many of these are of questionable value, either on account of the methods having been replaced by more up-to-date processes or because the materials specified, which were by-products of long-vanished industries, cannot now be obtained. Apart from this defect, which is inherent in all books of this type, there is no doubt that the present volume will be of great service to workers in laboratories as well as to those engaged in industry. The authors state that "the materials have been principally derived from German technical literature, which is especially rich in receipts and processes which are to be relied on." From the impossible nature of several of the processes, one might have guessed this: British workers are familiar with the "reliable" character of some German specifications.

Photography and its Applications. By William Gamble. (Pitman's Common Commodities and Industries.) Pp. xii+132. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2s. 6d. net.

MR. GAMBLE, having had a lifelong experience in connection with technical photographic processes and their applications, speaks with authority on these matters. But the very limited scope afforded by so small a volume as this, and the innumerable applications that have to be dealt with, give him only a poor opportunity of presenting the subject to his readers. The short summary often passes into a mere catalogue of operations, and this into a mere dictionary-like mention. A little more care might well have been bestowed on the revision of the text. Working instructions are not given. We can recommend the book to those who wish to get in a small compass a general, but superficial, knowledge of the character of photography and its applications.

The Chemists' Year Book, 1920. Edited by F. W. Atack, assisted by L. Whinyates. Vol. i., pp. vi+422; vol. ii., pp. vii-viii+423-1136. (London and Manchester: Sherratt and Hughes, 1920.)

SUCCESSING editions of this handy laboratory manual are increasingly useful. The present volumes supply the need formerly satisfied by the "Chemiker Kalender"; English chemists have now no necessity to go outside their own country for such books. A valuable feature of "The Chemists' Year Book" is the series of articles written by specialists, such as that on "Alkaloids" by Dr. E. Hope. The tables and numerical data are very complete.

Ions, Electrons, and Ionising Radiations. By Dr. J. A. Crowther. Pp. xii+276. (London: Edward Arnold, 1919.) Price 12s. 6d. net.

THE subjects dealt with include gaseous conduction, thermionic emission, photo-electricity, X-rays, radium rays, and the electron theory. The treatment involves a knowledge of elementary mathematics, and the work forms a useful appendix to the ordinary text-book of physics. A clear and very readable account is given of the "quantum" theory of radiation.

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Letters to the Editor.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. No notice is taken of anonymous communications.]

University Grants.

THE article on university grants in NATURE of August 5 is opportune, and does not overstate the gravity of the situation. The proposed recurrent half-million is welcome, but quite inadequate. The annual grant to the universities of the United Kingdom should be at least three millions.

We have been rigidly economical in our expenditure. There is no question of the value of the work which has been done. Everyone agrees that vigorous and well-found universities are indispensable to the national welfare, but they are hampered at nearly every point by insufficiency of income. Large numbers of their teachers are very seriously underpaid. Many departments are undermanned. Advanced studies and research are lamentably curtailed. Libraries are stinted of necessary books.

Before prices rose the universities had not the financial resources which their work required. Since the change in the value of money their position has become critical; some of them are threatened with disaster. In Leeds we have done everything in our power to raise salaries in order to meet the increased cost of living. The emergency was so grave that we decided to run a great risk. We have incurred obligations which will entail an annual deficit of 25,000l. Even this expenditure falls far short of what should be incurred if the high standard of university teaching is to be maintained permanently. It will be impossible for us to continue the present rate of expenditure unless large new grants are forthcoming. In the absence of further aid from the Government I see nothing for it but the abandonment of work which is now well done, indispensable, and nationally advantageous. We need an additional income of about 60,000l. a year in order to maintain the supply of teachers of the right type. The annual grant from the Government to the universities of the United Kingdom should be three times as large as what is given this year.

M. E. SADLER.

The University, Leeds, August 9.

The Carrying Power of Spores and Plant-Life in Deep Caves.

My sister and I observed a similar growth of vegetation to that which Mr. Lough. Pendred describes in the Cheddar Caves in NATURE of August 5, p. 709. We were on a knapsack-walking tour together in the Hartz Mountains in 1900, and saw this effect in the beautiful, great, deep Rübeland Caves. These were then lit up by both oil and electric lamps placed, as in the Cheddar Caves, in recesses or on the floor so as to illuminate the stalactites and bone remains. We were told that the ex-Kaiser had ordered the electric illumination, not being content with the previous oil lamps, but both kinds of lighting were still there.

It was very noticeable that the vegetation spread out fan-like in front of the electric lamps to a much greater extent than behind them, or than near the oil lamps, and yet the electricity must have been, at that date, of fairly recent supply. It is true that the

oil lamps are more likely to have had an indefinite position, as they must be handled to fill, but they had probably been much longer close to the situations in which we saw them. The less vegetative growth round them and the shadow effect behind the electric lamps would seem to show that it was the shorter light-waves which were requisite for this plant-life rather than contact-warmth or longer heat and reddish light.

With regard to the transport of the spores to the depths of the caves, some experiments by Profs. Zeleny and McKeehan are of interest. At the Winnipeg meeting of the British Association in 1909 they read a paper, followed by a discussion, on experimental verifications of Stokes's law for the fall of spherical bodies in a viscous fluid. They deduced a discrepancy between theory and experiment which would seriously affect the cloud estimate of gaseous ionisation. A fuller paper and further experiments were published in *Physikalische Zeitschrift* for February, 1910, in which they showed that while a cloud of minute smooth paraffin spheres or mercury droplets obeyed Stokes's law, yet similar experiments with the spores of *Lycopodium*, *Polytrichum*, and *Lycopodium* (all nearly spherical) gave only about half the terminal velocities required by mathematical theory. In *NATURE* of January 6, 1910, I offered an explanation of the apparent discrepancy shown by their results. By using a large-aperture microscopic objective with oblique illumination and spectrum-sifted blue solar light, the spores can be seen, just within the limits of visibility, to be coated with a mass of very fine hairs more than a radius in length. Substituting in Stokes's formula for the terminal velocity

$$v = \frac{2ga^2d}{9\mu},$$

where a is the radius, μ the air viscosity, and d the density of the spores, the effective diameter comes out to be just double that of the measured diameter as seen in an ordinary microscope. This increase of effective diameter is what should be expected if a mass of air be entangled with the spore, or a tail of eddies formed. Hence the physical measurement of the terminal velocity of fall confirms the microscopic observation of the hirsute coating in all the three sets of cases where spores were used. The spores are enabled to be wafted great distances, therefore, much as are the seeds of a dandelion. No Brownian motion or rotation was observed, and this also suggests the coating of hairs. Since the spore-walls are not absolutely spheres or smooth in the sense that surface tension makes the droplets, some Brownian motion would have been expected if the external air molecules could strike directly on the spore-wall. The air entangled in the *chevaux de frise* of hairs will, however, soften down the average result of individual impacts of external air molecules by making the effect slower, and therefore the resultant average smoother.

Yet another indication of this coating of long hairs is the difficulty of wetting *Lycopodium* dust until it has lain on the water long enough to get water-logged, viz. long enough, probably, for the entangled air to be dissolved out. While the air is so entangled the effective density is more nearly one-eighth than a little above unity as measured by Profs. Zeleny and McKeehan.

That this hairy coating provides these spores with a special mechanism which enables them to be carried great distances, is only to make them resemble many other wind-borne fruits, and the fact is therefore likely from general considerations.

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The method of verifying a difficult, almost ultra-microscopic, observation in botany by measuring the terminal velocity, as of a small falling body in a viscous fluid, is perhaps not common.

EDITH A. STONEY.

King's College for Women, London.

Curious Formation of Ice.

IN *NATURE* of December 12, 1912, was published a letter wherein I described a curious formation of ice in the hope that some of your readers would be able to explain the cause, but there was no reply. After five years the formation occurred again in similar circumstances, and I submit a partial explanation which occurred to me on seeing this second example of the phenomenon. The ice was again formed on water in a rough hole or pond (about 2 ft. by 1 ft.) in the garden in clay soil. It was observed at 3.30 p.m. on January 13, 1918. The "dark, sinuous lines" in this case were about $\frac{1}{4}$ in. wide, and again ran "about parallel to the major axis" of the small pond. These dark lines were again due to the ridges of ice on the under-side of the ice covering the water, but were closer together than before, being about $1\frac{1}{2}$ in. apart. The cross-section of the ridges was again of "dovetail" shape, the attachment being at the smaller end of the "dovetail."

The partial explanation appears to be as follows: A uniform layer of ice about $\frac{1}{4}$ in. thick forms over the whole surface of the water. The water slowly leaks out of the pond. The ice sags in the middle, keeping in contact with the water over its central area, but, owing to the support of the sides of the pond, the edges do not sag, and an air-space forms under the ice round its margin. The vertical cross-section of this air-space is a long, narrow triangle lying on one long side (the free surface of the water); the under-side of the ice forms the other long side, and the mud-bank of the pond the short side. At night, or at any other time when the temperature again falls below freezing point, the water at the margin (where the ice and surface of the water meet at an acute angle) freezes to the slab of ice and forms a ridge on the under-side of the ice. The water leaking slowly from the pond all the while would help the formation of the ridge. The next day, or when the temperature is again slightly above freezing, the water, continuing to leak away, allows a further slight sagging of the ice and the enlargement of the air-space, thus giving the space between the ridges of ice. The next freezing forms the second ridge, and so on.

This explanation appears to account for the ridges, their spacing, and their being roughly parallel to the major axis of the pond, but it does not account for the beautifully sharp, regular, and symmetrical formation of the cross-section of the ridges. One expects an asymmetrical cross-section instead of the symmetrical "dovetail." It has been suggested to me that the "dovetail" shape is due to the ridge being partly melted (where it is joined to the top slab of ice) during the period when the temperature is above freezing by the comparatively warm top surface of the water. This seems to be a possible explanation if the cross-section of the ridge when first formed is rectangular.

I hope that with this as a basis someone will be able to complete or modify the explanation of the curious formation of ice observed.

ALFRED S. E. ACKERMANN.

25 Victoria Street, Westminster, London,
S.W.1, August 3.