

plane figure on a plane. Plan and elevation of a line which is inclined at given angles to the co-ordinate planes. The meaning of the terms "trace of a line," "trace of a plane."

The difference between a *scalar* quantity and a *vector* quantity. Addition and subtraction of vectors.

Slope of a line; slope of a curve at any point in it. Rate of increase of one quantity  $y$  relatively to the increase of another quantity  $x$ ; the symbol for this rate of increase, namely,  $\frac{dy}{dx}$ ; how to

determine  $\frac{dy}{dx}$  when the law connecting  $x$  and  $y$  is of the form  $y = ax^n$ . Easy exercises on this rule.

In setting out the above syllabus the items have been arranged under the various branches of the subject.

It will be obvious that it is not intended that these should be studied in the order in which they appear; the teacher will arrange a mixed course such as seems to him best for the class of students with whom he has to deal.

#### ANALYTICAL PORTRAITURE.

IT seems well to put on record the principal results of experiments that I have recently made to *isolate the particulars* in which one portrait differs from another. They had a measure of success, but not enough to deserve illustration or lengthy description. The objects I had hoped to attain are important; namely, to define photographically the direction and degrees in which any individual differs from the race to which he belongs, the race being represented by a composite picture of many individuals belonging to it. Or, again, to define the particulars in which any variety of a plant or animal differs from its parent species. Or to define family features; or to isolate expressions, recollecting that these consist both of subtractions from, and additions to, the features as seen in repose.

My starting point was that the exact superimposition of a rather faint positive upon its rather faint negative produces an approximately uniform grey, when they are viewed as a single transparency. Thus, I photographed a rotating disc that had been faced with white paper and divided into concentric rings. The innermost disc was left white, the outermost ring was painted black, and the intermediate rings contained successively increasing proportions of black to white. The photographic negative showed rings of graded tints, and from this I took a positive by contact. Subsequently applying the positive to the negative, film to film, and viewing them as a transparency, a nearly uniform grey surface was produced. It was necessary to superimpose them with exactness; otherwise the edges of the rings were conspicuously dark in one part, and light in the opposite part. Another test experiment was to paste together thicknesses of tracing paper—two-fold, three-fold, &c., up to twelve-fold—to cut distinctively shaped snippets of these and to variously distribute them over the surface of a glass plate, which was then photographed, and a positive taken as well. On treating the positive and negative as above, all the tints between those of the three-fold and the nine-fold inclusive produced a uniform grey.

Let A and B be any two pictures whose respective negatives and positives will be called *neg. a*, *pos. a*, *neg. b*, *pos. b*. My object was to produce photographically a third picture X which should express the difference between A and B; that is, should be equal to  $A - B$ , or else a fourth picture Y which should represent  $B - A$ .

It will, however, be simpler to treat the problem at first as an optical one, based on the following equations:—

$$(I.) \text{ pos. } a + \text{ neg. } a = \text{grey}; \quad (II.) \text{ pos. } a + x = \text{pos. } b$$

(if treated as a photographic problem, (II.) would be replaced by  $\text{pos. } a + x = \text{neg. } b$ ). From these we obtain

$$(III.) \text{ pos. } a + \{\text{pos. } b + \text{neg. } a\} = \text{pos. } b + \text{grey}$$

and

$$(IV.) \text{ pos. } b + \{\text{pos. } a + \text{neg. } b\} = \text{pos. } a + \text{grey}.$$

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Calling the terms within brackets by the name of "transformers," the transformer of  $b$  into  $a$  is the negative of the transformer of  $a$  into  $b$ . The two terms within brackets may be "composited" together on equal terms, then the result may be composited with the first term, allowing two-thirds of the total time of exposure to the transformer, and one-third to the first term. Or, what comes to the same thing in the end, all three terms may be composited in equal shares, allowing one-third of the total time of exposure to each. The transformers in (III.) and (IV.) being respectively  $x + \text{grey}$  and  $y + \text{grey}$ , are nearly equivalent for the purposes of the inquiry to  $x$  and  $y$ , because the addition of a uniform shade of grey has little or no effect on pictorial resemblance. A portrait does not cease to resemble the original when it has become somewhat browned by exposure to a London atmosphere, or when it is viewed in shade, or under a tinted glass. Its distinctiveness depends on the *differences* (not the ratios) being preserved between the tints of all adjacent elements of its surface. Of course the grey must not be too dark; otherwise the deeper tints of the portrait would appear indistinguishably black.

This method of transformation succeeds fairly well. I changed an F on a white ground into a good G on a grey ground, and I changed with passable success one portrait A on white ground into another portrait B on grey ground, but the transformer itself gave little of that information to the eye which I had expected. It *must* have nearly isolated, but it failed to exhibit in an intelligible form the differences between A and B. Then I photographed two faces, each in two expressions, the one glum and the other smiling broadly. I could turn the glum face into the smiling one, or *vice versa*, by means of the suitable transformer; but the transformers themselves were ghastly to look at, and did not at all give the impression of a detached smile or of a detached glumness.

Part of the ghastliness was due to the different densities of the superimposed positives and negatives, which did not neatly obliterate one another in the unchanged portions of the face, and part was due to their not being superimposed in the best possible way. There can be no doubt of the best fit when engaged in making the transformer of an I into an L; but the eye must determine the best fit and proportions of the two components of the transformer of one portrait into another. I cannot yet make up my mind whether or no the process admits of substantial improvement, but feel sure that the only satisfactory experiments now would be those made by two converging lanterns on a screen, one at least of which admits of easy and delicate adjustment in direction and in the intensity of its illumination. The most suitable portraits for the attempt are apparently such as are popularly, and sometimes reproachfully, termed "artistic," that is to say, with blurred outlines and medium tints; certainly not those which in photographic language are called "plucky." I have no means in my house for experiments of this kind, but perhaps a trial might be made in some laboratory where they exist. The point is to ascertain whether the images of *neg. a* and *pos. b* can be so combined on the screen as to give an intelligible and useful idea of the differences between A and B.

FRANCIS GALTON.

#### A RECOLLECTION OF KING UMBERTO.

HOW enthusiastically the late King of Italy could devote himself to the welfare of science and art, those of us who were at Como last September had an opportunity of seeing. One very hot day he arrived with the Queen and the Duke of Naples by train from their palace at Monza, near Milan. First they made an official inspection of the galleries and machinery in the Silk and Electricity Exhibition, then they visited the Exhibition of Sacred Art, and, after lunch, they opened

the Electrical Congress, held to celebrate the Volta centenary.

This was a no mere regal opening occupying a fraction of an hour, for a solid afternoon's work was done in receiving various addresses and listening to a long lecture on Volta and his pile, in which Volta's work was described at length, and even discussed from the modern standpoint of the ionic theory of voltaic action. Finally, the king had several foreigners presented to him, and he chatted with us about the things in which *we* were interested.

But even this was not enough for one day's work, since, before leaving, the Royal party went to the cathedral to listen to the new oratorio, *The Nativity*, which was exciting so much interest in Como at that time.

Such a keen personal interest in science and art made the king much loved by a people who venerate even the tomb of a worker like Volta. And those of us who saw King Umberto only at Como last year feel that it is not merely a king, but a friend who has now been killed.

W. E. AYRTON.

#### NOTES.

ON Monday next, August 6, the International Congress of Physics will be opened at Paris with an address by the president, Prof. Cornu. The Congress will then be divided into the seven following sections, which will meet in the rooms of the Société française de Physique: (1) general questions, instruction, measurements; (2) mechanical and molecular physics; (3) optics; (4) electricity and magnetism; (5) magneto-optics, radio-activity, discharges in gases; (6) cosmical physics; (7) biological physics. As many of our readers are aware, much attention has been given to the organisation of the Congress. The secretaries of the committee, Prof. Poincaré and Dr. Guillaume, have been entrusted with the production of three volumes, already in the press, containing more than seventy reports on physical questions of current interest and importance, contributed by physicists of various nationalities. Among the subjects dealt with by British physicists are: the movements produced in an indefinite solid by the displacement of a material body, by Lord Kelvin; the constant of gravitation, by Mr. C. V. Boys; the propagation of electricity, by Prof. Poynting; electric discharges in gases, by Prof. J. J. Thomson; properties of alloys, by Sir W. C. Roberts-Austen; and the unit of heat, by Mr. E. H. Griffiths. In addition there are contributions by Profs. Lorentz, van 't Hoff, Warburg, Voigt, van der Waals, H. Poincaré, Cornu, Lippmann, Potier, Becquerel, Arrhénius, Exner, Spring and others. The sectional meetings will partly be held simultaneously and partly at different hours, in order to give members an opportunity of hearing papers of interest to all physicists. In addition to the serious work of the Congress, provision has been made for lighter entertainment. The Municipal Council of Paris will hold a reception on Tuesday, August 7, and the French President will give a reception to the members on August 9. Prince Roland Bonaparte will give a soirée on August 11, and in his splendid library an exhibition of new apparatus and experiments will be held. There is thus every promise that the meeting will be both interesting and pleasant to all who are able to take part in it.

It is announced that permission has been granted for the Institution of Electrical Engineers to hold a reception in the British Royal Pavilion in the Paris Exhibition from 5 to 7 p.m., on Wednesday, August 22, and that arrangements for the reception are being made accordingly.

We learn from *Science* that the New York Board of Estimate and Apportionment has authorised the expenditure of 200,000 dollars for the Botanical Garden, and 150,000 dollars for an addition to the American Museum of Natural History.

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MR. LEONARD S. LOAT, who is investigating the fishes of Egypt for the British Museum and the Egyptian Government, was last heard of at Korti, where he reports (on May 18) a hot wind and a temperature of 115° in the shade. He had sent home upwards of 2200 specimens of Nile-fishes to the Natural History Museum, and as soon as the river had risen sufficiently would proceed to Senaar and Khartoum.

MR. J. S. BUDGETT, who is engaged in collecting fishes on the River Gambia, dates his last letters (June 22) from McCarthy's Island in the interior. There had been a disturbance in the colony, and one of the Commissioners and a party of police were believed to have lost their lives; but this had not affected Mr. Budgett's operations, and he had a large number of Polypteri and Protopteri in floating cages in the river. He was in good health, and expected to be home again in September.

THE Rocky Mountain Goat (*Haploceros montanus*) in the Zoological Society's Gardens has now put on its full white summer dress, and is well worthy of inspection. This animal, until lately, was supposed to be the only representative of the Mountain or Goat-like Antelopes in the New World, but a second species of the same genus has recently been discovered in Alaska, and named by Mr. D. G. Elliott, of Chicago, *Oreamnus kennedyi*. The form is no doubt closely allied to *Nemorhaedus* of the mountain ranges of Asia, and probably found its way to the New World in company with the Rocky Mountain Sheep and Wapiti Deer.

THE *Electrician* states that the German Electro-Chemical Society is arranging to hold its seventh annual meeting at Zürich on August 5-7. In addition to the reading of a number of papers, visits are to be paid to the Polytechnic and to the works of the Oerlikon Co.

THE Moxon gold medal of the Royal College of Physicians, founded in 1886 in memory of the late Dr. Walter Moxon, and awarded every third year for distinction in clinical medicine, has been awarded to Sir William T. Gairdner, K.C.B., F.R.S., Emeritus professor of medicine in the University of Glasgow. Prof. Clifford Allbutt will deliver the Harveian Oration on October 18 (St. Luke's Day); and Dr. A. E. Garrod, the Bradshaw Lecture in November. Dr. Henry Head has been appointed the Goulstonian, Dr. J. Frank Payne the Lumleian, and Dr. Halliburton the Croonian Lecturer for 1901, and Dr. J. W. Washbourn the Croonian Lecturer for 1902.

WE are indebted to Mr. C. Repington, of Bridge End, Ockham, Surrey, for some eggs of the Wood Leopard Moth (*Zeuzera *Æsculi**). They resemble strings of small oval beads, of a yellowish testaceous colour. The moth, although reputed scarce, is commoner round London than is generally supposed, and would be very destructive, if its numbers were not kept down by birds, notably by sparrows and woodpeckers. The eggs might be reared by placing them in chinks of the bark of almost any deciduous tree (apple, elm, &c.). The larvæ feed, like those of the Goat Moth (*Cossus ligniperda*), in the wood of growing trees, but are much less common.

QUESTIONS referring to the Marine Biological Association were asked in the House of Commons on Thursday last, and were replied to by Mr. Ritchie as follows:—"In 1885, the Treasury, when agreeing to a grant to the Plymouth laboratory of the Marine Biological Association, made it a condition 'That the council undertakes to place space in the Plymouth laboratory at the disposal of any competent investigator deputed by a recognised authority to carry out any investigation into fish questions for which the laboratory can give facilities.' The Board of Trade have never employed any naturalist to make investigations on fishes at the laboratory, and they have no staff or funds to devote to such a purpose. I have no information as