either (*a*) a characteristic absorption, consisting of one or more narrow bands and depending on the chemical structure of the dye molecule, or (*b*) a "resonance" spectrum due to colloidal particles, and much more remotely connected with chemical constitution. This spectrum is ill-defined.

The detailed experiments which have led to these conclusions will be communicated in a paper shortly to be published. A word or two is desirable in explanation of the term "resonance" spectrum. By this is denoted the type of absorption exhibited by colloidal metal solutions, glasses, and certain photographically prepared films (F. Kirschner, *Drude's Annalen*, 1904, xiii., 239; Kirschner and R. Zsigmondy, *ibid.*, 1904, xv., 573; K. Schaum and E. Schloemann, *Zeit. wiss. Phot.*, 1907, v., 109). It is probable that all absorption is due to resonance, no doubt, and hence the narrow-band type (*a*), but in this case the resonators would be the molecules or the contained electrons, whereas in case (*b*) the resonance of larger aggregates is the cause of the absorption.

The investigation is to be continued, but a striking case was found in one of the pinacyanols, a class of dyes recently introduced as photographic sensitisers. This dye gives in aqueous solution a flattish, ill-defined absorption, the solution showing all the characteristics of a colloidal solution. In alcohol and organic solvents the absorption was of a narrow-band type, entirely different, and *this spectrum was also obtained by heating the aqueous solution to boiling point*. The behaviour was quite analogous to that of starch, which gives crystalloid solutions at the boiling point.

S. E. SHEPPARD.

Phys. Institute, Marburg a. L.

The Convection Explanation of Electrolysis.

AT p. 12 of a recent text-book entitled "Electrochemistry," by Prof. R. A. Lehfeldt, the author mentions the convection explanation of electrolysis, and states that "Faraday was sufficiently impressed with it to form the hypothesis of *ions*, *i.e.* of charged particles in the liquid travelling under the action of the electric force."

So far from being impressed favourably by this "explanation," Faraday considered it might have a "dangerous influence" and "do great injury to science by contracting and limiting the views of those engaged in pursuing it." He therefore constructed his terminology of electrolysis specially to get clear away from this "explanation."

Again, Faraday did not form a "hypothesis of ions as particles." The word ion refers to the nature of the substance evolved at the electrode, not its dimensions. The ion of Faraday might weigh an ounce or a ton.

The opinions which the modesty of the great observer permitted him to express may be found in the seventh series of his "Experimental Researches." To attribute to him, for any purpose, other opinions absolutely alien to these is, I submit, either scientifically reprehensible or grossly careless.

J. BROWN.

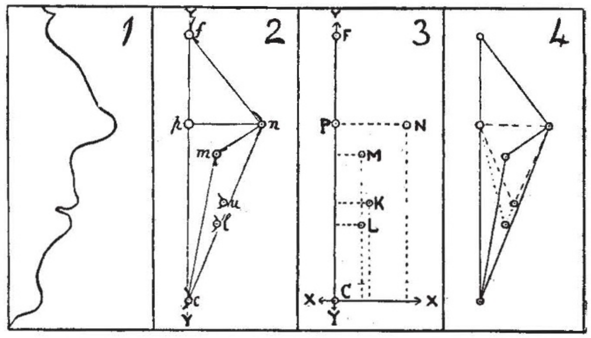
Belfast, August 18.

CLASSIFICATION OF PORTRAITS.

EXPERIMENTS of various kinds that I have made to define the facial peculiarities of persons, families, and races by means of measurement led to the following results that seem worthy of publication. The most elementary form of portrait will alone be considered here, namely, the outline of the face from brow to chin, as in a shadow or in a silhouette. It contains no sharply defined points whence measurements may be taken, but artificial ones can be determined with fair precision at the intersections of tangents to specified curves. It will be shown that it is easy to "lexiconise" portraits by arranging the measurements between a few pairs of these points in numerical order, on the same principle that words are lexiconised in dictionaries in alphabetical order, and to define facial peculiarities with greater exactness than might have been expected.

The individuality of a portrait lies more in the relative positions of six cardinal features (see the figures below) than in the shapes of the lines that connect them, so long as the general character of the connecting lines is roughly indicated. A few standard types, perhaps ten in all (though I prefer to use more), represent as many concave, convex, and sinuous varieties of outline, between each specified pair of the six cardinal points, as need to be noted. I may recur to this in a future letter.

This will be apparent to the reader's satisfaction if he compares portraits under unfavourable conditions, as through a blurring medium, or out of focus; or, again, if he substitutes connecting links that differ somewhat from the true ones. Consequently my first endeavour was to define accurately six points that should severally be good representatives of the six cardinal features in the outline. Those features the limits of which are vague are expressed by *italic* letters in Fig. 2, and their representative points by the same letters in *capitals* in Fig. 3. The features are these:—*c*, the tip of the chin; *l*, the lower, and *u*, the upper lip; *m*, the hollow between the upper lip and the nose; *n*, the tip of the nose; *f*, the hollow between the nose and the brow. In order to find their respective representative points, proceed as shown in Fig. 2, by drawing (upon tracing paper) a tangent, YY, to both *c* and *f*. Then draw a short tangent to *n* parallel to YY (accidentally omitted in the Fig.). A tangent to



both *c* and *n* intersects the first of these lines at C and the second at N, and determines them. A line drawn from N tangential to *f* determines F. Thus the fundamental triangle CNF is obtained, in which YCFY is used as the axis of Y, and the length of CF (divided into 100 equal parts, here called "cents") determines the scale of measurement. In the life-sized portrait of an adult, 1 cent may be regarded as roughly equivalent to $1\frac{1}{4}$ mm. or to 1/20th of an inch. M, and consequently the triangle CMN, is determined by the intersection of one line drawn from C with another from N, both tangent to *m*. U and L lie at the intersections of tangents drawn in either case, parallel to X and CN respectively. They require less attention than the preceding letters, because *u* and *l* are usually small.

The positions of the six cardinal points may be expressed in either of two ways—(1) as in Fig. 3, by rectangular coordinates, YCY being the axis in Y, and XCX perpendicular to it, the axis in X. Or (2) as in Fig. 4, by triangulation. Here an additional line, NP, drawn perpendicularly from N to YCY, is convenient. I have compared both of these methods, and found each to have its advantages and disadvantages, depending on many variable causes, of which the scale of the portrait is one and the available in strument is another, and am inclined on the whole to prefer the method of coordinates.[1]

In my experiments I have chiefly used the side-view portraits by George Vance, R.A., of his distinguished contemporaries, published in 1809 (2 vols., folio, Longmans), which yielded sixty-eight pure profiles of about one-third the natural size. I lexiconised these in respect to the measures (entered to the nearest cent) of the two coordinates of N and M respectively (4 measures in all), and found, first, that no two of the numerical formulæ were the same, and, secondly, that in two-thirds of them the *smallest* difference between the most nearly resembling pairs was 3 cents in one or more of the four measures. This conspicuous difference, equivalent to between 1/6th and 1/7th of an inch in a portrait of the natural size, could never be due to the inherent imperfection of the art of measurement, but to some gross blunder. It follows that the collection of sixty-eight portraits was lexiconised with remarkable precision. The data were insufficient to enable me to speak with much assurance of the gain that would accrue from taking L and U into additional account, but their correlations with C, M, N, and F, seeming to be very small, the gain ought to be great. I am content to underrate this gain considerably, and to allow only fifteen-fold for it. On that basis a collection of 1000 profiles from brow to chin could be lexiconised and searched with great ease. In 667 cases each portrait would have a clearly distinctive formula; in the remaining 333 there would be doubtful duplicates, and even triplicates, just as in any list of the names of 1000 British persons there would be more than one Smith.

In the report of a committee appointed by the Secretary of State in 1894 (C.—7263, price 10*d.*) to inquire into the best means available for identifying habitual criminals, the following remark appears on p. 18:—"An enormous amount of time is spent in examining the books of photographs. It will be seen from the figures furnished by Chief Inspector Neave that on March 1 last twenty-one officers searched for twenty-seven prisoners—the total time spent being $57\frac{1}{2}$ hours—and made seven identifications. This was an average of more than two hours for each prisoner sought for, and more than eight hours for each identification." A similar search in a lexicon of portraits of the same size would occupy apparently fewer minutes than the above occupied hours.

I will go no further now into the results of my experiments than to say that I have applied the above method to portraits of persons of very different races, and have thus far found it efficient in all of them.

Francis Galton.

[1] In some cases brevity is very desirable, and may be obtained by regarding only the limits within which the variability of each link most commonly occurs and by dividing the interval between those limits into 8 equal parts. Then 0 would signify all measures below the lower limit, and 9 all above the upper one. The range of the rectangular coordinates to N and M within the limits above explained varies between 12 and 20 cents, so the value of each of the eight equal parts will vary from $1\frac{1}{2}$ to $2\frac{1}{2}$ cents according to the coordinate in question. These "parts" are more suitable for classification than cents, which are too small to be quite trustworthy. But I will not go further here into this question than to add that the 8 rectangular coordinates of M, N, L and U can be described in this way by only 8 figures, and the connecting outlines CL, LU, UM, MN, NF by 5 (or say 10) more, so that a portrait can be expressed (say be telegraphed) in a rude but recognisable form by only 13 (or 18) figures.

WEIGHTS AND MEASURES REGULATIONS.

THE new regulations, which came into force on October 1, apply only to weights, measures, and weighing instruments used for the purposes of trade. They are, in some respects rather less stringent than the preliminary draft issued by the Board of Trade in August, 1906, a review of which appeared in these columns last year.

There are but few points of scientific interest in the regulations. Specific instructions as to temperature are now given for the first time to inspectors of weights and measures. Measures of length are to be verified by comparison with a local standard at or near the normal temperature, which is 62° F. for imperial measures. For imperial measures of capacity the standard temperature of their water contents is also 62° F.; for metric measures of capacity it is 4° C.; but metric measures graduated at 15° C. or 60° F. may also be verified for chemical or pharmaceutical purposes, or for volumetric estimations. Measures marked with the temperature at which they are graduated must be tested against measures standardised at the same temperature. An apothecaries' measure, marked with equivalents in weight, is permitted, provided that the words "of water" are marked on it in addition to the denomination.

Certain restrictions are placed upon the weighing instruments to be used by dealers in precious metals or precious stones, retail chemists or druggists, and silk merchants. These traders are permitted to use three kinds of weighing instruments, the first kind being chemical and assay balances provided with means for relieving all the bearings and knife edges, the second being beam scales of a lower order of sensitiveness and accuracy, which must be marked "Class B," and the third being instruments other than beam scales which satisfy the requirements for Class B. The first and third of these types of instruments are not to be marked with a "class."

The requirements of Nos. 69 and 78 of the regulations, prohibiting adjusting contrivances which are not permanently fixed to the weighing instrument, will render some kinds of analytical and assay balances ineligible for official stamping in the future. Traders who use such balances should be careful not to keep them upon their trade premises if unstamped, otherwise they may be liable to forfeiture if they come under the notice of an inspector of weights and measures.

Counter weighing machines of the "accelerating" type are prohibited by the regulations. It is often difficult to distinguish between a vibrating and an accelerating instrument, especially when these are sluggish or have been in use for some time. The requirement prescribed in No. 68 of the regulations that the machine shall balance when unloaded will, however, be sufficient in general to determine this point. When the machine is unloaded, if either of the pans be pressed down and then released, the beam will be set in oscillation about its horizontal balancing position, if the instrument is of the vibrating type; but if the instrument is accelerating, it will be found that one or other of the pans when pressed down will remain down, and the beam, failing to oscillate, will rest out of balance.

Spring balances are somewhat rigorously dealt with, but, on the whole, the Board of Trade has taken a fairly lenient view with respect to these instruments in permitting them to be used for ordinary trade, rather than restricting their use to such purposes as the weighing of postal parcels and passengers' luggage, as is the case on the Continent.

Weights, measures, and instruments at present stamped and in use, but which do not comply with the new regulations, may be continued in use for certain prescribed periods, and, with the exception of a particular type of spring balance, may be re-stamped from time to time.

Appendix 2 contains a useful list of all the denominations of weights and measures which are at present legal in this country. It will be seen from this list that weights of $\frac{1}{4}$ grain, which are frequently employed by chemists in compounding drugs, are not legal for use in trade.