narrow groove into which light rectangular frames of wood, each with a spectacle lens in it, can be slipped and will stand upright (Figs. 1, 4). I chiefly use lenses of 12, 24, and 48 inches; my eye can accommodate its focus to intermediate distances, but I possess others which are sometimes serviceable. Younger persons with normal eyesight would want no lenses at all. The length of the box suffices for cabinet-size photos. An opera-glass reversed enables it to be used with larger ones, the minifying power of the opera-glasses at various short distances having been ascertained.

Mutual mistakability may occur under any one or more of the following conditions, which are to be noted, together with further remarks :—

a a. The portraits are apparently exact copies or reductions on different scales.

a. They appear to be portraits of the same person at about the same age, though differing in pose and dress.

b. They would be mistaken for portraits of the same person, even though they differ in sex and considerably in age, if the hair had been cut and dyed alike, and the dress arranged in the same way.

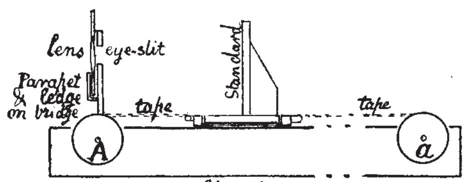

fig. 1

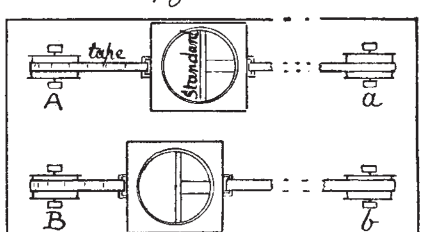

fig. 2

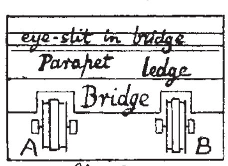

fig. 3

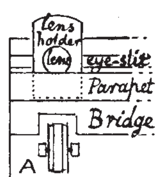

fig. 4

c. As above, if much disguised, as for theatrical personations.

b–c. Applies to cases intermediate between *b* and *c*.

P. Their resemblance is partial only, being confined to specified features.

The following little table saves trouble in operating; my own is more extended :—

Values of d_c in terms of N and of u_m $\left(d_c = \frac{100\ u_m}{N}\right)$

N	u_m 1	2	3	4	5	6	7	8	9	10
5	20	40	60	80	100	120	140	160	180	200
7·5	15	30	45	60	75	90	105	120	135	150
10	10	20	30	40	50	60	70	80	90	100
15	7	15	22	30	37	45	52	60	67	75
20	5	10	15	20	25	30	35	40	45	50
25	4	8	12	16	20	24	28	32	36	40

The procedure adopted after many trials was to measure the u_m of each portrait to the nearest half-millimetre and to write it below. Then to mount the two portraits, each on a separate sledge if their facial units differed, otherwise on the same. When they differed, the facial unit of the one about to be used for d_c was distinguished as u_m, the other was in brackets as (u'_m). Next, after referring to the above table, to send them to their respective d_c for N=5, to consider them carefully, and to note the result. Then to do the same for N=10, and so on, until the eye became familiarised with the differences between the portraits. Finally, guided by these provisional attempts, to fix on the suitable index and letter, adding such remarks as may seem wanted.

I became gradually more consistent in judgment, as ascertained by comparing the results on different days, but have felt all along that it would conduce to trustworthiness if two or more companions worked together and criticised one another, and recorded their common verdict.

A very brief example will suffice. Usually an entry consists of more lines followed by general remarks.

Two Sisters, Registers (so and so).
$u_m = 8{\cdot}5$; $(u'_m = 9{\cdot}0)$

N	d_c	Character of likeness
5	170	*b*
10	85	Nearly *b*
After trials	115	Just *b*

Accept $N(b) = \frac{850}{115} = 7{\cdot}4$

I will add a few words on dealing with mistakability caused through obscurity or other hindrances to clear vision. I prepared test cards, each containing numerals printed in different types, and, having ascertained by experiment the value of d_c for each kind of type when just able to read it in a clear light, wrote that value boldly by its side. An appropriate test card was put by the side of the portraits, and at the time when the portraits themselves were just mistakable, the written d_c of that row of figures which were just unreadable, was noted. The value of d_c remains constant whatever be the character or amount of the optical hindrance. If the hindrance increases, the portraits and the accompanying test card must be brought nearer to the eye. They will increase simultaneously in legibility. The written d_c will always show what the d_c would be in a clear light.

The applications of the process are numerous, as must always be the case when a hitherto vague perception is brought within the grip of numerical precision. To myself it has the especial interest of enabling the departure of individual features from a standard type to be expressed numerically. The departure may be from a composite of their race, or from a particular individual. The shortcomings of a pedigree animal from a highly distinguished ancestor could be measured in this way. Many other examples might be given.

I must not conclude without expressing gratitude for answers to a request, published by me some time ago in NATURE, for waste photographs from amateurs and professionals. If I be allowed to mention a single name, it would be that of Mr. Norman Campbell, whose photographs have been eminently serviceable.

FRANCIS GALTON.

Models of Atoms.

AN interesting and instructive variant of Prof. Mayer's experiment with floating magnets, which has been used so much to illustrate the structure of atoms, is to do away with the *centripetal* magnetic force and to arrange that its place be taken by forces arising from capillarity. This is managed as follows :—

A small circular dish is filled almost to overflowing with water the surface of which will be convex. A single floating magnet (with its axis vertical) placed on this moves at once to the centre; two or more such magnets placed on it form regular equilibrium figures, as in the usual form of the experiment. The chief interest of the modification arises, however, from the fact that *the figures are not in general the same as in the ordinary arrangement.* This is instructive, because it brings out clearly the necessity of knowing the exact law of force between the parts of an atom before it can be possible to predict its structure.

The experiment is so easily tried by anyone that there is no need to go into great detail here; but it may be mentioned that with the particular dish and magnets used by me it is possible to arrange ten in a single ring without any central nucleus, and that in a larger dish more can, of course, be so arranged. These ten also form stable groups as a ring of nine with one in the middle, or a ring of eight with two in the middle. But a ring of seven with three in the middle is not possible; if temporarily so placed one of the three gradually moves out and joins the seven. The first arrangement in three groups occurs for eighteen magnets in all; these are stable when placed with twelve in an outer ring, five in an intermediate ring, and a single one in the centre. ALFRED W. PORTER.

University College, London, September 17.

Chemical and Electrical Changes induced by Light.

THE issue of NATURE for August 30 (p. 455) contains an abstract of a paper read before Section A of the British Association by Sir Wm. Ramsay and Dr. J. F. Spencer on the chemical and electrical changes induced by ultra-violet light, in which the "fatigue" shown by certain surfaces is discussed. I have for some time been engaged in an investigation of the fatigue shown by metals for the photoelectric effect, and have made a careful examination of the rate at which the photoelectric current decays in the case of a zinc plate, polished or amalgamated. A large Nernst lamp supplied with current from storage cells was used to give a steady source of light. The decay immediately after exposure to the light was very rapid, but after about twenty minutes became much slower. For a change taking place according to the "compound interest law," as in the case of a monomolecular chemical reaction or a single purely surface effect, we know that the curve can be represented by an exponential term involving the time. In the case of zinc, I find that the activity at any instant can be represented with considerable accuracy by the sum of two exponential terms. It is possible to interpret this result somewhat on the lines followed by Rutherford in explaining the decay of the excited activity of radium or thorium, by supposing that a succession of changes takes place.

Similar results have been obtained in the case of aluminium, and also with specimens of coloured fluorspar. In the latter case the colour is attributed to the presence of particles of reduced metal.

It is interesting to note that the longer waves of light tend to produce a change in the opposite sense, so that the rapid decay at first observed on exposure to light may be followed by a small increase in activity unless the long waves are absorbed by a solution of alum.

These experiments were carried out partly in the laboratory of Lord Blythswood, to whom my thanks are due, and partly in the Wheatstone Laboratory of King's College. H. S. ALLEN.

King's College, London, September 21.

The Rusting of Iron.

THE experiments made by Mr. J. Newton Friend, and described by him in NATURE of September 27, confirm similar experiments previously made by me, and furnish further evidence that the rusting of iron is primarily a result of acid attack. That cast iron, a very complex material frequently containing a high percentage of sulphur and phosphorus, decomposes hydrogen peroxide "with astonishing rapidity," and that the metal becomes covered with rust in a few minutes, is not, however, to be referred to catalytic action, as Mr. Friend suggests, but is a consequence of the formation of acids by the oxidation of some of the impurities present in the iron, and of the subsequent electrolytic action. As Mr. Friend says, "the purer the iron the less is the action of the peroxide upon it," which is another way of stating that the intensity of action will be determined by the amount of acid formed on the surface of each particular sample of metal when in contact with the peroxide.

Cast iron is known to oxidise in air more readily than wrought iron, and this is probably due to the former containing impurities which on oxidation yield acids. The rust formed on cast iron exposed to air often contains appreciable quantities of combined sulphur.

The fact that cast iron is attacked by water in absence of air, becoming darker in colour, whilst pure iron under identical conditions remains unchanged, may also be referred to the production of a minute quantity of acid. In this case the acid is not formed by oxidation, but it is probably hydrogen sulphide resulting from the interaction of sulphides, such as silicon sulphide, contained in the crude iron, with water. GERALD T. MOODY.

Central Technical College, October 1.

Remarkable Rainbow Phenomena.

MAY I be permitted, with reference to Mr. Spence's observation of a remarkable rainbow, described in your issue of September 20, to direct attention to a number of phenomena of the same kind observed in Holland during the last ten years, and published by the Dutch Meteorological Institute in *Omweders, Optische Verschijnselen enz.* At Fort William, also, on August 16, 1887, a phenomenon of this sort was seen, a drawing of which is to be found in Trans. Roy. Soc. Edin. (vol. xxxiv., p. xvii, Fig. 17). Readers of NATURE will find an observation of a double rainbow, with drawing, similar to the oval described by Mr. Spence, made by Prof. Tait on September 11, 1874, in the issue of October 1, 1874, with a comment by Maxwell upon it.

The explanation of the phenomenon is simple, and seems to have been first given by Rubenson. The upper of the two ordinary and the two secondary bows is generated by rays which enter the raindrops after reflection from a level of water situated behind the observer. It is obvious that the altitude of the ordinary rainbow being $42^\circ - h$, the altitude of the one generated by reflection will be $42^\circ + h$, h being the sun's altitude; the same holds good for the secondary rainbow. The centres of all the bows lying in the same vertical, it is clear that the two ordinary bows and the two secondaries touch each other at the horizon. For further information see my "Meteorologische Optik" (pp. 491 and 555). J. M. PERNTER.

Vienna, September 28.

Fugitive Coloration of Sodalite.

WITH reference to the properties of Indian sodalite shown by Mr. T. H. Holland at the York meeting of the British Association (September 27, p. 550), will you permit me to point out that, although not generally noticed in the text-books, the change of colour referred to is not peculiar to the Rajputana mineral. The first sodalite discovered had the same property, and Giesecké, under date August 28, 1806, records the occurrence of "pfirsichblüthenroth-farbene" sodalite from Kangerdluarsuk, in Greenland, "welche die hohe Farbe auf frischem Bruche sogleich beinahe ganz verliert." The same observation was made independently by Allan (Thomson's "Annals of Philosophy," 1813, vol. i., p. 104); but I am not aware that there is any record of a recovery of the lost colour, which Mr. Holland appears to have observed.

JAS. CURRIE.

Edinburgh, October 1.