dressings of nitrogenous fertilizer in early spring produce a rapid growth of succulent herbage containing a high percentage of crude protein. If this herbage is grazed by dairy cows as their sole diet, it provides an unbalanced ration containing excess of protein equivalent. The effect of the sudden change from the winter ration to such an unbalanced diet in the spring is not infrequently to induce severe hypomagnesæmia and 'tetany'.

Rumen fermentation of such spring herbage has been shown to lead to increased production of ammonia; the ammonia is absorbed from the rumen into the blood stream and can be demonstrated in the portal vein and sometimes in the peripheral blood. This production of ammonia in the rumen can be depressed by feeding starch. Ammonia in the circulating blood may be toxic in relatively low concentrations.

Hypomagnesæmia in the cow in spring is due in part to the low availability to the animal of the magnesium in spring herbage, and in part to the relatively low daily intake of magnesium in the grass diet in comparison with the intake from winter feed. The hypomagnesæmia is most severe in those cows with the highest levels of ammonia in the blood. If the ammonia concentration in the rumen of a cow is artificially raised, the magnesium-level in the blood is depressed. On the other hand, low level of magnesium in the blood induced by feeding young spring grass may be raised again by feeding maize starch, which at the same time causes a drastic reduction in ammonia-levels in the rumen.

The final paper in this symposium, by Dr. W. A. McGillivray (Palmerston North, New Zealand) and Dr. S. Y. Thompson (Shinfield), was concerned with the influence of pasture on the vitamin A and carotene in the milk of cows. Calculation shows that, in the average human diet in Britain, cows' milk contributes about 20 per cent of the daily requirements of vitamin A. Three factors influence the vitamin A content of cows' milk, as follows: stage of lactation—colostrum and very early lactation milk are richer in both carotene and vitamin A than milk secreted during the rest of the lactation period; hormonal influences—the thyroid plays a part in carotene metabolism in the cow; and feed of the cow—the major factor. The cow converts carotene inefficiently into vitamin A. Intake of carotene is, however, probably quite sufficient on pasture to produce butter with high vitamin A potency; but on a winter diet this potency diminishes markedly. In New Zealand, where cows—predominantly Jerseys—are fed outdoors on pasture throughout the year, a uniformly high vitamin A potency in milk fat might be expected. In fact, the potency depends in large part on the botanical composition of the herbage, less carotene being absorbed and utilized on a pasture containing much clover than on one containing little clover. The tocopherol content of milk fat is likewise decreased on a high-clover pasture. There are probably two forms of carotene in blood plasma, one which contributes little to milk-fat-carotene levels and is associated with vitamin A alcohol, and the other which is present on a carotene-containing diet and is associated with vitamin A ester and dietary fat in the chylomicrons, taken up directly by the mammary gland to contribute to the synthesis of milk fat.

Quickly growing, 'improved' pasture produces a number of metabolic disturbances in sheep and in cows in New Zealand. Muscular dystrophy is found in young sheep (though there is adequate tocopherol in the pasture). There seems to be an anti-vitamin D factor in pasture, producing rickets in young lambs. Bloat in cows is a serious problem in New Zealand—drenching the cows with oil appears to be an effective treatment. Facial eczema in sheep, associated with lush pasture, also causes serious losses in some years; its cause is not yet understood.

Each paper in the symposium was followed by a short but lively discussion; from these discussions it is clear that two of the present urgent needs in relation to the feeding of farm livestock on pasture are: first, more knowledge of those constituents of rapidly growing herbage which at times upset the metabolic balance of grazing ruminants; and second, how such upsets can be most conveniently prevented in practice on the ordinary farm, without diminishing the advantages of modern methods for improving the efficiency of grassland production.

H. D. KAY

THE 1956 CAMBRIDGE SUMMER SCHOOL IN PHYSICAL CHEMISTRY

THE rate at which modern science advances continues to increase, and most scientists, though confining their activities within narrow channels, find themselves incapable of synchronizing with the acceleration. One way of contending with this situation is by means of the refresher course, where a small number of lecturers who have paid special attention to certain selected subjects give brief reviews on recent developments, stressing general theoretical principles rather than detailed experimental technicalities. With this object in mind, the Department of Physical Chemistry of the University of Cambridge has arranged summer schools, at intervals of three years, since the end of the Second World War.

This year's summer school, held during August 18–25, began with an inaugural lecture on Saturday night by the head of the Department, Prof. R. G. W. Norrish, who outlined briefly the history of the University of Cambridge and in particular of the origin and growth of its scientific departments. Prof. Norrish is particularly well qualified for such a lecture, being a Cambridge man in every sense of the word; he was born in the City, and, before entering the University, was educated at the Perse School, the ancient hall of which is now one of the most attractive features of his Department. The lecture, though full of fact, was interspersed with adequate humour, and helped to create an atmosphere of welcome to the 116 visitors who attended the school. The first real mingling of the visitors among themselves and with many Cambridge dons began in a garden party held on Sunday in the pleasant grounds of Sidney Sussex College.

The scientific course, which started on August 20, consisted of a course of fourteen lectures devoted to two broad topics, both of which are rapidly developing, namely, the applications of spectroscopy to chemical problems and the application of intermolecular force theory to the study of fluids. The first lecture was given by Prof. H. C. Longuet-Higgins on the nature of intermolecular forces and the properties of imperfect gases. Direct electrostatic, induction and dispersion forces play a part in determining intermolecular potential energies, and must be supplemented by repulsive forces, which predominate when molecules get very close together. This led naturally to a treatment of the liquid state of matter, which was given by Dr. E. A. Moelwyn-Hughes. Theories of free space, moving holes and anharmonic oscillators were reviewed, and new data presented on the heat capacities of liquids at constant volume. Both these lecturers spoke later, and from different angles, on current theories of solutions of non-electrolytes. Longuet-Higgins showed how the thermodynamic properties of regular solutions could be derived on a statistical basis, while making a small number of assumptions concerning the form and relative magnitude of the three interaction-energy terms. Dr. Moelwyn-Hughes explained how the theories of van Laar, Hildebrand and Scatchard can be derived in terms of a simple model of a solution and of the partition function to which it leads. Dr. J. N. Agar gave two lectures on selected topics dealing with solutions of electrolytes. He dealt with heats and entropies of hydration of ions, with the limitations of Born's theory, and with a new hypothesis on solvation which can explain the magnitude of the ionic activity coefficient in quite strong solutions. Mr. R. P. Bell, of Oxford, one of the visiting lecturers, spoke on the hydrogen bond and the very wide range of phenomena connected therewith. The hydrogen bond deserves to be treated as distinct from other types of bonds. Our knowledge in this field began with the study of the interaction of two carboxylic acids, and now extends to the interpretation of the so-called anomalous properties of hydroxylic liquids and solutions.

The discussion on modern developments in spectroscopy was opened by Mrs. D. M. Agar, who gave an account of infra-red and Raman spectra, with their application to such problems as rotational isomerism and forbidden transitions. There followed a lecture by Prof. W. C. Price, of King's College, London, the second visiting lecturer, on observations made in the visible and ultra-violet regions. Electronic spectra and ionization potentials of polyatomic molecules are now telling us much about the pattern of electrons in molecules and of their energy states, just as atomic spectra long ago provided Rutherford and Bohr with a picture of electronic arrangements and energies in free atoms. The nature of the chromophoric group in the normal and excited states of the molecule can be understood in terms of a fairly simple free-electron theory. Among the more spectacular spectroscopic developments of the past decade are those associated with the production of free radicals under the influence of an intense flash and with their characterization during their transient existence. The first lecture on this subject was delivered by Prof. Norrish, who first described in general terms the methods of kinetic spectroscopy and their application to isothermal reactions of free radicals. Among the many problems which have been tackled by the new method are the rates of combination of free atoms, the mechanism of the interaction of carbon monoxide with various gases and the conversion of the vibrational energy of the oxygen molecule into energies of other forms. The marked advances made in radio-frequency spectroscopy, and the related topics of nuclear magnetic resonance, were treated in two lectures by Dr. T. M. Sugden. Moments of inertia, intermolecular distances, valency angles and dipole moments are among the molecular properties which can be measured by the radio-frequency method. Dr. Sugden's third lecture dealt with the applications of spectroscopy to the study of flames. The concentration of free electrons in flames can now be determined fairly accurately, and the results can be applied to estimate the energy required to dissociate molecules into radicals, and complex radicals into simpler ones. Values of the bond energies thus found have been confirmed by other means. The course concluded with a lecture by Prof. Norrish on the study of explosions by means of kinetic spectroscopy. The mechanisms of the reaction between hydrogen and oxygen and of the oxidation of hydrocarbons have been studied by the new method, which has served also to throw light on the nature of the knock and anti-knock effects met with in combustion.

Each lecture was followed by discussion, and the two morning lectures at 9.30 and 11.15 were separated by an interval when discussions continued over coffee. One cannot attend lectures and take part in discussions the whole day through, and the organizers of the summer school had wisely provided amenities to fill in the leisure hours. Most of the men attending the school were housed in Corpus Christi College and Pembroke College, and the five women were accommodated in the Corpus Christi College Hostel. There was a reception in the Guildhall on August 21, when scientists forgot that they were scientists and relaxed in dancing or sipping wine under the influence of pleasant music. Mr. Hugh J. McLean gave an organ recital in the chapel of King's College on August 23, when the visitors had an opportunity of listening to some of the fugues and voluntaries of Orlando Gibbons, a chorister of the College in 1596, and of Bach, Mozart, Franck and Willan. Those who attended the school were also entertained by Prof. and Mrs. Norrish at their home and by the senior members of his staff at evening parties given at their homes or in their colleges. On August 24 the school and a number of guests dined in the hall of Pembroke College under the presidency of Prof. Norrish, with Sir Owen Wansbrough-Jones, chief scientist of the Ministry of Supply, as principal guest.

Most of those attending the school were research workers or those engaged in teaching physical chemistry. Fifty-four came from industrial research establishments, which included Bakelite, British Celanese, British Rayon, Bush, Boake Roberts, Courtaulds, Distillers, Dow Chemical Co., Esso, J. Lyons, Imperial Chemical Industries, Laporte, Monsanto Chemicals, Metropolitan-Vickers, Philips (Eindhoven), Pilkington's, Rolls-Royce and Shell. There were thirty-two academic scientists from the Universities of Belfast, Berlin, Columbia, Copenhagen, Delft, Geneva, Glasgow, Göttingen, Hong Kong, Leyden, Liège, London, Marburg, Moscow, Prague, Southampton, Texas, Tokyo, Virginia and Warsaw. There were nine representatives of research and development establishments of the various Ministries of the Crown and six teachers from public and grammar schools.

It is almost impossible to over-rate the importance of the contacts established in such a gathering. The great number of questions put to the lecturers in private conversations proved that the topics dealt with were of immediate interest and value. The lecturers themselves have also learnt much of what is happening in wide fields of research enterprise outside their own university. Ideas were freely exchanged and, like the poet's joy, improved on being poured from one vessel to another. There was a refreshing frankness in all the school's deliberations, and there was a free trade of thought.

No account of the physical chemistry summer school at Cambridge would be complete without some reference to the happy human relationships which were established, and in many cases strengthened, between academic research workers and industrial research workers, and between British scientists and foreign scientists. Politicians have yet to learn that scientists are men who are kindly disposed towards one another, have a common faith and interest in their subject and desire nothing more than freedom to study Nature and to subjugate her to the benefit of mankind. A gathering of this kind can be lightly described as just another conference, conducted with evident pleasure, and not unprofitably. On the other hand, its consequences are incalculable. To bring industrial and academic research workers together is a vital step in furthering the national economy. To bring foreign scientists from all over the world—including that part which lies beyond the 'iron curtain'—into harmonious contact with British scientists is to increase the volume of international goodwill, in an age when that commodity is none too abundant, and when the contribution of the scientists to it is paramount. E. A. MOELWYN-HUGHES

GLAZED FROST IN ENGLAND OF JANUARY 1940

GLAZED frost, the phenomenon of rain or drizzle falling on a frozen earth and covering everything with a layer of clear ice, is not of very frequent occurrence in Britain and, when it does occur, it is usually short-lived and quickly followed by an influx of air warm enough to melt the ice. In the United States it is sufficiently common and severe to be called an ice storm. The main economic effects are severe disturbance of transport by the very slippery roads and paths and destruction of overhead telegraph and power lines. The precipitation falls from clouds at a temperature above freezing point through a low-lying layer of air at a temperature below freezing point. The supercooled droplets freeze on striking the ground, trees, telegraph wires and so on, forming a coating of clear slippery ice. Usually the phenomenon is transitory because it is produced by the fairly fast-moving warm front or warm occlusion of a winter depression.

During January 25–February 4, 1940, however, as is described by Dr. C. E. P. Brooks and Mr. C. K. M. Douglas in Geophysical Memoir No. 98 of the Meteorological Office, entitled "Glazed Frost of January 1940"*, intense persistent glazed frost formed over much of England south of a line from the Humber to the Mersey except East Anglia. It was especially intense along a wide belt from North Wales to Kent. The ice formed cylinders up to 2½ in. in diameter on telegraph wires, twigs, etc., and a coating an inch thick on the ground. Telegraph poles and trees collapsed in large numbers under the weight of the ice. The memoir contains some vivid photographs of the ice which the authors describe as probably unequalled, certainly in at least a century, for extent and persistence in Great Britain.

The meteorological circumstances producing the ice are fully described. At the time there was an anticyclone over Scandinavia and a depression south-west of Iceland. Between these systems a very cold south-easterly wind blew across most of the British Isles with temperatures between 25° and 30° F. inland. Two warm fronts moved successively early in the period from the south-west across Ireland, south-west England and Wales and then oscillated slowly backwards and forwards over the mouth of the Channel and south-west England, bringing the rain which fell through the cold surface air to produce the glazed frost. Finally, on February 3, the warm air swept northwards, displacing the cold south-easterly current over the country and melting all the ice. The chief technical meteorological interest lies in the motion of the fronts, which over a considerable period departed widely from that given by the components of geostrophic wind normal to them.

The differences were abnormally large. One warm front over south-west England on January 28, which should, on the geostrophic basis, have moved at the rate of 15 m.p.h. to the north-east, moved at 5 m.p.h. south-west. The differences between actual and geostrophic wind are too large to be accounted for by accelerations associated with pressure changes, and the best suggestion is that of a departure caused by turbulent friction in the frontal zone in which the wind changed rapidly in direction. This friction introduces a term in the hydrodynamic equations proportional to the coefficient of turbulence, multiplying the second differential coefficient with respect to height of the wind component parallel to the front. It is shown in the memoir that this would have the right order of magnitude.

* Air Ministry: Meteorological Office. Geophysical Memoir No. 98: Glazed Frost of January 1940. By Dr. C. E. P. Brooks and C. K. M. Douglas. Pp. 40+10 plates. (M.O. 584*f*.) (London: H.M.S.O., 1956.) 7*s*. 6*d*. net.

THE BUKIDNON OF MINDANAO

PROF. FAY-COOPER COLE'S recent field-work monograph on the people of one of the larger islands of the Philippines, entitled "The Bukidnon of Mindanao"*, is an unusual publication. Had it been written by an anthropologist as a result of recent field-work, it is doubtful whether there would have been any justification for having it published. But the field-work dates from 1910, and the author is a professor of anthropology (emeritus) writing in 1956. The situation has its possibilities, and on commencing to read the monograph one wonders whether the author will succeed in producing a work of contemporary interest on foundations that are left over from a different period. The answer is, unfortunately, no.

It would, of course, be unfair to take the author to task for not having had 1956 in mind in 1910; but it is obviously true that he has been unable to decide what to do with the material himself, and, as a result, the book is concerned with everything in general, but nothing in particular. There are good illustrations of material objects, houses and dress, all of which are interesting, but within the scope of a hundred-odd pages the text rushes through chapters with such diverse titles as "Making a Living"; "The Life Cycle, Social and Political Organization"; "The Spirit World"; "The Ceremonies"; "Music and Dancing"; "Celestial Bodies"; "Stories and Legends".

Prof. Cole seems to have had no concern for kinship, at least in 1910—which is a pity; for the Bukidnon appear to have a system of bilateral kinship on the Iban pattern, but there are scarcely

* *Fieldiana*: Anthropology, Vol. 46: "The Bukidnon of Mindanao". By Prof. Fay-Cooper Cole. Pp. 140. (Chicago: Chicago Natural History Museum, 1956.) 4 dollars.