of the origins of the solar system, in terms of ordinary physical and chemical ideas. It was typical of Prof. Urey that although his talk was not primarily about magnetism, he nevertheless provided the experts with some rather awkward problems to think about. In the evening an informal conference dinner was held in the dining room of the recently opened Portland building.

The last day of the meeting was devoted mainly to topics related to semiconduction, with the morning's lectures largely concerned with the applications of resonance methods. By way of introduction to this, Prof. M. H. L. Pryce (University of Bristol) gave an elementary and comprehensive survey of the three techniques of cyclotron, paramagnetic and nuclear resonance. Then followed E. H. Rhoderick (Services Electronics Research Laboratory, Baldock), who gave a detailed account of a number of experiments in which nuclear magnetic resonance had been used to study some of the III-V semiconductors. In this the nuclei are used essentially as probes to examine what the electrons are doing, which means that the value of the information depends critically on the electron-nuclear coupling. The III-V compounds are a much more promising field for this type of work than are germanium and silicon, but even so it must seem at times as if Nature is being deliberately unco-operative. Cyclotron resonance was represented by D. M. S. Bagguley (University of Oxford), who reported the observation of signals at 90° and 65° K. from two types of carriers in gold-doped germanium. The masses and relaxation times were found to be independent of temperature. Due to time-table changes, the final paper in this family was given later in the day, when E. E. Schneider (King's College, Newcastle) described the application of electronic resonance and optical work to the study of alkali halide crystals. There seems to be evidence of microstructures in these, and by studying the resonances from very small amounts of divalent manganese impurities, a lot of detailed information can be obtained. For example, one of the manganese resonances is so narrow that it can only be concluded that it comes from ions precipitated on grain boundaries. In addition, we heard from G. G. Macfarlane (Royal Radar Establishment, Malvern) and R. J. Elliott (University of Reading) of some recent work which they have been doing on the interpretation of the fine structure in the intrinsic absorption edge in germanium. It appears that a number of mechanisms contribute, and a first step is to break down the observations into the parts due to the various processes. These have then been studied in detail, particularly the part played by excitons, and a very satisfactory picture of the whole phenomenon has resulted. The final contribution of the morning came from A. L. Parsons, who described his recent theories about diamagnetism.

The first part of the afternoon session was given over to the chemists, beginning with Prof. D. D. Eley (University of Nottingham) describing his work on organic semiconductors. In these, excited electrons can travel fairly freely through the molecules, but are impeded by having to tunnel from one molecule to the next. As might be expected, the energy gap is correlated with the excitation energy of the molecule. As typical of the systems being studied, we may mention metal-free phthalocyanine, the complicated substance known more familiarly to physicists as the *g*-marker, and some of the proteins. Then C. H. L. Goodman (General Electric Company) pro-

pounded a number of empirical rules which he has found useful in predicting new inorganic semiconductors, and described various exotic new semiconductors which he had prepared with their help, usually by substituting an *A* and a *C* atom for two *B* atoms, while retaining the same number of electrons. There seems to be no end to this process of producing new semiconductors, but at present it is an open question whether any of them will prove to be as valuable as the more conventional ones. In the same vein, J. C. Woolley (University of Nottingham) described his experiments on making mixed III-V compounds. The literature about this is confusing, but it now seems to be definitely established that InSb-GaSb and InAs-GaAs can be made. It takes a long time to obtain equilibrium, so that annealing over extended periods has been necessary, although recent developments seem to promise that these long times (of the order of months) can probably be much reduced.

The final session consisted of a number of short communications. J. M. Lock (Royal Radar Establishment, Malvern) described his recent susceptibility and specific heat results on some of the rare earth metals, A. E. Liddiard (Atomic Energy Research Establishment, Harwell) spoke about his work on the thermoelectric power of ionic conductors, J. H. Smith (University of Sheffield) reported on the magneto-resistance of MnAu₂, and S. Altmann (University of Oxford) gave a progress report on his application of the cellular method to determine the band structure in hexagonal close-packed metals.

Throughout the sessions and the social gatherings in the evenings there was a good deal of discussion and exchange of ideas, and it seemed to be the general opinion that the meeting served a useful purpose in bringing together so many solid-state physicists. The majority of the papers described work being carried out in Britain, and the overall impression was that a lot of good research is going on, but that, except possibly in some of the very largest laboratories, we are rather slow in exploiting techniques which have been recognized elsewhere as being of great potential value in solid-state physics.

No conference report is being prepared, since it is assumed that the original contributions will be submitted for publication in the usual way.

K. W. H. STEVENS

INSTRUMENTS FOR USE IN OCCUPATIONAL HYGIENE

THE British Occupational Hygiene Society held its seventh conference in the Canterbury Hall, University College, London, on April 16 and 17. Eight papers were read dealing with the nature and use of instruments for guarding the health of industrial workers in the performance of their various occupations, which often expose them to potential danger if the materials they handle and their environment are not carefully controlled. Throughout the conference a broad view of the subject was taken, both by the authors and those who entered into discussion with them, and general surveys of the various techniques available, together with operational principles, featured more strongly than technical details, though the latter were by no means lacking.

The outgoing president of the Society, Dr. C. G. Warner, divisional dust suppression scientist of the National Coal Board, presided over the first day's proceedings, and was succeeded by the new president, Dr. P. Pringle, chief medical officer of the Central Electricity Authority, on the second day.

The first paper was presented by Mr. R. C. Tomlinson, of the National Coal Board, and dealt with "Sampling Programmes and Sampling Instruments". He said that the details of an experimental sampling programme are ultimately determined by three factors. First, there are the environmental conditions with their changes in space and time over which the experimenter has no control. Secondly, there is the information required—the purpose of the investigation. Over this the experimenter has some control, as he may modify his requirements if the programme would otherwise become too unwieldy. Thirdly, there is the sampling instrument, and the experimenter here has full choice from such instruments as may be available.

The greater part of the paper was concerned with a discussion of how the sampling could be arranged to fit in with these factors. It is most important to specify clearly the information required since the latest sampling and instrumental techniques often provide more efficient measurement of certain items at the expense of others. The discussion finally led to the question of what improved sampling instruments should be designed to do.

Dr. P. J. Lawther, of the Atmospheric Pollution Research Unit, then spoke of "Analytical and Clinical Methods in the Study of Atmospheric Pollution". In order to understand the harmful effects associated with dirty air it is necessary to study concurrently the character of the pollutants and the health of susceptible patients. Many complicated instruments are applied to each angle of the work but, in the last analysis, it is the effect on the human being which matters. Interpretation of this in terms of instrumental indices is so difficult that it has been found profitable to employ the human observer himself as a recording instrument. How this has been accomplished was described, together with reference to analogous experience in other fields.

Mr. C. A. A. Wass then gave an account of "Some Instruments and Instrument Techniques in Use at the Safety in Mines Research Establishment". Studies of the ways in which the safety and health of mine workers can be maintained and improved have led to the need for a wide variety of measurements and techniques, including observation and recording of phenomena associated with the development of explosions in gases and dust clouds, using high-speed cameras and devices for measuring blast (wind) speed, explosion pressures, etc.; examination of the air in mine roadways to determine the proportions of inflammable and toxic gases, especially methane and carbon monoxide; non-destructive testing and metallurgical examination of chains and other gear used for cage suspension in mines; determination of the proportions of quartz and other minerals in samples of dust from mines and from human and animal lungs; observation of the smaller dust particles by means of electron microscopes; high-speed photography of the growth or decay of flame 'kernels' initiated by small electric sparks; estimation of the concentration of respirable dust in mine air, and study of the dispersion of dust from its source. Work is needed both in the laboratory and in the mine. Instruments for use underground must

be designed to stand rough usage and must be safe in inflammable atmospheres: a wide variety of such instruments have now been developed for this work.

The final paper on the first day was read by Dr. P. J. Chapman, of the National Coal Board, and was concerned with "Medical Indices in Coal Workers' Pneumoconiosis". He explained why an index of the state of disease is desirable and how the chest X-ray picture has come to be accepted as satisfactory for the purpose. In order to give an unequivocal result the film has to be of high quality, otherwise even experienced readers may interpret it in different ways. This requirement has been achieved by instrumental control of exposure and processing by methods explained in detail. Another promising index, based upon the expiration of a single forced breath, was mentioned, and two instruments for measuring it were described.

The second day opened with a paper by Dr. B. E. Dixon, of the Department of the Government Chemist, on "Field Tests for Toxic Substances in Industrial Atmospheres". He explained the need for simple, reliable tests and discussed the acceptable standards of accuracy. Certain principles of analysis are dictated by these requirements and the fundamental limitations and possibilities of improvement were described with illustrative examples.

Mr. R. A. C. Isbell, of Hilger and Watts, Ltd., then spoke on "Instruments for Use in Absorption Spectrophotometry". He stated that the design of instruments for chemical analysis depends largely on the type of product being tested. If samples were coloured, or if specific colour could be produced by some chemical treatment, a simplified form of instrument can be employed. Such an instrument uses a very simple kind of monochromator, or even colour filters. The photocells may be of the self-generating type connected directly to a sensitive galvanometer. Balanced photocell circuits enable one to be independent of source fluctuations and fatigue. Where the specific band is very narrow, or if the absorption is in the ultra-violet or infra-red region, the instrument becomes more complicated. For the ultra-violet a quartz prism monochromator and vacuum type photocells with amplification are required. This involves greater stabilization, which increased the cost of the equipment. Instruments were described in which these problems have been successfully overcome. In the infra-red region there are further problems in the selection of light source, prism material for monochromator, and detector. Instruments for routine testing are available in which particular attention has been paid to the ease of operation, so that rapid and reliable records can be obtained.

The last two papers dealt with the hazards of radiation which arose both in the atomic energy industry itself and in the many concerns applying radiating substances to their own techniques. Mr. B. S. S. Smith, of Harwell, described "Instruments in Laboratories and their Use for the Control of Ionizing Radiation". He gave a brief summary of the maximum permissible levels recommended by the International Commission on Radiological Protection and mentioned how the principles established by the Commission are used for deriving maximum permissible levels for all kinds of conditions. The physical principles of the ionizing chamber, the gas counter and the scintillation counter were outlined, and it was shown how they are used to measure the parameters of interest to the health physicist. The radiation

sensitivity of photographic materials was also described. Examples were given of how instruments incorporating the above principles are used for environmental control and for personal monitoring.

The conference came to an end after a paper by Dr. T. E. Graham, of the Windscale works of the U.K. Atomic Energy Authority, on "Diagnostic Aids in Radiation Medicine". He said that the doctor's reliance on instruments is perhaps greater in radiation work than in any other occupational field. His clinical examination reveals almost nothing unless the case is an extreme one. Radiation-induced disease has such a long latent period before it becomes clinically detectable that an early assessment of exposure is of paramount importance in prognosis. The reassurance value of negative findings is of no less importance. Techniques were described for the assessment of radiation dosage both during the exposure and after it. Radioactive contamination of the skin and problems connected with contaminated wounds were also discussed. Internal contamination and the absorption of radioactive substances present the most serious diagnostic difficulties. Here the doctor is confronted with a symptomless patient, whose history might be quite unhelpful, with perhaps only a single fact—a positive urine analysis result, for example—to guide him. Radiochemical techniques, with all their inherent uncertainty, then become the main diagnostic aids. Descriptions were given of some remarkable instruments which perform quantitative analysis of the most complex mixtures of isotopes, often present in the minutest amounts in the body and its excreta.

A full report of the conference will appear in the June issue of *Instrument Practice*. Copies can be obtained from the scientific secretary of the Society, Dr. D. J. Turner, Medical Research Council Laboratories, Holly Hill, Hampstead, N.W.3.

C. N. DAVIES

PHYSICS TRAINING IN SCOTLAND

THE Scottish Branch of the Institute of Physics and the Education Group joined in conference at the Royal College of Science and Technology, Glasgow, on April 12 and 13. From the first it was clear that the main concern of the conference was the proper education of the future physicist, rather than simply 'training' in physics, as stated on the programme; and, once the slight but significant differences in terminology due to the Border were understood, there was a good measure of cordial agreement between both the suppliers and demanders of physicists as to the kinds of education desired.

In his opening address, Prof. W. H. J. Childs (Heriot-Watt College, Edinburgh) said that ineffective panic measures in the future could only be forestalled by facing the fact that the shortage of trained scientific workers would be permanent, and by planning ahead in these terms. Increase in the numbers of real scientists of university calibre was unlikely, and the problem is to develop the abilities of less gifted people. He suggested for consideration a reduction in the content of undergraduate courses, and the deferment of specialized instruction to the postgraduate stage; while, at the other end, steps

should be taken in the first year to fill the gaps in the knowledge supposedly acquired at school. These points were, in fact, dealt with by several speakers.

Mr. M. Milburn (Metals Division, Imperial Chemical Industries, Ltd.) spoke of the graduate physicist in industry. Versatility and an ability to apply fundamental physics logically to different types of problem were needed. Industry could provide its own specialist training; a basic understanding of physics, and some fluency in writing reports, were the qualities it sought in recruits. The needs of the Scientific Civil Service were voiced by Dr. R. A. Smith (Royal Radar Establishment, Malvern), who said that the university graduate required further training—not merely specialized training, but a postgraduate course in fundamental physics. This also was one of the points made by Mr. J. R. Atkinson (University of Glasgow), who advocated first-degree courses in pure and applied physics as university studies, with the technical colleges giving advanced postgraduate training for higher degrees, including the Ph.D. It seemed, from the discussion that centred around the role of the technical colleges, that the proud tradition of undergraduate teaching there would not willingly be exchanged for the status of a solely postgraduate school. Another of Mr. Atkinson's points—the recognition that people enter the university from school at various stages of preparedness, and the steps taken to deal with this in the first-year courses at Glasgow—raised the question of the desirability of extending university courses by a preliminary year for everyone. Prof. H. Lipson (Manchester College of Science and Technology) described the course at Manchester leading to the degree of B.Sc.Tech. Essentially, this is a course in fundamental physics, with a leaning towards engineering provided by one term's courses in engineering drawing and in workshop practice. Great importance is attached to training in essay writing. The final examination is not exclusively on matter covered by lectures, and includes a general paper on physics, and an English essay paper. To avoid overloading the students, a good deal of the more specialized theoretical work of the usual kind of undergraduate course, such as relativity and wave mechanics, is omitted.

As a relief from the day's preoccupation with purely intellectual development, the talk in the evening by Prof. Hugh Nicol (West of Scotland Agricultural College) gave much thought for food. A new factor in the world's economy had intervened at the turn of the century by the injection into the hitherto self-supporting nitrogen cycle of artificial fertilizers which needed fuel and power for their production. Food is now being grown by drawing on irreplaceable mineral resources, and though at present food-fuel consumption is only a small fraction of the whole, the way in which the use of fuel for non-food purposes makes inroads into this dwindling capital during the next few decades may be decisive later.

At the second session, Mr. A. L. Chilcot (Ferranti, Ltd., Edinburgh) described the schemes for the training of technicians. Student apprenticeship schemes undertaken by industry in conjunction with education authorities recruited people with 'higher science' and 'lower mathematics' in the Scottish Leaving Certificate, and carried training on to the level of the Higher National Certificate. Dr. G. Morris (Imperial Chemical Industries, Ltd., Stevens-