parts of the world where such systems are in existence, notably in Chicago (Illinois), on the north-east coast of England, on the Rand, and in certain industrial districts of Germany. Power production in large super-plants, with generating machines of 50,000 h.p. or more, will not only be far more economical than in a large number of smaller plants, but will also ultimately involve great economies of capital by securing a better load and a more effective use of the plant. Such super-plants, if suitably situated on large sites, would make it possible—so far as it was economical to do so—to extract the by-products in the shape of oils, motor spirit, etc., from the coal before using it as fuel, thus avoiding to a large extent the necessity of importing them.

(7) The super-plants would feed into the main trunk distribution system, which must be laid down throughout the country. For this purpose the country should be divided into some sixteen districts, throughout each of which there should be a standard periodicity and main trunk voltage.

(8) This main trunk distribution system would collect any waste power available wherever situated and deliver it where it could be profitably used. It would also, by saving the cost of transport, make it commercially possible to bring to the surface much coal at present wasted and left in the pit which, under the new conditions, would be turned into electrical energy at or near the pit-head.

(9) If power supply in the United Kingdom were dealt with on comprehensive lines and advantage taken of the most modern engineering development, the saving in coal throughout the country would, in the near future, amount to 55,000,000 tons per annum on the present output of manufactured products.

(10) If the coal so saved were used for the production of further power it would be possible to generate continuously not fewer than 15,000,000 horse-power, which would more than compensate for the absence of large water powers in this country and admit of the manufacture here of many products which are at present made only in America and on the Continent.

(11) The development of such a power system may be likened to the development of the railways of a country, and it is just as impossible to secure economical power generation and supply by each municipal area working independently, which is the position to-day, as it would be to have an efficient railway system if each municipal area owned its own lines, and long-distance transport were provided for by running-power agreements. History shows that in the early stages of railway development in this country exactly the same process of amalgamation had to be gone through.

(12) The present system of electrical power distribution throughout the country, which is undertaken by more than 600 authorities in as many separate districts, is technically wrong and commercially uneconomical. The present average size of a generating station is only 5000 horse-power, or about one-fourth of what should now be the smallest generating machine in the power station. The "Power Act" legislation inaugurated some fifteen years ago has not had the desired result on account of the restrictions imposed upon the power companies.

(13) A national system of electric power supply would greatly facilitate the electrification of railways with its attendant advantages, save large sums of money at present spent on the transport and distribution of coal, and bring within reach of the community as a whole the great benefits of an increase in the use of electricity for domestic purposes, advantages which, taken together, are perhaps of more value than the direct coal-saving.

PHYSICAL SCIENCE AND THE ART OF EXPERIMENT.[1]

THE exigencies of the war had seriously impeded the work of the Physical Society, as of all our scientific institutions. Many members were at the front; many others were busy on war work, and there was little time available for normal scientific pursuits. Since his predecessor's address, the scientific community had been stirred to an extent which he thought was unnecessary by the passing of the Daylight Saving Act. Scientifically the thing was a sham, and as such was naturally distasteful to us; but the community at large was not scientific, and had a very vague notion of the meaning of time. In the stress of war people had realised the desirability of starting the day earlier to save, not daylight, but paraffin and gas, and the simple operation of putting all the clocks wrong, though hateful in principle, did not disturb the public at all.

In reference to the question of the metric system, this was important in relation to education. The reason why English schools were so backward in mathematics was that so much of the available time had to be devoted to memorising tables of weights and measures and similar medieval relics.

Another matter of public importance was the recognition of science as an element of general education. It is sometimes urged that our officials need not be scientific, because they can get all the scientific advice they want. But they may not know when they require it, or appreciate the force of it when they get it. He might instance in this connection the wasteful method of street darkening which still prevails after three years. The annual trouble with frozen water pipes was another example of the general ignorance of scientific principles. Burst pipes were unknown in really cold countries, where the elements of common sense were allowed to prevail.

All his own contributions to physical science had been experimental, and some words on the art of experiment might not be out of place. In order to succeed as an experimentalist it was necessary to find by personal experience how as many materials as possible behave under as many conditions as possible, and this can only be done by one who will practise every art and use every tool and instrument that he can. While endeavouring at first to imitate the practices of the professional mechanic and acquire as much of his skill as possible, the experimentalist must not be bound by tradition and custom in his methods. It is the slavery to tradition and practice that makes the assistance of the professional so tiresome to the experimentalist. In this connection a saying of Fresnel had greatly impressed him—"If you cannot saw with a file and file with a saw you will be no use as an experimentalist," or words to that effect. He had made it his business to use every tool and to handle every material that he could. On one occasion he had had the somewhat rare opportunity of handling five or six large uncut diamonds, each as big as a walnut. Glass-blowers are familiar with the difference in the contact of freshly blown bulbs and of bulbs some time blown; but the contact of diamonds was unlike either. When brought lightly into contact they emit a curious squeaking note of possibly 2000 vibrations per second. This meant that the diamonds were bouncing with slowly diminishing excursions of 1/80,000 of an inch approximately, a phenomenon only possible with a material of such perfect elasticity or hardness. It was possible that a test of this kind might be useful for discriminating between the hardness of the harder materials. The whole question of what hardness was, and if, indeed, it were really

[1] Abstract of the presidential address delivered to the Physical Society January 25 by Prof. C. V. Boys, F.R.S.

a definable quantity having definite dimensions, was one to which the attention of physicists could profitably be devoted. Another such question was that of the oiliness of lubricants. This appeared to depend on something other than viscosity. Animal and vegetable oils lubricated better than mineral oils of the same viscosity.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

DR. W. BOXWELL has been elected professor of pathology and bacteriology in the schools of surgery of the Royal College of Surgeons in Ireland.

A RESEARCH scholarship in mental affections has been instituted at the Western Asylums' Research Institute, Glasgow. Its annual value will be 250*l.*, but no appointment will be made during the war.

THE Board of Education announces, in Circular 1026 of February 5, that after this year it will discontinue to hold its general examinations in science and technology. The higher general examinations will be held this year for the last time, and will be conducted in accordance with the "Regulations and Syllabuses for Examinations in Science and Technology, 1915," so far as they are still applicable. This intention to discontinue these general examinations was announced in the prefatory note to the 1915 regulations, and the decision was arrived at after consultation with representative educational and administrative bodies directly interested in the examinations. The present announcement marks the final stage in the gradual elimination of the personal examination of students in its classes by the Board. In 1912 the old elementary stage examinations in science, instituted by the now defunct Science and Art Department, were discontinued, and lower and higher examinations took the place of elementary, advanced, and honours stages. In 1909 the special examinations, which had for many years been held for young students attending day classes in science, were discontinued, as for some years the number of papers worked at day examinations had steadily diminished as the conditions of work in secondary schools improved. It is reasonable to hope that the abolition of these official examinations will strengthen the development of initiative of local education authorities and encourage them to promote schemes of instruction designed to meet local requirements.

THE main measure to be brought forward in the eighth session of the present Parliament, opened by the King on Tuesday, is the Education (No. 2) Bill. The British Science Guild has just circulated a memorandum in which cordial approval is expressed of the provision made in the Bill for the following:—(1) The general development and organisation of all forms of education other than elementary; (2) practical instruction for all elementary-school children, provided that such teaching does not involve direct instruction for a trade; (3) continuation schools and compulsory attendance thereat for 320 hours per annum; (4) co-operation of local education authorities, particularly by means of the formation of federations, chiefly because many local education authorities are obviously unable to deal adequately with higher education, *e.g.* university and higher technological work and the training of teachers; (5) the removal of the 2*d.* rate limit for higher education in county areas; (6) abolition of exemption from attendance at school between the ages of five and fourteen; (7) further restrictions as to employment of children; (8) school holiday camps, centres for physical training, playing-fields, school baths, school swimming-baths, etc.; (9) the extension to secondary schools and other provided schools of the powers and duties of local education authorities respecting medical supervision and treatment; (10) aiding teachers and students in carrying on research; (11) the collection of information respecting schools and educational institutions not in receipt of grants from the Board of Education. The British Science Guild recommends that provision be also made in the Bill (*a*) to compel local education authorities to provide nursery schools in those districts where the Board of Education deems such schools necessary; (*b*) for the inspection, by an approved authority, of all schools not now liable to inspection, whether a request for inspection is made by the school authorities or not; (*c*) for the adequate registration of all schools and other educational institutions.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 31.—Sir J. J. Thomson, president, in the chair. A. **Mallock**: The growth of trees. An account is given of some recent observations of the growth of trees. The observations consisted in the measurement, at short intervals of time, of the variation of the girth of the trees at a height of 4 ft. or 5 ft. above the ground. The measures were made by an "interference" method, which is described. The results showed a well-marked daily period in the variation of girth, different for different species of tree, but in all cases having a maximum at night and a minimum shortly after noon. Diagrams of sets of observations, each extending over several days, are included, showing the growth of a black poplar, an oak, and a Douglas fir. From twenty to thirty readings were taken in the course of each twenty-four hours.—Prof. B. **Moore** and T. A. **Webster**: Action of light rays on organic compounds and the photosynthesis of organic from inorganic compounds in presence of inorganic colloids. The results are recorded under three sections:—(*a*) Photosynthesis by inorganic transformers; (*b*) action of sunlight and of ultra-violet light upon concentrated solutions of formaldehyde; (*c*) the general formation of formaldehyde by the action of light upon organic substances of biochemical origin. In the concluding section a general reversible reaction is described as a result of which formaldehyde rises in all intense reactions of light upon substances of biochemical origin. This reaction in presence of excess of light is an interesting reversal of the process by which all organic matter has been built up from inorganic sources. The bearing of this process upon the germicidal action of sunlight, and upon the destruction of living organisms by ultra-violet light, is discussed, and it is pointed out that the simple organic products so formed are incompatible with the life-processes of living organisms and so lead to their destruction. Taking such a reaction as travelling in the reverse direction, it is shown that the building up of organic matter from inorganic must have been a necessary precedent to any existence of living organisms on the earth, and that all accumulations of reduced substances possessing stores of chemical energy must have arisen in this manner from storage of the energy of sunlight.—Capt. W. J. **Tulloch**: The isolation and serological differentiation of *Bacillus tetani*. (1) More than one variety of non-toxic endosporing bacillus resembling *B. tetani* in morphological characters can be recovered from wound-exudates in cases of the disease. (2) There are at least three different types of toxic *B. tetani*. (3) The "U.S.A. type" of the bacillus—that commonly used for the preparation of antitoxin—is not frequently obtained from wound-exudates in cases of the disease occurring among men who have received prophylactic inoculations of antitetanic serum. (4) Culture in a selective medium, followed by agglutination