and Prof. H. E. Armstrong, whom he described as closely similar in their devotion to science, but markedly different in their personal characteristics and in the scope and manner of their work. Lord Rutherford was a supreme example of a modern scientific investigator, fertile in conception, ingenious in experiment, with brilliant insight into the relation between causes and consequences of phenomena in a sublime field of physical inquiry. Prof. Armstrong, on the other hand, though his original work belongs mainly to the field of organic chemistry, had extensive interests in much wider fields such as geography, geology, natural history and agriculture. He took a great and active interest in educational matters, though he was critical—and sometimes caustic—in his comments on science teaching and science teachers.

The comparison of these two great men of science led Sir Richard to his main theme, which was that the scientific worker must not subordinate his citizenship to his science. If he does, society may itself take measures to prevent the perversion of science to destructive purposes. Our national leaders and administrators need wide knowledge and keen foresight to enable them to make the most effective use of the scientific forces which are shaping the conditions of modern life. Science can render the fullest service to the community by harnessing the relations between the scientific workers and the general citizen so that a nobler type of citizenship becomes possible, adequate to defend us against the dangers to which civilization is exposed.

Education may be defined as the deliberate adjustment of a growing human organism to its environment, and therefore preparation for citizenship must involve instruction in the principles of human biology: a course of general biology should open and close with man in the centre of the picture. In schools and universities there is still a tendency to teach science only as a specialized study and not as an essential part of a general education. As science is responsible for the industrial developments and economic changes which have caused violent disturbances in our social structure and provided the means by which civilization may commit suicide, it has a right and a duty to occupy a position of authority in the government or control of the powers it has created. Men of science are citizens as well as scientific workers, and they are beginning to realize their special responsibilities for securing that the fruits of scientific knowledge are used for human welfare. It would be a betrayal of the scientific movement if scientific workers failed to play an active part in solving the social problems which their contributions to natural knowledge have created. They must promote the extension of the application of scientific method to the consideration of social, economic and political questions, so that accurate knowledge may be obtained upon which sound conclusions may be based and progressive policies established.

Other lectures at the meeting were varied in type. Prof. P. M. S. Blackett talked on cosmic rays; Mr. W. D. Seymour on the heating, lighting and ventilation of schools; Dr. Sherwood Taylor on the origins of chemistry; Prof. Allan Ferguson on capillarity; Mr. J. Z. Young on "Brain Waves" (dealing with the regular rhythmical changes of electrical potential recorded for numerous parts of the brain); Mr. A. Rodger talked on vocational guidance and Dr. C. C. Paterson on the appraisement of lighting.

Two discussions were also held. The first dealt with the problem of laboratory assistants in schools. The Committee of the Association is in the course of preparing a memorandum on this matter, and the opinions expressed at the meeting will be incorporated therein and will be published. The second discussion dealt with the relations between school and university science teaching. Discussions of this type almost invariably lead to the difficulties of university scholarship examinations, and this was no exception.

At the business meeting, Prof. James Gray of Cambridge was elected as president for next year. In succession to Mr. F. R. Snell (Eastbourne College), Mr. W. Ashhurst (Stretford Grammar School), Mr. L. G. Smith (Trowbridge Grammar School) and Dr. W. G. Davies (Royal Grammar School, Newcastle), who retired from the Committee, the meeting elected Mr. J. W. Cottingham (Barnsley), Mr. R. E. Williams (Oxford), Mr. G. Fowles (Latymer Upper School) and Mr. R. P. Ayres (Leys School). Mr. S. V. Brown (Liverpool Institute) was re-elected general secretary, Mr. B. M. Neville (William Ellis School), honorary treasurer and Mr. W. Ashhurst (Stretford) as annual meeting secretary. S. V. B.

The Mathematical Association

Annual Meeting

At the annual meeting of the Mathematical Association, which was held at the Institute of Education, London, W.C.1, on January 4 and 5, Prof. E. H. Neville, in taking the chair, explained that he occupied that position in consequence of the sudden death of the president, Prof. L. N. G. Filon, which took place on December 29. After the members had stood in tribute to the late president, the business meeting took place, at which Mr. W. Hope-Jones was elected president for the following year. The existing officers were all re-elected and Miss M. A. Hooke and Mr. F. J. Swan were elected to the Council in succession to Miss G. K. Stanley and Mr. C. T. Daltry, who retired under the regulations. A presidential address, prepared by Prof. Filon previously to his illness, was read by Prof. G. B. Jeffery. The address, which was entitled "Mass and Weight in Newtonian Mechanics", and contained an analysis of the fundamental ideas of dynamics, will be printed in full in a forthcoming issue of the *Mathematical Gazette.*

Prof. D. R. Hartree then spoke on "The Mechanical Integration of Differential Equations". Prof. Hartree referred first to the need for mechanical contrivances for carrying out extended calculations in pure and applied science. So far as purely arithmetical calculations are concerned, this need has been largely met, but the use of machinery for dealing with problems relating to rates of change is not yet widespread. He explained, illustrating by lantern slides, the mathematical and mechanical principles of the differential analyser, a type of machine invented by

Dr. Bush of Boston, U.S.A. Only four complete machines are at present in existence, two others being in the course of construction. He showed a number of slides illustrating the machine in use at the University of Manchester and explained that this machine contains some devices which represent an English improvement on the American model, notably in regard to the solution of equations involving a time-lag. Some results, including those of problems arising from practical and technological sources, were shown.

At the first session on January 5 a discussion on "The Relative Value of Pure and Applied Mathematics" was opened by Dr. W. G. Bickley. Dr. Bickley put forward a case for the wider inclusion of applied mathematics in the school curriculum. He laid stress on the fact that the performance of university students in pure mathematics is invariably superior, on the average, to their performance in applied mathematics. Mr. C. G. Nobbs, while agreeing with Dr. Bickley, pointed out that this discrepancy of results may be due, at least in part, to difficulties inherent in the experimental nature of the subject and the close interplay of principles involved. Miss K. I. Sayers pleaded for a closer association between physics and mathematics and issued a warning against premature specialization to the exclusion of literary and artistic subjects.

Mr. N. R. C. Dockeray read a paper on "The Law of Quadratic Reciprocity". Mr. Dockeray first gave an introductory series of results on quadratic residues and then passed to the consideration of Gauss's Law. He gave an exposition of the third of the six proofs which Gauss constructed. This proof (as modified by Eisenstein) can be cast into a geometrical form suitable for discussion with a Sixth Form. Mr. N. M. Gibbins read a paper on "The Feuerbach Quadrilateral", namely, the figure formed by the four tangents at the points where the nine-points circle touches the inscribed and escribed circles. The subject was approached by areal co-ordinates, and many interesting and elegant results were given.

In the afternoon, at a crowded meeting, Mr. M. Black spoke on "The Relevance of Mathematical Philosophy to Mathematical Teaching". He defined mathematical philosophy as an attempt to analyse the nature of mathematics and its relation to other branches of knowledge. Mr. Black outlined in some detail the system of symbolic logic proposed by Boole and, after referring to other systems, dealt with some famous paradoxes arising out of the attempt to construct such systems. The attempt to avoid, or explain, these paradoxes led Russell to the theory of types. Mr. Black demonstrated how, if this were adopted, certain types of mathematical proof would be rendered invalid and pointed out that these considerations all seem to point to the fact that mathematics would be for ever an 'unfinished system'.

The last meeting was devoted to a discussion on "Teaching the Complete Duffer". This was opened by Mr. B. L. Gimson, who denied the existence of a *complete* duffer. He said that in the attempt to rouse the dormant interest of backward pupils in mathematics, one should appeal to both curiosity and utility. In the former case he stressed the use of magic squares, dissection puzzles and historical considerations, while the latter might well lead to a treatment of such topics as accounts, arithmetic of citizenship, insurance, etc. He emphasized the need for small classes in this work. Mr. F. C. Boon stated that the duffer' as well as the brilliant boy ought to have a 'fair deal'. For this purpose 'duffer' classes must be small, their pace slow and their atmosphere right, so that these children may not be deterred from asking questions which might appear obvious by the fear of ridicule. He referred also to the difficulties arising out of the misinterpretation of common words.

Dr. F. H. Dodd commenced by stating that he approached the problem from the angle of the psychologist. Cases of 'duffers' may be attributed to (*a*) educational or environmental failures, (*b*) emotional disturbance. He went on to consider various types of these failures, illustrating his remarks by comments on cases from his own experiences. He added some interesting remarks on the discovery of the precise 'point of failure'. In cases of emotional disturbance, he said that he had frequently noticed that mathematics is the first subject to be affected. An interesting discussion followed.

A publisher's exhibition was held in connexion with the meeting. A full report of the proceedings will be published in later issues of the *Mathematical Gazette*.

Thyrite Surge Diverter

WHEN a lightning flash takes place near overhead lines, it starts an impulsive rush of electricity in them which, unless it is diverted in its path, may damage or even smash costly machinery with which it is connected. Electricians, first in connexion with communication circuits and afterwards in connexion with power transmission circuits, have sought for many years for a substance which is an insulator at the working pressure but at high pressures is a conductor. Connecting a cylinder of this substance between an overhead conductor and earth does not interfere with the ordinary working of the line, but when a surge of electricity raises the pressure the conducting power of the substance leads the surge safely to earth and so protects the machinery. These devices were formerly called 'lightning arresters' but are now known as surge diverters.

The discovery of thyrite provided the desired material. It is a dense, homogeneous inorganic compound of a ceramic nature, perfectly stable, mechanically strong and is an insulator at one voltage and an excellent conductor at a higher voltage. Its electrical resistance increases 12·5 times each time the voltage is doubled. It appears to conform to this law indefinitely without change, regardless of the rate at which the voltage is applied for either continuous or alternating pressures or fast impulses. In a list (Thyrite Surge Diverters, No. H. 4506–1) issued by the British Thomson-Houston Co., Ltd., of Rugby, a descriptive account of these diverters is given for alternating current circuits not exceeding 220,000 volts working pressure.

A complete diverter consists of a number of standard size units stacked in series, the number depending upon the voltage rating. Each unit has a normal rating of 11,000 volts and has its own built-in series-gap. It is 11 in. in diameter, 15 in. high and weighs 75 lb. Cathode ray oscillograms are shown which show the impulse protecting characteristics of the standard 11,000 volt unit. When the crest of the impulse wave is 40,000 volts the insulation breaks down. The impulse voltage attending a 1,500 ampere surge current across the diverter unit is only 34 kv. crest. The surge voltage permitted by the thyrite diverter increases in direct proportion to the number of diverter units from line to earth.