus, with arms 29 feet radius, was rotated by means of a small steam-engine. On the arms of the whirler four different anemometers were placed. Each experiment lasted fifteen minutes, the steam-pressure remaining constant during the run. For the Kew standard anemometer, with arms 2 feet long, the experiments give a mean value for Robinson's factor of 2·15; and for two smaller instruments the factor is 2·51 and 2·96. Mr. Dine's helicoid anemometer gave very satisfactory results, the mean factor being 0·996.—On the measurement of the increase of humidity in rooms by the emission of steam from the so called bronchitis kettle, by Dr. W. Marcet, F.R.S. The author described a number of experiments which he had made by steaming a room with a bronchitis kettle, and ascertaining the rise and fall of the relative humidity from readings of the dry- and wet-bulb thermometers. He found that the air in the room could not be saturated, the relative humidity not exceeding 85 per cent.

Entomological Society, June 6.—Dr. D. Sharp, President, in the chair.—Mr. Pascoe brought for exhibition a book of fine plates of *Mantidæ*, drawn by Prof. Westwood, which it had been hoped would have been published by the Ray Society.—Mr. E. Saunders exhibited a species of Hemiptera, *Monanthia angustata*, H-S., new to Britain, which he had captured by sweeping, near Cisbury, Worthing. The insect is rather closely allied to the common *Monanthia cardui*, L.—Mr. McLachlan exhibited a species of *Halticidæ*, which had been sent him by Mr. D. Morris, Assistant Director of the Royal Gardens, Kew, who had received them from Mr. J. H. Hart, of the Botanic Gardens, Trinidad, with a note to the effect that they had attacked young tobacco and egg-plants badly in that island. Mr. Jacoby had, with some reserve, given as his opinion that it might possibly turn out to be *Epitrix fuscata*, Duv., a species which had been described from Cuba.—The Rev. H. S. Gorham exhibited a collection of beetles lately captured in Brittany including *Diachromus germanus*, L., *Onthophagus taurus*, L., *Hister sinuatus*, Ill., and other species which are exceedingly rare, or altogether wanting in Britain, and yet occur very commonly in the north of France.—Mr. White exhibited living larvæ of *Endromis versicolora*, from near Bristol, and remarked that when quite young they are nearly black, owing to being very thickly spotted with that colour; the body-colour is green, and after two or three changes of skin the spots disappear. Mr. White also exhibited two preserved larvæ of *Phorodesma smaragdaria*, which he had recently taken, and made some remarks concerning the so-called "case," which this insect is said to construct from the leaves of its food-plant, *Artemisia maritima*. This he did not consider to be really a case, but he had discovered that the larva possessed on its segments certain secretory glands, at the apex of each of which there is a bristly hair; this appears to retain pieces of the plant, which are probably fixed firmly afterwards by means of the secreted fluid. These pieces are very irregularly distributed, and their purpose does not seem quite evident.—Mr. Lewis exhibited about three hundred specimens of the genera *Hetærius*, Er., and *Eretmotus*, Mars. The most remarkable of these was *Hetærius acutangulus*, Lewis, discovered last year by Mr. J. J. Walker near Tangier, and recently taken by him at San Roche, in Spain.

PARIS.

Academy of Sciences, June 11.—M. Janssen, President, in the chair.—A study of the refrigerant mixtures obtained with solid carbonic acid, by MM. Cailletet and E. Colardeau. These researches seem to show that the ether generally used in combination with snow and carbonic acid for the purpose of obtaining intense cold, plays a much greater part than has been supposed in lowering the temperature of the mixture.—Representation of the attitudes of human locomotion by means of figures in relief, by M. Marey. The figure of a runner at a given moment is here reproduced from a relief obtained by M. Engrand by means of the photochronograph. It is pointed out that a continuous series of such figures, obtained by this process, would be of great service in determining for artists and physiologists the successive changes of attitude in running and walking.—Determination of the mean level of the sea, by means of a new instrument, by M. Ch. Lallemand. In a previous note (*Comptes rendus*, May 28, 1888) the principle was described of this apparatus, which is here figured and named the *medimaremeter*. It gives the mean sea-level without any mechanical adjustments, and almost without the need of calculations.—On the artificial reproduction of hydrocerusite, on the chemical composition of this mineral species, and on the constitution of white lead, by M. L. Bourgeois. These synthetic researches throw much light on the hitherto problematical nature of hydrocerusite, as well as on the constitution of white lead (ceruse), in which the author distinguishes only two definite substances, both existing in nature—hydrocerusite and cerusite. Analysis shows that the formula of the artificially prepared hydrocerusite is $3PbO,2CO_2,HO$, or $2(PbO,CO_2) + PbO,HO$, which is no doubt that of the natural substance also.—On the variations of the personal equation in the measurement of double stars, by M. G. Bigourdan. Thiele supposes that the personal equation of each observer remains somewhat constant during a "season of observations," and then takes a different value for another period, the duration of the "seasons" varying from a few days to several months. But according to Struve these variations are rapid, occurring in a few hours, and lasting only a single night. The observations of the author tend to show that these apparently contradictory views are capable of being reconciled, both being to a certain extent true.—On the determination of some new rings of Saturn lying beyond those already known, by Dom Lamey. These were first vaguely perceived by the author in 1868, and have been repeatedly observed since February 12, 1884, with the 16 cm. refractor in the clearer atmosphere of the Grignon Observatory. They are four in number, and are visible as well-defined elliptical rings in the regions intermediate between Mimas and Titan, first and sixth satellites of Saturn. The semi-diameter of the planet being taken as 1, the semi-diameter of the rings, measured from the middle of the most intense region, would be $2·45 \pm 0·05$; $3·36 \pm 0·02$; $4·90 \pm 0·50$; $8·17 \pm 0·23$. They were also independently observed by two of the author's fellow-workers, and cannot therefore be explained away as optical illusions due to the terrestrial atmosphere or any other sources of error.—On a point in the history of the pendulum, by M. Defforges, with remarks by M. C. Wolf. In connection with Kater's memoir of 1818, presented to the Royal Society, on the "convertible" pendulum, and his repudiation of de Prony's claim to priority of invention, M. Defforges announces the discovery of some documents in the Ecole des Ponts et Chaussées fully confirming de Prony's claim. M. Wolf, however, points out that these documents (undated, but no doubt written in 1800) were never published, and certainly unknown both to Bohnenberger when he announced the project of a pendulum with reciprocal axes (1811), and to Kater when he rejected de Prony's claim to priority of invention (1818). Hence, although de Prony now appears to have been the precursor, the rights of Bohnenberger and Kater remain intact as discoverers of the principles to which is due the revolution effected in the observations of the pendulum during the present century.—On a correction to be made in Regnault's determinations of the weight of a litre of the elementary gases, by M. J. M. Crafts. The error already pointed out by Lord Rayleigh is here corrected for air, N, H, O, and CO_2.—Experiments with a non-oscillating pendulum, by M. A. Boillot. It is shown that the oscillating pendulum, which in Foucault's experiment demonstrates the movement of the globe, may be used for the same demonstration by suppressing the oscillatory action and operating in a room.—Measurement of the velocity of etherification by means of electric conductors, by M. Negreano. A process is explained for measuring the rapidity of the chemical reactions which take place between certain resisting bodies at the moment their electric resistances become varied. These resistances have been measured according to the method indicated by Lippmann.—On a diamantiferous meteorite, which fell on September 10/22, 1886, at Novo-Urei, in the Government of Penza, Russia, by MM. Ierofeieff and Latchinoff. Analysis of this specimen, weighing 1762 gr., shows that it contains 1 per cent. of very fine carbonado, or diamond dust, besides 1·26 of amorphous carbon. The other chief substances were—peridot, 67·48; pyroxene, 23·82; and nickled iron, 5·45.

Berlin.

Physical Society, June 1.—Prof. von Helmholtz, President, in the chair.—Dr. Lummer gave an account of experiments which he had made on the determination of the focal length of lenses by the method of Abbe in Jena. The method is based upon the equation $f = \frac{a}{\beta_1 - \beta_2}$; where f is the focal length, a the distance of two objects from the lens, and β_1 β_2 the respective magnifications of their images. The speaker discussed first the way by which Abbe had arrived at the above equation, and then went thoroughly into an explanation of the methods for measuring the amount of magnification of the images. It must suffice here to say briefly that the magnification was measured by a microscope directed along the principal axis of the lens, and at right angles to its surface, the microscope then being moved backwards and forwards, until the upper and lower ends of the image were visible. Prof. von Helmholtz explained that during his physiological-optical researches he had already determined the focal lengths of lenses by the measurements of the magnification, in accordance with the formula given above, admitting at the same time that his methods were perhaps less exact.—Dr. Lummer then gave an abstract of a paper on the movement of air in the atmosphere, which he had recently read before the Academy of Sciences. In solving the problem, he had made use of the principle of mechanical similarities. When the hydrodynamic equation for a given motion is known, it is only necessary to multiply all the factors by n in order to represent the motion in much larger dimensions. Accordingly if the conditions of the occurrence of air currents, such as take place in the atmosphere, have been experimentally determined in the laboratory for 1 cubic metre of air, and if the atmosphere is assumed to be 8000 metres high, then the space, time, and moment must be multiplied by 8000, while on the other hand the internal friction must be taken as being only 1/8000 of that which has been determined by experiment. It follows from this that the internal friction is of very small account; but as against this, the friction of the earth's surface has a considerable influence and cannot be neglected. Supposing a mass of air moving horizontally is considered, then a series of particles of air, which were at the outset vertically each above the other, will finally place themselves along a curve of sines as the result of friction at the earth's surface. Calculation shows that it would require a period of 42,000 years before the motion was reduced to one-half as the result of internal friction. The speaker then considered the atmosphere as made up of rings of air which surround the earth in coincidence with the parallels of latitude: each of these rings of air has its own moment of rotation, which depends on its radius, and is therefore greatest at the equator and least at the poles. If the air which is streaming upwards at the equator were to stream down again to the earth in higher latitudes, it would be moving with a velocity far exceeding that of any known storm, even at the latitude of 30°. Since the internal friction of the air is so small that it may be neglected, the speaker proceeded to point out the other factors which have an influence in slowing down the air as it falls. He regards them as being the vortex motions which take place in the atmosphere at the discontinuous surfaces of two masses of air moving with different velocities. These vortex motions cause the adjoining layers of the two masses of air to mix, and thus diminish their velocity. This is the explanation of the calms, trade-winds, sub-tropical rains, and other phenomena which occur in the atmosphere. It would occupy too much space to give even a brief statement of how these conclusions are arrived at.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

A Course of Practical Instruction in Botany, Part 1, 2nd edition: Prof. F. O. Bower (Macmillan).—Lessons in Elementary Mechanics, Stage 2: W. H. Grieve (Longmans).—Observations on the Embryology of Insects and Arachnids: A. T. Bruce (Baltimore).—Smithsonian Report, 1885, Part 2 (Washington).—Birdsnesting and Bird-skinning, 2nd edition: M. Christy (Unwin).—An Elementary Treatise on Mensuration: E. J. Henchie (School Books Publishing Co.)—First Elements of Experimental Geometry: P. Bert; translated (Cassell).—Introductory Inorganic Analysis: E. H. Cook (Churchill).—Origin and Growth of Religion as illustrated by Celtic Heathendom: Prof. J. Rhys (Williams and Norgate).—Sierra Leone; or the White Man's Grave: G. A. Lethbridge Banbury (Sonnenschein).—Explorations and Adventures in New Guinea: Capt. J. Strachan (Low).—Longmans' School Geography for Australasia: G. G. Chisholm (Longmans).—On the Dicotylinæ of the John Day Miocene of North America: E. D. Cope.—On the Mechanical Origin of the Dentition of the Amblypoda: E. D. Cope.—The Theory of the Tides: J. Nolan (Dulau).—The Perissodactyla: E. D. Cope (Philadelphia).—The Mechanical Origin of the Sectorial Teeth of the Carnivora: E. D. Cope (Salem).—Recent Advances in our Knowledge of the Law of Storms: F. Chambers (Bombay).—Causation of Pneumonia: H. B. Baker (Lansing).—Quarterly Journal of the Royal Meteorological Society, April (Stanford).—Quarterly Weather Report, Part 3 (Eyre and Spottiswoode).—Hourly Readings, 1885 (Eyre and Spottiswoode).—Travaux de la Société des Naturalistes de St. Pétersbourg, vol. xix. 1888, Section de Géologie et de Minéralogie (St. Pétersbourg).—Notes from the Leyden Museum, vol. x. Nos. 1 and 2 (Brill, Leyden).—Madras Journal of Literature and Science, Session 1887–88 (Madras).—Proceedings of the Academy of Natural Sciences of Philadelphia, Part 1, 1888 (Philadelphia).—Internationales Archiv für Ethnographie, Band i. Heft 3 (Trübner).

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