Ltd., showed a Fabry-Perot etalon with variable separation. This is a beautifully made apparatus. The plates are supported on invar in order to reduce temperature effects to a minimum during long exposures. The instrument is suitable for measuring wave-lengths in terms of a standard and observing fine structure in the longer wave-lengths of the spectrum. The Munsell Colour Books, intended to form the basis of a system of colour specification, and X-ray gratings prepared in the laboratories of Prof. M. Siegbahn, were on view, as well as an all-metal quartz spectrograph. Of special interest to teachers was the astronomical model designed by Mr. W. Wilson and exhibited by Messrs. A. Gallenkamp and Co., Ltd., which demonstrates the motion of the earth, moon, and sun. Each separate movement can be shown alone and the bodies can be made to perform hypothetical motions. This should prove particularly valuable for educational purposes, since the reasons for day and night and seasons will be understood at once on seeing movements which do not produce them. Both the M.O. Valve Co., Ltd., and the Mullard Wireless Service Co., Ltd., had a large selection of transmitting, rectifying, and modulating thermionic valves. The M.O. Valve Co., Ltd., was demonstrating an assembly operation in which the supports for the inside of a valve were bent to the required shape by one movement of a handle.

In the section for apprentices and learners started last year some good workmanship was on view. In Class A (Craftsmanship), first prizes were awarded to T. E. Bayley (under eighteen years), of Marconi's Wireless Telegraph Co., Ltd., for a signalling relay, and to H. G. Freshwater, of Messrs. H. Tinsley and Co., for a vibrating galvanometer suspension. This competitor also obtained the Finsbury prize. In Class B (Draughtsmanship), first prizes were taken by W. G. Hill (under eighteen years), of Messrs. H. Hughes and Son, Ltd., for a periscope wind gauge bearing plate, and by E. G. Mansfield, of the General Electric Co., Ltd. (Research Laboratories), for a controller for a motor operated rheostat. It is to be hoped that this section will continue to grow as time goes on, since the importance of good instruments to the physicist cannot be over-estimated.

Two discourses were delivered in the large physics lecture theatre, both extremely interesting and very well attended. The first, by Mr. E. Lancaster-Jones, was entitled "Searching for Minerals with Scientific Instruments". Mr. Lancaster-Jones described the four methods used in locating salt deposits, oil, and other minerals, and mentioned the fact that all the instruments which he had in the room were—with only one exception—of British manufacture. The four types of instrument used are: gravitational, magnetic, seismic, and electrical. In the first of these methods the instrument measures the value of gravity at different points, and from the variation from normal a mound of denser material than the surrounding earth can be easily located. Salt is generally discovered in this way, and its discovery is important, since oil usually occurs with it. In the second method the horizontal intensity of the earth's magnetic field is measured, and the existence of magnetic veins disclosed. The third method is very interesting. An explosion is made at one point, and three sound waves travel to the recording instrument: one through the air, one just beneath the ground, and one penetrates the surface as far as a layer of material of different density below ground and then travels along the top of this layer. The velocities of sound in air and in the two substances are known, the times of arrival of the waves are recorded by the seismograph and, with the distance of the explosion, all the necessary data for finding the position of the mineral deposit are available. The fourth method consists in tracing out lines of equal electrical potential between two electrodes across which an alternating current is passing. These lines have a curved shape when copper or similar material exists below the surface. The lecture was illustrated by experiments and slides.

On Thursday, when the exhibition was open free to the general public, Sir Gilbert Walker gave an interesting account of "Physics in Sport". Sir Gilbert said that the tendency to separate applied mathematics from the happenings of everyday life was to be deplored, and then proceeded to make his audience agree with this statement by giving an explanation of the behaviour of balls. He went on to give some idea of the principles involved in such sports as curling, spear-throwing, and boomerang-throwing. The discourse was illustrated by a selection of slides and experiments, the strange behaviour of a coin when rolled on a billiard table causing much amusement.

Many hours can be spent at an exhibition of this kind and another visit will still reveal something fresh. The secretary is to be congratulated on the success of his organisation. The amount of time and thought devoted to making a success of these occasions is scarcely ever realised by those who enjoy its fruits.

E. M. COLLINS.

Annual Meeting of the Science Masters' Association.

THE thirty-first annual meeting of the Science Masters' Association was held at the University, Edgbaston, Birmingham, on Jan. 6-9. The meeting opened during one of the worst fogs on record, but in spite of this more than two hundred members and guests, including the Lord Mayor (Alderman Saunders), were able to find their way to the dinner and the presidential address. Altogether more than four hundred members attended the meetings. The University buildings are admirably adapted for the purposes of such a conference, and the staffs of the various departments of pure and applied science arranged a very fine series of demonstrations in the laboratories. The exhibition of apparatus and books was held in the spacious drawing office, which is an ideal room for the purpose.

The presidential address was given by Sir Charles Grant Robertson, Vice-Chancellor of the University, who referred to the fact that boys and girls and the young university graduate and teacher of to-day fail to realise the immense revolution that has taken place in the world of thought and education during the last fifty years. In that period there has been a scientific renaissance comparable in the quality and scope of its range to the humanistic renaissance of the fifteenth and sixteenth centuries. The result is that the monopoly of the classical humanists has been overthrown and smashed to pieces, resulting in the admission of other subjects into the school curriculum. Sir Charles went on to say that, "confronted with the modern curriculum, Huxley would have insisted that the number of subjects taught is far too large and must be drastically reduced, and for the simple reason that the identification of education with the acquisition of information is an indictable misdemeanour". He (Sir Charles) was profoundly impressed with the ability of undergraduates in the faculties of science, but he often found that they were lacking in general culture. Personally he would like to see the training in science continued for every boy

and girl up to the age when they left school, even if it meant for the specialist in humanistic studies some diminution in the school time allotted to the specialist subjects, just as he wanted to see the humanistic culture continued for the specialist in science. In reference to science scholarships, he would like these to be determined by the joint action of teachers in both schools and universities.

In the course of an address on "A Finite Universe?" the Bishop of Birmingham said that over-confident dogmatism during the nineteenth century produced a reaction which has resulted in a spirit of agnosticism in religion. In the present century this has spread to science, so that, at any rate in their better moments, science teachers are none of them dogmatic, not even the youngest of them. It is now recognised that the bases of our knowledge are probabilities, and these to-day threaten to become the ultimates of the physicist. Absolute truth is beyond us, and superstition is the refuge of fools. We shall be wise men if, knowing our ignorance, we search honestly that our understandings may be enlarged, and if, in our search, we never forget that man's intellectual and spiritual faculties are his supreme endowment. On first reflection we feel that the universe must be infinite in extent. Progress as to our understanding of space is due to the mathematician rather than to the metaphysician. Dr. Barnes referred to the following words of Gauss, written in 1824 in regard to what is now known as non-Euclidean geometry: "I think, in spite of the meaningless word-wisdom of the metaphysicians, that we know too little . . . about the real meaning of space, to stamp anything as absolutely impossible because it appears unnatural to us". He went on to contrast the basic principles of Euclidean and non-Euclidean geometry and the deductions from each as to the properties of space, saying that it is highly probable that our space is curved and not flat, although at present, possibly owing to the limitations of our minds, we cannot get a concrete picture of what this means. In order to test the validity of this conclusion, mathematicians can devise experiments on the nature of the radiation from distant nebulæ, and the tests so far have indicated that the universe is finite and yet unbounded. He referred to Lemaitre's theory of an expanding universe, which has gained the sympathy of astronomers because it seems to offer an explanation of the surprising and perplexing fact that the spiral nebulæ in the depths of space appear to be receding from us with velocities of the order of a thousand miles a second. In conclusion he said that, like Clifford, who was the first man in England to appreciate the significance of Riemann's researches, he found relief from the dreary infinities of flat space in the consoling hope that, after all, the universe may be finite.

A discussion on general science was opened by the chairman, Mr. Fairbrother, of The Cedars School, Leighton Buzzard, who said that general science was proposed by the Association in 1916 as a remedy for what was then called neglect of science. There is a danger that general science should be interpreted as that vague and indefinite type which leads to a nodding acquaintance with many topics of science but to a thorough knowledge of none. Mere snippets are not what the apostles of general science mean to develop. Their aim is to humanise science, to regard man as the central theme of the universe, and to show how man has bent the forces of Nature to his will and how he has made new substances by causing naturally occurring substances and their derivatives to act on one another. General science should cover the whole field of science. Not only should chemistry and physics form an essential part, but also astronomy, physical geography, and elementary biology should be given a place. The teachers of the various branches should be specialists in their own subjects, but the syllabus should be so arranged as to admit of close correlation between one section and another. It must always be remembered that good syllabuses do not necessarily mean good general science, the essence of which lies not so much in the syllabus as in the interpretation of it. Success or failure very largely depends on the outlook of the teacher. It has been suggested that examining bodies do not yet recognise the claims of general science, or give it the dignity of the usual science subjects; but surely that is a matter for the teachers themselves to settle. Let them create the demand and the examining bodies will supply the papers.

The discussion which followed was stimulating and instructive, member after member giving an account of his own course in general science and testifying to the interest aroused in the boys, who are often inspired to continue their studies to greater depths in their own time.

Prof. F. W. Burstall initiated a discussion on "The Science Education of a Boy up to the Age of Eighteen". He said that boys of eighteen who come up to the university have a competent knowledge of science; they can express themselves in clear English and have a fair knowledge of other humanistic studies. When we consider average boys who do not reach university standard, we must divide them into two sections—up to about fourteen and from fourteen to eighteen. Prof. Burstall considers that the young boy can be taught only through his memory, which is the reason why Latin and Greek can be taught him with a considerable degree of success. His view is that the only science taught at this stage should be what is known as Nature study—the description in simple words of the ordinary phenomena of Nature as he observes it in his everyday life. Like all simple subjects, this requires a born teacher to teach it properly. At fourteen the boy's mind is sufficiently developed to enable some science to be taught. Science consists solely of experiment, observation, and deduction, and is therefore by no means a new subject. It has been the study of humanity from the earliest days, when prehistoric man experimented on boring a hole through a flint, and it has been carried on by successive stages to produce our present civilisation. The boy up to fourteen is a young animal who delights in exercising his muscles, who is full of impish mischief and a disinclination to use his mind for any purpose of abstract reasoning. At the same time, he is curious to know how everything works and also the reasons for all the changes he observes in Nature. Prof. Burstall suggested that school science is attractive to the average boy because it gratifies his desire to make something or to change a substance. He urged that the boy should have an outlet for showing his own individuality. Boys differ so much that to attempt to find a curriculum to fit them all is bound to fail. Boys who are stupid in school are only so because they have never had a chance of displaing their faculties. He said that not too much emphasis should be placed on examinations, which, dealing as they do almost entirely with questions of fact, offer a premium to a boy with a good memory and a rapid power of assimilation, but are detrimental to the boy whose mind works slowly.

During the discussion which followed, Prof. H. E. Armstrong expressed his surprise and delight with the discussions he had heard. He was glad to observe that general science is taught in so many schools and that the movement is gaining ground. He disagreed

with Prof. Burstall in regard to the boy up to fourteen; up to that age Prof. Armstrong considers the boy to be intelligent—it is afterwards that his faculties became blunted.

Mr. Cameron, Director of Education for Oxford City, gave an account of the work of the Commission on Educational and Cultural Films. At the request of the Commission, the Science Masters' Association has already appointed a sub-committee to view and criticise films on scientific subjects, and two of those passed by this committee, "The Life of a Plant" and "The Mechanism of a Motor Car", were shown to a crowded meeting. The Association unanimously decided to give the Commission financial support.

Mr. J. Young, in the course of a lecture on "The Lunar Landscape", showed many beautiful slides from photographs taken by his students; he outlined the research which is in progress on the nature and features of the moon's surface.

Prof. A. W. Nash gave an address on "The Work of the Physicist and Chemist in the Petroleum Industry", which emphasised the value of applied science. There are only two Departments of Oil Technology in the country, one at Birmingham and the other at the Imperial College of Science in London. These work in the closest correlation, each tackling different aspects of the petroleum problem

Prof. W. N. Haworth lectured on "Complex Molecular Structures", and Prof. Munro Fox showed a series of biological experiments suitable for schools.

E. N.

University and Educational Intelligence.

LONDON.—The following doctorates have been awarded: *D.Sc. Degree in Biochemistry* on G. F. Marrian (University College) for a thesis entitled "The Chemistry of the Oestrin-producing Hormone" (*Biochem. Jour.*, 1929–30). *D.Sc. Degree in Geology* on R. G. Hudson (University College) for a thesis entitled "The Lower Carboniferous (Dinantian) of the Craven Reef Belt" (*Proc. Geol. Assoc.*, 1930). *D.Sc. Degree in Physiology* on P. Eggleton (University College) for a thesis entitled "The Significance of Creatine-Phosphoric Acid in the Mechanism of Muscular Contraction" (*Jour. Physiol.*, Oct. 1930). *D.Sc. Degree in Statistics* on J. O. Irwin (University College) for a thesis entitled "Researches in the Theory of Sampling" (*Biometrika*, 1927; *Metron*, 1930).

LIVINGSTONE COLLEGE, Leyton, E.10, which gives courses of instruction to missionaries in the elements of medicine, has issued the annual report and statement of accounts for the year 1929–30. Many former students testify to the value of the instruction they received at the College. Income for the year has more than balanced expenditure, and the accumulated deficit has been reduced. The deficit, however, still amounts to £758, and structural repairs and replacement of worn-out equipment, deferred from year to year, have now become urgent. A sum of £800 is required to put things in order, and donations are asked for, and may be sent to the Principal, Dr. Tom Jays.

TEACHER-TRAINING principles and methods have been exhaustively investigated during the past two years by a special committee of the Teachers' Training Syndicate of the University of Cambridge. The resultant recommendations, recently adopted by the University, emphasise the importance of practical work and of guarding against the tendency of courses in the theory of teaching to produce doctrinaires with but little aptitude for dealing with the ordinary problems of school life. It is interesting in this connexion to read the article published in the November issue of *School Life* on "Training Teachers on the Job". This expounds the principles on which the University of North Carolina bases its preference for 'in-service' training as compared with training conducted wholly or mainly within a college of education, and describes some of the methods in use. A staff of itinerant instructors is employed exclusively on weekly circuits, one day being given by an instructor each week to the members of his classes employed in each of the instructional centres in his circuit. He observes throughout each morning all phases of their work and in the afternoon meets them for instruction, which his observations enable him to adapt to individual and group needs. While admitting that some courses, such, for example, as those in the history of education or the physiology of the nervous system, can probably be conducted more effectively in residence in the university college of education, the rest—methods and materials in the various subjects, curriculum construction, investigation of educational problems, individual differences, educational measurements, diagnosis and treatment of failures, and the psychology of learning—can, it is claimed, be given with much greater immediate effect and permanence when taught by the 'in-service' method.

THE British Broadcasting Corporation has secured the services of many men and women who are eminent specialists in the worlds of art, science, economics, languages, philosophy, and so on, for its several series of broadcast talks from January to April of this year. Judging from the pamphlet published in connexion with these series, radical changes in the composition of each series have been made. For example, the series of talks on "Marriage: Past and Present" consists of five lectures by Prof. B. Malinowski and Dr. R. Briffault. They will take the form of a debate, Prof. Malinowski giving the first talk on "The Present Crisis in Marriage and the Historical Background". The second will be given by Dr. Briffault. Then will follow three talks in the form of a discussion between Prof. Malinowski and Dr. Briffault, concluding with a recapitulatory talk entitled "What can we learn from all this?" by Prof. Malinowski. Such a series has much to commend it; but one drawback is its actual seriate form, which demands regular attention to such talks—and this is often impossible—if full value is to be obtained from them. There are three or four series of talks with a scientific bias, which will be given by single lecturers. Mr. L. F. Gibbon is to talk on "Commerce the Peacemaker", Prof. A. E. Heath on "Thinking Ahead", and Prof. W. Cramp on "Faraday and his Contemporaries". This last is clearly chosen because this year marks the centenary of Faraday's discovery. The other series of scientific interest are to take a still different form. Each talk in the series will be given by a different person. One series, "What is Science?" seems to have no common basis; the reason for putting them in one group seems to be that the listener is invited to co-operate with the speaker in making investigations. This is an experiment in what the B.B.C. refers to as "co-operative science". Such an attempt is deserving of commendation; but its value may be lessened by the fact that it is based upon the belief that science is now so professional and associated with such forbidding technique that the amateur scientific worker has almost disappeared and with him the journeyman's interest in science. However this may be, the B.B.C. is to be congratulated on its attempts to stimulate general interest in science by its varied and original programme.