Although not so trustworthy as the figures relating to mineral output, the statistics of persons employed and of accidents in mines are quite as important. The number of persons employed at mineral workings in 1899 throughout the world amounted to 4,312,000, of which 1,635,000 were engaged in the British Empire. The United Kingdom headed the list with 862,000 persons. Then followed Germany with 527,000, the United States with 488,000, France with 302,000, Russia with 239,000, Austria-Hungary with 219,000, Belgium with 164,000, and Japan with 133,000. Prior to the war the late South African Republic employed 100,000 miners. It appears that the British Empire employs more than one-third of all the persons engaged in mining and quarrying in the world. It must, however, not be forgotten that published figures are far from being absolutely accurate, and those cited by Dr. Le Neve Foster are merely the best obtainable at the present time. As an example of inaccuracy, the official returns from Ceylon give 1,108,306 persons employed in 1898 in mining in that island. It is incredible that the mining industry of Ceylon, which is comparatively insignificant as regards output, should afford occupation to as many persons as are employed in mining in all the other countries of the British Empire put together. Such figures are utterly useless for calculating death rates, and have, consequently, been discarded. The standard adopted for death rates is the number of persons killed per 1000 employed, and a comparison of the figures in different countries affords a good idea of the relative safety of the miner's occupation. In Great Britain, in 1899, there were killed in coal mines 1·24, in other mines, 1·76, in quarries 1·19, and in all mines and quarries 1·26 per 1000 employed. For the British Empire the average was 1·27 for coal mines and 1·64 for metal mines, and for the world 1·83 for coal mines and 1·64 for gold mines. In foreign countries the average was 2·25 in coal mines. It is evident, therefore, mining is conducted in Great Britain with a far smaller risk of accident to the workers than in most other countries. This gratifying result is due in no small measure to the untiring efforts made to improve the conditions of mining by means of legislation and Government inspection. BENNETT H. BROUGH.

THE MINERAL CONSTITUENTS OF DUST AND SOOT FROM VARIOUS SOURCES.[1]

NORDENSKJÖLD collected and described three different kinds of dust, one consisted of diatoms, a second of a siliceous and apparently felspathic sand, both from the surface of the ice in Greenland; while a third consisted of sooty-looking particles composed of elements invariably associated with iron meteorites and of uncommon occurrence in terrestrial matter, namely, besides metallic iron, cobalt, nickel, carbon, silicon and phosphorus. He concluded that it was meteoric matter showered down upon the earth, and that cosmic dust is falling imperceptibly and continually.

A great variety of mineral matters, including dust from various sources, having been examined spectrographically by the authors, they give an account of its composition. Specimens which fell from the clouds were compared with those from known terrestrial sources. The first comprised (1) solid matter forming the nuclei of hail-stones collected during a storm on April 14, 1897; (2) solid matter from hail and sleet collected during a heavy shower from 2.30 p m. to 3 o'clock on March 28, 1896; (3) pumice from the Krakatoa eruption of 1883. These were examined for Prof. J. P. O'Reilly, who had collected them. (4) Dust from a dish exposed on November 16 and 17, 1897, in the outskirts of Dublin; and other samples with a similar origin which had fallen into porcelain dishes placed on a grass-plat in a garden. Varieties of flue-dust, (4) from Crewe gas-works, (5) iron-works, (6) sulphuric acid works, and (7) copper-smelting works, (8) volcanic dust from three different sources, (9) soot from laundry, laboratory, kitchen and bedroom chimneys. Flue-dust is characterised by the larger proportions of lead, silver and copper than other varieties of dust and coal ashes contain. Nickel and manganese are notably present, but the most striking feature is the quantity of rubidium, gallium, indium and thallium in all samples. Volcanic dust shows the bands of lime and magnesia with strong spectra of the alkali metals, and these are evidently its leading basic constituents.

[1] By Prof. W. N. Hartley, F.R.S., and Hugh Ramage. Abstract of a ead at a meeting of the Royal Society, February 21.

Soot is of variable composition, not so much with respect to the substances present as to the relative proportions of each in any two samples. Its larger proportion of lime distinguishes it from dust collected from the heavens. Nickel, manganese, copper, silver and lead are constant constituents. The presence of nickel is probably due to minute quantities of this element being disseminated in coal, which is first converted by the carbon monoxide produced in the fire into nickel tetracarbonyl, which is naturally volatile but subsequently becomes decomposed and nickel or nickel oxide is deposited.

Dust from the clouds, collected either by itself or in hail, snow, sleet or rain, exhibits a regularity in composition not seen in other varieties of dust. It contains, apparently, the same proportions of iron, nickel, calcium, copper, potassium and sodium. The chief difference occurs in dust suddenly precipitated in sleet, snow and hail, since lead is found in larger proportions in these, and particularly so in one specimen from sleet.

It is evident that the presence of nickel is not positive evidence that the dust from the clouds comes from other than a terrestrial source.

The dust which fell on November 16 and 17, 1897, with its similarity in composition to that of meteorites, its being attracted by the magnet and its appearance are quite in favour of its being of cosmic origin. On the other hand, in its composition it is unlike volcanic dust, flue-dust or soot.

STUDIES IN VISUAL SENSATION.[1]

THE object of these studies is to frame if possible a scale of visual sensation analogous to, and in correlation with, a scale of physical luminosity. The method is the employment of rotating discs.

If a disc be divided into eleven concentric areas of equal width, of which the inner is all white and the outer all black, while the intervening areas have sectors giving a series of 10 per cent. increments of white, this gives on rotation a series of grey rings between the black and white; but they are of very unequal values for sensation. While the step from black to the darkest grey involves a large stride in sensation, seemingly almost half-way towards the white, that from white to the lightest grey is of no great amount.

A contrast effect is very noticeable. Each grey annulus, especially in the darker rings, is differentiated in sensation into a darker moiety where it adjoins a lighter ring, and a lighter moiety when it adjoins a darker ring. But although contrast introduces a factor which somewhat distracts the judgment, the disturbance is not sufficient to invalidate the conclusion that equal, or approximately equal, increments of stimulus produce increments of brightness which differ widely in value.

By the use of slit discs on Maxwell's method the proportions of white stimulus may be so adjusted as to give, say, three rings intervening between white and black which do give approximately equal sensation steps. It is somewhat difficult, however, to estimate their value, and contrast again introduces a disturbing element. We obtain only a first approximation to a scale of sensation. Taking the black employed (admittedly only a very dark grey and not an absolute black) as a zero, and calling the value of the white 100 per cent., both for sensation and stimulus, we have, on the arbitrary scale thus formed, the following percentages:—

	Sensation.		Stimulus.	
	Increment.	Sum.	Increment.	Sum.
Black ring	0	0	... 0	0
Dark grey	25	25	... 6·5	6·5
Mid grey	25	50	... 13·5	20
Light grey	25	75	... 27	47
White ring	25	100	... 53	100

Here the equal increments of sensation are correlated with increments of stimulus very nearly in geometrical progression.

By interpolation a smoothed curve can be drawn through the observed mid-point of 20 per cent. stimulus and translated on to a disc. But this does not give a smooth increase of sensation from black to white through intervening greys. The value of the mid-point is too high.

Experiments with smoothed curves show that a mid-point of

[1] Abstract of the Croonian Lecture delivered at the Royal Society on March 21 by Principal C. Lloyd Morgan, F.R.S.

12 per cent. gives an approximately even passage from black into white.

The discrepancy between the ring-grading and the smooth shading is shown to be probably due to the contrast effects before mentioned, of which a rough quantitative estimate can be given.

The curve through 12 per cent. mid-point, with equal increments of sensation correlated with increments of sensation in geometrical progression, is accepted as affording an arbitrary and empirical scale for increase of brightness due to increase in physical luminosity.

Colours are dealt with and even shading is obtained from black into blue, and into red, orange, &c. ; white into similar colours, and one colour into another—for example, red into blue through intervening shades of purple.

The luminosity of these colours is determined in terms of the arbitrary scale on Sir Wm. Abney's method ; and the results, as deduced from the empirical curve, are compared with those directly observed by the method of shading in rotating discs.

For comparison, the results are given in terms of the mid-points of curves analogous to that for the shading of black into white :—

Mid-point Percentages.

	Deduced from luminosity.	Observed by method of shading.
Yellow on black ...	13·8 per cent.	13·5 per cent.
Orange ,, ...	18·6 ,,	18·0 ,,
Light blue ,, ...	19·7 ,,	19·0 ,,
Red ,, ...	23·6 ,,	23·0 ,,
Full blue ,, ...	29·5 ,,	28·0 ,,
White on full blue ...	24·7 ,,	25·0 ,,
,, red ...	30·6 ,,	30·0 ,,
Orange on full blue ...	35·4 ,,	36·0 ,,
Yellow on light blue...	39·1 ,,	40·0 ,,
Red on full blue ...	43·0 ,,	44·0 ,,

If these results be accepted as giving a sufficiently close agreement, it follows, first, that for colour shading the percentages of stimulus required are dependent on the luminosity of the colours employed ; and, secondly, that all the data obtained by the method of shading can be plotted on a single curve which exhibits the relation of stimulus to sensation in visual impressions.

If we assume that the black on the arbitrary scale has a value of 1·87474, and if this amount be added to the stimuli throughout the scale, so that the white becomes 101·87474, the mid-point 13·87474, and so on, the scale becomes, so far as stimulus is concerned, an absolute scale. And on this absolute scale of stimulus, the sensations, plus some undetermined constant, form an arithmetical series, while the stimuli which are in relation to them form a geometrical series. In other words, the addition of this constant to the summed increments of stimulus at any stage of the scale causes these summed increments to fall into line as the terms of a geometrical progression. The stimulus value of the mid-point on the absolute scale is the geometrical mean between the values of the extremers on the same scale. *On this assumption*, therefore, and *between these limits*, Weber's Law and Fechner's expression of it hold good.

Its validity beyond these limits is questionable. Dr. Waller has shown good reasons for believing that near the threshold of sensation the completed curve shows change of sign, and becomes sigmoidal. Apart from the evidence he adduces, some such assumption seems to be well nigh necessary if we are to attempt to give a complete curve, which, near the threshold of sensation, does not land us in the maze of difficulties arising from the asymptotic character of a wholly logarithmic curve.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. J. J. SUDBOROUGH, senior lecturer and demonstrator in chemistry of Nottingham University College, has been appointed professor of chemistry at the University College of Wales, Aberystwith.

RECENT gifts in aid of the funds of the McGill University, Montreal, amount to more than 42,000*l*. Of this sum, nearly one-third was provided by the chairman, Sir William C. Macdonald, who has already given over half a million sterling to the same institution. As the development of the University has recently been mainly on the lines of applied science and medicine, it is the faculty of arts which will mainly benefit by this new donation.

IN the Court of Appeal, on Monday, it was decided that School Boards cannot provide out of the rates for instruction in subjects prescribed by the Department of Science and Art, either in day schools or in evening continuation schools. It is thus declared illegal for a School Board to expend money out of a local rate for any purpose other than elementary education. In schools in which instruction is given in subjects such as those in the Science and Art Directory any assistance afforded to them must come from funds other than those provided by the ratepayers for primary education. As many School Boards have been providing instruction of this kind, it is evident that the decision accentuates the urgent need of an authority to describe the powers of the various bodies concerned with primary and secondary education.

THE Association of American Universities recently met at Chicago and discussed, among other topics, (1) inter-university migration of graduate students ; (2) fellowship ; and, (3) the examination for the degree of doctor of philosophy. From a report in *Science* we learn that with regard to the first topic it was considered desirable to promote by all possible means the inter-university migration of graduate students, to the end that they may come under the guidance of teachers of varying points of view, and so may receive the broadest possible introduction to their chosen field of study. As regards the question of fellowships, the opinion was expressed that it would be advisable to make some of the fellowships distinctly research fellowships, to be awarded only to students who had already taken the degree of doctor of philosophy, and who had, therefore, received their academic equipment for their life work. In discussing the best type of examination for the doctor's degree, it was held very emphatically that the practice which is growing up in American universities, especially in some of the departments dealing with natural science subjects, of permitting the candidate to pass his examination course by course, as is usual in undergraduate instruction, is a pernicious one, and one which stands in the way of the attainment of the best and broadest scholarship. It was held that the examination for the doctor's degree should, in all cases, be upon subjects and not upon courses of instruction, the underlying principle being that the courses of instruction which a graduate student attends are but a small part of the work which he is supposed to do in order to prepare himself for his examination.

MR. ANDREW CARNEGIE has presented to the Iron and Steel Institute thirty-two 1000-dollar Pittsburg, Bessemer and Lake Erie Railroad Company 5 per cent. debenture bonds, the income derived from which will be applied to awarding annually one or more research scholarships of such value as may appear expedient to the council of the Institute. The awards will be made on the recommendation of the council irrespectively of sex or nationality. Candidates, however, must be under thirty-five years of age, and application must be made on a special form to the secretary of the Institute before the end of April in every year. The scholarships will be tenable for one year, but the council will be at liberty to renew them for a further period if thought desirable instead of proceeding to new elections. The object of this scheme of scholarships is to enable students who have passed through a college curriculum, or have been trained in industrial establishments, to conduct researches in the metallurgy of iron and steel and allied subjects, with the view of aiding its advance or its application to industry. It is suggested that the National Physical Laboratory—on the governing body of which the Iron and Steel Institute is represented—would for many reasons be a very suitable establishment in which such researches could be carried out. There is, however, no restriction as to the place of research that may be selected, whether University, technical school, or works, the only absolute condition being that it shall be properly equipped for the prosecution of metallurgical investigations. The results of the researches are to be communicated to the Iron and Steel Institute in the form of a paper to be submitted to the annual general meeting of members. If the paper appears to the council to be sufficiently meritorious, the author will be awarded the Andrew Carnegie gold medal.