actual time of the camera exposure; when this is long, as in the photography of faint celestial objects, the sensitizing exposure must take place beforehand and must consist in a short flashing of the plate; when the camera exposure is relatively short, the uniform exposure must follow and must be to a low intensity for a long time. In either case, the added exposure is adjusted in amount to produce only a small general fogging which does not greatly affect the interpretation of the record. Uniform after-exposure or pre-exposure can thus be useful, if applied deliberately; but equally they may lead to serious errors if they occur accidentally and pass unrecognized.

A manifestation of reciprocity failure that has long been recognized as a source of error in photographic photometry is the intermittency effect: an exposure given intermittently may produce a greater, or lesser, density than when the same total exposure is received continuously. Quite recently it has been shown that, if the interruptions are sufficiently rapid, the effect is the same as that produced by a continuous exposure of an intensity equal to the *average* intensity of the intermittent exposure. The frequency of interruptions must be so high that on the average each grain receives only one quantum during each separate exposure. Owing to the small size of the grains, the critical frequency is not as high as might be imagined: an exposure of one second duration need be interrupted at a rate of only a hundred per second. From being a source of error, valuable use can now be made of the effect: by rotating sectors at high speed, variations in time can be converted effectively into variations in intensity. Apart from the occasional advantages that can be made of these effects of reciprocity failure, the fact of importance in photographic photometry is that the calibrating exposure should always be of the same duration as the exposure to the unknown source. There are only two exceptions to this rule: X-rays, and other high energy quanta, because they make a grain developable by a single impact, show no reciprocity failure; the log It/log t curves for different wave-lengths are always parallel. If, then, during the process of calibration, one spectrum line is reduced in intensity until it matches in density another line of the same spectrum, the relative energy of which is known, the result will be independent of the exposure time; so that, in certain cases, the calibrating exposure need not be of the same duration as the unknown.

The general rules of photographic photometry follow readily from what has been said. The calibrating exposure should always be impressed on the plate used for recording the unknown radiation, so that errors of development may be reduced. Whenever possible, the two exposures should be made on contiguous areas, since the plate may show small local variations in sensitivity. The spectral composition of the calibrating radiation should be identical to that of the unknown radiation, although in spectrophotometry within narrow spectral regions it is permissible to use a mean wave-length for the calibrating radiation, for example, by the use of sharp cutting filters. The time of exposure must be the same for both exposures, apart from the two exceptions mentioned.

It has been assumed that the exposed areas are large and that edge effects can therefore be neglected: the sensitive layer has been imagined to be a two-dimensional continuum, and any effects caused by its finite thickness have been ignored. During the course of manufacture, the photographic 'emulsion', which is a suspension of silver halide in a solution of gelatin, is coated evenly on to its support, and dries down to form a layer about one thousandth of an inch in thickness. During development, the layer swells to some five times this thickness. The images to be recorded are often of comparable dimensions, for example, the image of a star or of a spectral line; and second-order effects arise, owing both to the penetration of the light and the penetration of the developer. The light is strongly scattered on entering the layer, and a sideways spreading of the image results: the developer solution reaches the grains by diffusion, and the products of the chemical reaction diffuse outwards; they inhibit the reaction and produce local variations which may sometimes cause the density distribution of an image to depart seriously from its true form. Full development and vigorous agitation of the developing solution over the surface of the plate will generally reduce these effects to negligible proportions; but the effect of light scatter is not so easily overcome. Use can sometimes be made of this, as in astrophysics, where the growth of the image with exposure is used as a measure of stellar magnitude. More often the scatter tends to destroy the fine detail of the image, and can be limited only by the best choice of materials. The effect depends both on the grain size and the number of grains per unit volume of the layer, as well as on the wave-length of the light; and the finest grain emulsions are not necessarily those which scatter least. The discrete nature of the developed image also plays a part in the detection of fine detail. A microdensitometer record of a uniformly exposed and developed area shows irregularities caused by this granularity of the image; variations due to this cause will be superimposed on those which are the subject of investigation, and will tend to mask them. The graininess increases both with the density of the image and with the size of the grains; its effect on visibility tends to outweigh that of light scatter, so that slower emulsions almost invariably have greater resolving power than faster ones. An additional reason is that slower emulsions generally have higher contrast, and this naturally increases the ability to differentiate small brightness differences.

It is not surprising that an almost bewildering array of photographic materials is available. The choice must depend upon the problem in hand. Sometimes the need is for high resolving power and for low graininess; at other times, these desirable features must be sacrificed for extreme speed for some part of the spectrum; and consequently a compromise must usually be made.

OBITUARIES

Prof. A. W. Nash

ALFRED WILLIAM NASH, professor of oil engineering and refining at the University of Birmingham, died in his fifty-sixth year at his home in Solihull on March 14. After training as a mechanical engineer at King's College, London, he had some experience in dock construction in Hong-Kong, and shortly afterwards joined the (then) Anglo-Persian Oil Company and took part in the building of the great refinery in Abadan, South Persia. In 1913 he proceeded to the Caucasian oil territory and remained in Russia for more than five years, chiefly engaged in field production problems.

Then began Nash's long and successful career in Birmingham in the footsteps of that great pioneer, the late Lord Cadman, who had founded the first school of petroleum technology in Great Britain under his charge as professor of mining. When Cadman left, the chair was divided and a separate professorship of oil technology was established, and in 1924 Nash was appointed to the post. A very substantial endowment of £125,000 had been raised by the great British oil companies, and Nash's first task was to erect a block of laboratories, offices, museum and library to house his school. This was opened in 1926 and remains as his chief monument.

During his whole career in Birmingham, Nash was responsible for a constant stream of scientific contributions to oil technology. He was a man of ideas and well able to stimulate his staff and students. With his ample background of first-hand experience in oil-fields and refineries, he was well equipped to sense the relative importance of both practical and academic problems, and to direct a vigorous and progressive school of research, while in the course of his many visits to centres of oil activity in America, Europe and the East he made innumerable contacts with the men on the spot, and thus realized the need for investigation on this or that project.

Throughout his active life he was intimately concerned with the affairs of the Institute of Petroleum —known, when he became a member in 1914, as the Institution of Petroleum Technologists. For many years he served on the Council and as vice-president; three years ago he was elected president, and he died in that office. Most of his contributions to science are to be found in the pages of its *Journal*, but he was a prolific worker, and many of his papers appeared in American technical journals.

In collaboration with his colleague Dr. Bowen he wrote "The Principles and Practice of Lubrication"; with Dr. D. A. Howes, "The Principles of Motor Fuel Preparation and Application"; and he played a great part in the organization and editing of the four volumes of "The Science of Petroleum". His work with Howes on knock-rating of pure hydrocarbons was of great merit; he demonstrated the synthesis of lubricants from the simple olefines by polymerization; with Hunter he developed the fundamental study of solvent extraction, the dewaxing of lubricating oil and the refining of waxes. With Dr. A. H. Nissan he published a valuable paper on the relation between viscosity and constitution. His presidential address on "Petroleum as a Raw Material" showed real insight into the ever-growing utilization of oil and its gaseous by-products as raw materials for chemical syntheses.

This brief note would be very incomplete did I not pay a personal tribute to my old and valued friend and collaborator. Nash had a most lovable nature, and those of us who enjoyed his close friendship for many years feel his passing acutely. Especially will he be missed by his old students who, working in all parts of the world, always kept in touch with him, and were always delighted to visit him on their return home.

A. E. DUNSTAN.

WE regret to announce the following deaths:

Dr. B. M. Griffiths, formerly reader in botany and head of the Department of Botany in the University of Durham, on March 25, aged fifty-five.

Mr. R. W. Haydon, formerly lecturer in agriculture, University of Leeds, on March 28.

Mr. H. J. Hughes, formerly principal of the Muresk Agricultural College, Western Australia, on September 27, aged sixty-seven.

Dr. T. B. Macaulay, formerly president of the Sun Life Assurance Company of Canada, founder of the Macaulay Institute of Soil Research at Aberdeen, on April 3, aged eighty-one.

Mr. F. J. Rae, director of the Melbourne Botanic Gardens and Government botanist for Victoria, on September 18.

Mr. L. Wray, I.S.O., formerly director of the State Museums, Malaya, on March 14, aged eighty-nine.

NEWS and VIEWS

India

THE breakdown of the negotiations conducted by Sir Stafford Cripps on behalf of the British Government with the chief Indian communities for a settlement of relations between the British and Indian peoples is a cause for profound regret. At a time like the present, every jarring note in the concord of the free nations is eagerly awaited in the Axis camp, and is represented by every device of propaganda as a major disaster. This it certainly is not, for although the leading communities in India have been unable to agree either among themselves or with the British Government on any immediate change in the form of government of the country, on the major issue, namely, resistance to aggression, there has been striking agreement. Further, the various parties have been able to put their views to a member of the British Cabinet, and have themselves been able to study concrete proposals for a settlement. The fundamental stumbling block is clearly lack of mutual understanding and sympathy, and, one fears, an under-estimate of the complex factors involved in ruling a sub-continent. The old divisions and the old distrust are still painfully apparent. As Sir Stafford Cripps said in his farewell broadcast to the Indian people: "Someday, somehow, the great communities and parties in India will have to agree upon a method of framing their new constitution". The problem will have to be approached in the scientific manner, assembling all the data and weighing them without prejudice, in the sure hope that a true solution will eventually be found.

Science and Ethics: A Hindu View

THE symposium on science and ethics, opened by Dr. C. H. Waddington, which appeared in these columns during September and October of last year, aroused world-wide interest. We have already published a communication from Prof. Chauncey D. Leake, who was chairman of a discussion on the same topic by American biologists; and we hear that the Aristotelian Society is arranging a meeting early in June at which Dr. Waddington will be invited to defend his views. A comment on the symposium by D. V. Gundappa was published in the Indian journal *Current Science* in December last, and