The abnormality of the distribution of the estimates now becomes manifest, and is of this kind. The competitors may be imagined to have erred *normally* in the first instance, and then to have magnified all errors that were negative and to have minified all those that were positive. The lower half of the "observed" curve agrees for a large part of its range with a normal curve having the p.e. = 45, and the upper half with one having its p.e. = 29. I have not sufficient knowledge of the mental methods followed by those who judge weights to offer a useful opinion as to the cause of this curious anomaly. It is partly a psychological question, in answering which the various psychophysical investigations of Fechner and others would have to be taken into account. Also the anomaly may be partly due to the use of a *small* variety of different methods, or formulæ, so that the estimates are not homogeneous in that respect.

It appears then, in this particular instance, that the *vox populi* is correct to within 1 per cent. of the real value, and that the individual estimates are abnormally distributed in such a way that it is an equal chance whether one of them, selected at random, falls within or without the limits of −3·7 per cent. and +2·4 per cent. of their middlemost value.

This result is, I think, more creditable to the trustworthiness of a democratic judgment than might have been expected.

The authorities of the more important cattle shows might do service to statistics if they made a practice of preserving the sets of cards of this description, that they may obtain on future occasions, and loaned them under proper restrictions, as these have been, for statistical discussion. The fact of the cards being numbered makes it possible to ascertain whether any given set is complete.

FRANCIS GALTON.

THE WORK OF THE OPTICAL SOCIETY.[1]

THOUGH it is perhaps seldom that the Transactions of the Optical Society contain much record of original research, yet they often furnish matter of considerable value to the practical optician, and will usually be found to contain more than one paper of importance to the student of optics. The first paper in the present volume will have interest for many readers. It is a short and clear statement, by one well qualified to judge, Mr. W. A. Dixey, of the case for the use of periscopic lenses in spectacles. A periscopic lens, as defined by Mr. Dixey, is one through which its wearer can look obliquely as well as directly without his vision being impaired by radial astigmatism. The result is attained either by deepening the curves of the lens so as to produce an approximation to a sphere the centre of which coincides with the centre of rotation of the eye, or by the use of toric lenses. A careful reading of Mr. Dixey's paper would probably lead many wearers of spectacles to pay another visit to the optician.

The paper by Mr. Theodore Brown, on direct stereoscopic projection, is of special interest. It describes an ingenious device for obtaining stereoscopic effects in pictures projected on a screen, of which probably more will be heard. The argument is that in binocular vision the stereoscopic effect is due to the fact that the two images of the same object in the two eyes are not formed in similar positions on the retina, and that it should be possible to produce stereoscopic effects even when one eye only is used if by some means two simultaneous pictures can be formed on the retina in appropriate positions. Owing to the permanence of retinal impressions, this can be effected by throwing on the screen with rapid alternation the two stereoscopic pictures in somewhat displaced positions. The displacement is produced by giving a motion to the projection camera, and the stereoscopic can be combined with the "bioscopic" effect by the use of a kinematograph mechanism. It is clear from the paper and the discussion that further perfection of detail is necessary to produce completely satisfactory results, but there seems no reason why the difficulties should not be overcome. There is, however, some reason for suggesting that perhaps a one-eyed spectator would be the most appreciative.

In "A Method of Testing Prisms," Mr. S. D. Chalmers, the head of the optical department at the Northampton Institute, suggests some useful applications of the method of auto-collimation for the determination of the angles of prisms to the highest possible accuracy. We would direct attention especially to the procedure suggested for the measurement of one of the angles of a 60° prism ABC. Rays entering perpendicular to the face BC are totally reflected at 30° from CA or AB, and reflected normally at AB or CA, emerging again approximately perpendicular to BC. From the separation of the incident and emergent rays the error in the angle A can be determined. Only one reflection takes place normally at a glass-air surface, and there is, therefore, no difficulty in seeing the image. Simultaneous observation of the direct reflection from BC aids in setting the prism. A similar method can readily be applied in other instances, and the figures in the paper suggest at once the procedure in the cases which occur most frequently. The lack of parallelism in plane parallel glass can also be tested in this manner. Rigidity is, of course, essential in the apparatus to be employed for the observations, and Mr. Chalmers has obviously given some attention to details in the construction of a suitable auto-collimator; drawings or diagrams of this would have added to the value and interest of the paper.

Mr. L. W. Phillips, student member, in a paper on the measurement of absorption in tinted glasses, describes some observations on the absorption of light by coloured glasses, such as are used for spectacles, a "flicker" photometer being employed for the measurements. The method does not admit of great accuracy, but is no doubt useful within certain limits for rough work of the kind suggested. It raises, however, some vexed questions as to the photometry of coloured lights, and some points of interest in relation to the "flicker" instrument were brought up in the discussion by Dr. Garnett and others.

A presidential address by Prof. Silvanus P. Thompson, on the early literature of optics, demands no more than passing mention here, great though its interest must have been to those who had the pleasure of listening to it. The volume closes with a contribution by Mr. A. T. Bull, entitled "Some Notes on the Nature of Vision." The paper, being essentially of the nature of notes, passes rapidly over many points of interest in connection with the mechanism of vision and the molecular and other phenomena accompanying it. Various topics are thus touched on, from the accuracy of the photometric results obtained with rotating sectors to the difficulties yet requiring explanation on the Darwinian theory in regard to the process of evolution of vision. The notes are suggestive, but would make more interesting reading if less loosely put together.

We would venture to suggest, in conclusion, that the editing of the volume leaves something to be desired. It may be possible to interpret such phrases as "beep lenses on the Willaston principle," and to escape being deceived by the "dissimulation" of a photochemical body, but the fact that Lewis Carroll was a mathematician does not sufficiently justify such imitation of his playful extravagances in a scientific journal; and the volume is marred by many such misprints.

[1] Transactions of the Optical Society, London, Session 1904–5. Pp. 93. Price 10s.

THE COMPRESSIBILITY OF CRYSTALLINE ROCKS.[1]

THE latter-day revival of interest in geological physics has led to a keen demand for experimental data, the absence of which has hitherto rendered futile most speculation in this domain. Our almost complete ignorance of the simplest physical constants of rocks and the rock-forming minerals is easy to account for. The kind of investigation required is both difficult and laborious, calling for skill and practice as well as the appliances of a well-equipped physical laboratory; and the geologist may lack either the capacity or the opportunity for such re-

[1] "An Investigation into the Elastic Constants of Rocks, more Especially with Reference to Cubic Compressibility." By Prof. Frank D. Adams and Prof. Ernest G. Coker. Pp. 69. (Washington, D.C.: Carnegie Institution, 1906.)

searches. On the other hand, the professed physicist, interested in the properties of matter from a more general point of view, prefers to work on materials of a more tractable nature than those with which the geologist is concerned.

The memoir before us, the joint work of a geologist and an engineer, deals with the constants of elasticity of a number of crystalline rocks, and gives the results of a series of experiments made in the laboratories of McGill University at Montreal. The quantities investigated are among the prime desiderata of geological mechanics, being involved in the calculation of the velocity of propagation of earthquake shocks and in other important questions. The only data of this kind previously published seem to be open to serious criticism, and the contribution by Profs. Adams and Coker is specially opportune and welcome.

The authors describe the method employed and the precautions taken to ensure such accuracy as is possible. The rock is cut to the shape of a column 3 inches high and 1 inch in diameter, either square or circular in cross-section. The column is subjected to pressure applied perpendicularly upon its ends, and the resulting longitudinal compression and lateral extension are observed. In this way are obtained Young's modulus, E (the longitudinal stress divided by the longitudinal compression), and the ratio (m) of longitudinal compression to lateral extension (*i.e.* the reciprocal of Poisson's ratio). The modulus of cubical compression (D) is then calculated from the relation

$$D=\tfrac{1}{3}\left(\frac{m}{m-2}\right)E,$$

and the modulus of shear (C) from

$$C=\tfrac{1}{2}\left(\frac{m}{m+1}\right)E.$$

From the theoretical point of view these equations do not seem to be fairly applicable to the case in hand. A crystalline rock is an aggregate of many crystals, each of which is anisotropic; and in the case of such a rock as granite the crystals belong to a number of distinct minerals, differing as regards their elastic constants. The argument that an average isotropic effect will result from the random orientation of a large number of anisotropic crystals is not quite convincing. Nevertheless, the results found are reasonable and consistent, and go far towards justifying the method adopted.

When the relation of strain to stress is plotted on a diagram, it is seen in every case that the progressive loading gives a curve not very different from a straight line, while the corresponding line for unloading is a curve lying very near the other, and returning to the initial point. It follows that the rocks examined approximate nearly to perfect elasticity, and obey Hooke's law somewhat closely, and with small hysteresis, for pressures ranging up to 10,000 lb. or even 15,000 lb. to the square inch. Many of them compare favourably in these respects with cast iron. We quote some of the results obtained for the seventeen rocks examined. The figures are to be multiplied by 10^{11} to give the measure in C.G.S. units :—

	D	C
Cast iron	6·897 ...	4·132
Carrara marble	4·090 ...	2·171
Peterhead granite	3·300 ...	2·340
Quincy granite	2·750 ...	1·916
Nepheline-syenite, Montreal	4·290 ...	2·505
New Glasgow Anorthosite	5·760 ...	3·275
Sudbury diabase	7·329 ...	3·700

It appears that the granites offer less resistance, both to compression and to shearing, than the basic igneous rocks. The authors connect the greater compressibility of the granites with the presence of quartz, but the granites appear to be actually more compressible than that mineral. We should suppose rather that the alkali-felspars, which constitute the greater part of an ordinary granite, are notably more compressible than the ferro-magnesian silicates and lime-felspars; and this seems to be confirmed by the intermediate value found for the nepheline-syenite.[1] The general character of the rocks which compose the bulk of the earth's crust is doubtless fairly represented by the crystalline igneous rocks selected for investigation, and the average compressibility must lie between the highest and lowest values tabulated above. A simple average of all the igneous rocks examined gives a modulus of compressibility $4·374\times10^{11}$, which is slightly less than that for plate glass. In such an average the acid rocks are probably over-represented, and the value consequently too low.

A. H.

[1] The authors cite Voigt's value for the compressibility of quartz. The more accurate determination by Amagat gives 4·212 in terms of the unit adopted above. For the felspars there are no known data.

CYANOGENESIS IN PLANTS AND THE CONSTITUTION OF PHASEOLUNATIN.

SINCE 1900 a considerable number of plants yielding prussic acid have been investigated in the Scientific and Technical Department of the Imperial Institute. Among these are *Lotus arabicus*, a plant which grows commonly along the valley of the Nile; *Sorghum vulgare*, widely cultivated as a cereal in tropical countries; the Lima bean (*Phaseolus lunatus*); common flax; and cassava (*Manihot utilissima*). The source of prussic acid in each of these cases has been proved to be a glucoside, which in the presence of water is decomposed by an enzyme, also occurring in the plant, yielding prussic acid, glucose, and a third neutral substance. Three of these glucosides have been fully studied by Prof. Dunstan and Dr. Henry. Lotusin, $C_{28}H_{31}O_{16}N$, from *Lotus arabicus*, is comparatively complex in structure, and is the lotoflavin ether of maltose cyanohydrin, lotoflavin being a yellow colouring matter isomeric with fisetin and luteolin, and belonging, like these, to the quercetin group of dyes. Dhurrin, $C_{14}H_{17}O_7N$, from *Sorghum vulgare*, is a dextrose ether of parahydroxybenzaldehyde cyanohydrin. Phaseolunatin, $C_{10}H_{17}O_6N$, which occurs in the Lima bean, flax, and cassava, has been shown to be a dextrose ether of acetone cyanohydrin (Phil. Trans., 1901, B, 515; 1902, A, 399; Proc. Roy. Soc., 1903, lxxii., 285; 1906, lxxviii., 145 and 152; British Association Reports, 1906, and *Ann. Chim. Phys.*, 1907, [viii.], x., 118).

In a paper communicated to the meeting of the Royal Society held on February 28, the same authors, in conjunction with Dr. Auld, gave the results of some further investigations carried out with the object of determining the nature of the dextrose residue present in phaseolunatin.

Fischer and others have shown that glucosides are divisible into two classes, derived respectively from the α and β forms of the hexoses, and that the glucosidolytic enzymes which occur in plants also belong to two groups, the one, typically represented by maltase, being capable of decomposing α-glucosides, and the other, of which emulsin is the best known, having the power of hydrolysing β-glucosides. From the results of the examination of the sugar initially produced when phaseolunatin is hydrolysed by the enzyme, which occurs in association with it in the Lima bean, it is clear that this is α-dextrose, and, therefore, that phaseolunatin is the α-dextrose ether of acetone cyanohydrin. It is the first naturally occurring glucoside of this type so far known.

This conclusion has rendered necessary a further investigation of the enzymes, which occur with phaseolunatin in the Lima bean, the flax plant, and cassava. The mixture of enzymes, prepared in the usual manner from the Lima bean, decomposes amygdalin and salicin, and may therefore be assumed to contain emulsin. The latter, prepared from sweet almonds, has, however, no action on phaseolunatin, and this is in harmony with the constitution now assigned to the latter glucoside, since the emulsin of almonds has been shown to hydrolyse only glucosides containing β-sugar residues.

It has now been found that the Lima bean contains, in addition to emulsin, a second enzyme, which is of the maltase type, and that the decomposition of phaseolunatin, which takes place when the beans are ground up in water, is due to the action of the maltase-like enzyme. The maltase of yeast is also capable of decomposing phaseolunatin, so that the enzyme which occurs in the Lima bean appears to be of the same type as the maltase present in yeast.

The mixtures of enzymes occurring in association with phaseolunatin in the flax plant and in cassava have also been investigated and found to behave in the same manner as the mixture of enzymes prepared from the Lima bean.