science as subject-matter. Systematised knowledge is science only because of the care and thoroughness with which it has been sought for, selected, and arranged. Only by pressing the courtesy of language beyond what is decent can we term such information as is acquired ready-made, without active experimenting and testing, science. The force of this assertion is not quite identical with the commonplace of scientific instruction that text-book and lecture are not enough—that the student must have laboratory exercises. A student may acquire laboratory methods as so much isolated and final stuff, just as he may so acquire material from a text-book. One's mental attitude is not necessarily changed just because he engages in certain physical manipulations and handles certain tools and materials. This problem of turning laboratory technique to intellectual account is even more pressing than that of utilisation of information derived from books. Almost every teacher has had drummed into him the inadequacy of mere book instruction, but the conscience of most is quite at peace if only pupils are put through some laboratory exercises. Is not this the path of experiment and induction by which science develops?

It must not be supposed that, in dwelling upon the relative defect and backwardness of science teaching, the intention is to deny its absolute achievements and improvements, but it must be pointed out that only to a comparatively slight extent has the teaching of science succeeded in protecting the so-called educated public against recrudescences of all sorts of corporate superstitions and silliness.

It is not to be expected that our schools should send forth their students equipped as judges of truth and falsity in specialised scientific matters; but that the great majority of those who leave school should have some idea of the kind of evidence required to substantiate given types of belief does not seem unreasonable. Nor is it absurd to expect that they should go forth with a lively interest in the ways in which knowledge is improved and a marked distaste for all conclusions reached in disharmony with the methods of scientific inquiry.

The future of our civilisation depends upon the widening spread and deepening hold of the scientific habit of mind, and the problem of problems in our education is therefore to discover how to mature and make effective this scientific habit. Mankind, so far, has been ruled by things and by words, not by thought, for until the last few moments of history humanity has not been in possession of the conditions of secure and effective thinking. Without ignoring in the least the consolation that has come to men from their literary education, it is not too much to say that only the gradual replacing of a literary by a scientific education can assure to man the progressive amelioration of his lot. Unless we master things we shall continue to be mastered by them; the magic that words cast upon things may indeed disguise our subjection or render us less dissatisfied with it, but, after all, science, not words, casts the only compelling spell upon things.

The modern warship seems symbolic of the present position of science in life and education. The warship could not exist were it not for science—mathematics, mechanics, chemistry, electricity supply the technique of its construction and management; but the aims, the ideals in the service of which this marvellous technique is displayed, are survivals of a pre-scientific age, that is, of barbarism. Science has as yet had next to nothing to do with forming the social and moral ideals for the sake of which she is used. Even where science has received its most attentive recognition, it has remained a servant of ends imposed from alien traditions. If ever we are to be governed by intelligence, not by things and by words, science must have something to say about *what* we do, and not merely about *how* we may do it most easily and economically; and if this consummation is achieved, the transformation must occur through education, by bringing home to men's habitual inclination and attitude the significance of genuine knowledge and the full import of the conditions requisite for its attainment. Actively to participate in the making of knowledge is the highest prerogative of man and the only warrant of his freedom. When our schools truly become laboratories of knowledge-making, not mills fitted out with information-hoppers, there will no longer be need to discuss the place of science in education.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

GLASGOW.—Committees of members and friends of the University have procured contributions amounting to some 1500*l.* for the purpose of commemorating the services of Dr. John Cleland, regius professor of anatomy from 1877 to 1909, and Dr. William Jack, professor of mathematics from 1879 to 1909, who retired last year. It has been decided to present to the University a portrait of Dr. Cleland, painted by Sir George Reid, with a replica for Mrs. Cleland; and a portrait of Dr. Jack, painted by Sir James Guthrie, and also a prize, to be awarded at intervals, for the best thesis on a mathematical subject approved for the degree of Doctor of Science during the preceding period.

The University Court and Senate have had under consideration a proposal, emanating from the general council of graduates, for the establishment within the University of an order of independent lecturers, analogous to *privat-docenten*, who should give courses of lectures qualifying for graduation, and duplicating those already given by the regular professors and lecturers. The new lecturers were to be provided with class-room accommodation, and were to depend for their remuneration on the amount of fees received from students attending their classes. After a prolonged discussion, in which the Senate expressed the opinion that the proposal was not likely to contribute to educational efficiency, and the finance committee that it would seriously disarrange the University funds, the Court decided that effect could not be given to the scheme under the existing constitution of the University.

The University Court has sanctioned the establishment of a new course of instruction in chemistry, including metallurgical chemistry, for students of engineering. The course will be given by Dr. Cecil H. Desch, and will extend over the first two terms of the session. The ordinary course by Prof. Ferguson will be attended by students of arts, medicine, and pure science. Dr. Desch announces a course in metallography during the summer session.

THE Civil Service Estimates in class iv. (education, science, and art), just issued as a White Paper, show a net increase for 1910–11 of 697,718*l.* over the figures for 1909–10. The total estimates of 18,651,483*l.* for the ensuing year include the following:—Board of Education, 14,064,677*l.*, increase 417,663*l.*; British Museum, 175,895*l.*, decrease 3333*l.*; scientific investigation, &c., 74,228*l.*, increase 9764*l.*; universities and colleges, Great Britain, and intermediate education, Wales, 218,100*l.*, increase 700*l.* Scotland: public education, 2,253,725*l.*, increase 106,434*l.*; Ireland: public education, 1,656,901*l.*, increase 34,980*l.*; endowed school commissioners, 925*l.*, increase 5*l.*; universities and colleges, 168,080*l.*, increase 139,930*l.*; Queen's Colleges, nil (last year 4700*l.*).

A DEPUTATION from the Trade Union Congress waited upon Mr. Runciman, President of the Board of Education, on March 17 to urge, among other matters, technical training in day-time classes, the raising of the school age, entirely free secondary education, and the appointment of a Royal Commission to inquire into the misappropriation of educational endowments. In replying, Mr. Runciman said he hopes that by next Session a Bill will be introduced which will deal partly with the raising of school age and partly with the question of day technical classes. If day technical classes are to be of much use, there must be pressure brought to bear on employers. All educationists desire to see the school age raised. Children who leave school at thirteen or fourteen know practically nothing about arithmetic or writing with ease. This deplorable state of things can be remedied in two ways, by raising the school age and by bringing the technical classes nearer to them. Trade unionists, he said, can do as much towards the advancement of education as Parliament can. Dealing with free places in secondary schools, Mr. Runciman said that, taking the whole of the secondary schools of this country in 1907–8, there were 2 per cent. more than the 25 per cent. standard, while in 1909–10 31 per cent. of the total places in the secondary schools were free places.

The State is making a change in many of the endowed charities which are scattered all over the country. In the course of time it will be possible, not only to apply the whole of the educational endowments to the original purposes of their founders, but to combine the small endowments so as to make them effective.

THE issue of the Journal of the Association of Teachers in Technical Institutions for January contains a paper by Mr. John Wilson, the president of the association, on the relation of the technical institution to the modern university. After commenting upon the advanced character of much of the teaching carried on in technical institutions, and mentioning the creditable amount of research work published yearly by the staffs and senior students of these schools and colleges, Mr. Wilson gave some interesting statistics as to the students who graduated in science at the University of London during 1909. It appears that altogether 292 candidates were awarded the degree of B.Sc., and that 57 of these studied entirely at technical institutions, while if the students who did part of their work at a technical institution are included, the number reaches 80. Mr. Wilson also gives the numbers of registered "internal" students and "recognised" teachers in London polytechnics, and compares the total with those in the case of certain other London colleges. During the session 1908–9, the number of registered internal students in the faculty of science was:—at University College, 224; King's College, 175; East London College, 162; and at eight "recognised" polytechnics, 372. In these eight polytechnics there are 94 "recognised" teachers of arts, science, and engineering. In other words, the polytechnics have become important centres of university work. Mr. Wilson maintains that the success of even the limited recognition of London polytechnics by the University of London clearly points to the desirability of the extension of that recognition by the University and to a widely increased measure of recognition of local technical institutions by the provincial universities.

AT a meeting of the Royal Dublin Society on March 9 Prof. Senier delivered a lecture on "The University and Technical Training." From the account of the meeting in the *Irish Times* of March 10 we learn that Prof. Senier considered four types of institutions for the advancement and diffusion of learning and of its applications to society; institutions of acknowledged university rank or residential college universities, exemplified by Oxford; the research university, as seen at Berlin; the examination university, first known in Napoleon's University of Paris; and the technical research university, Charlottenburg. In England, he said, where numerous new universities have been established in recent years, the type adopted has been a combination of the German Research University and the German Technical Research University, the one or the other type predominating, according to local needs, and the whole adapted to its surroundings, particularly to the conditions of secondary education. Whatever view may be held respecting the German practice of separating these two types, as adapted to German conditions, Prof. Senier thinks that for the conditions which prevail in the British Isles the combination of the two in new universities is a wise arrangement. The two new universities in Ireland are also of this combined type, and are to be adapted to Irish educational conditions and the needs of the country. After directing attention to the influence Liebig exerted through his students in the direction of scientific research, Prof. Senier said so great is that influence that science laboratories after the model of Giessen have become the recognised attribute of science professorships throughout the world. Another advantage possessed by the German university is the character of the leaving examination of the secondary school. It corresponds to a matriculation examination, with the added knowledge acquired by about two years' university study in arts, and its acceptance by the university as evidence of sufficient knowledge for matriculation relieves the university of the practice of giving the student an examination as his first experience on entering. In Prof. Senier's opinion secondary schools should abandon all attempts to teach experimental science. To rival the work of the German universities the better organisation and coordination of the entire educational system is necessary. Germany has built up a chemical industry with tens of millions of pounds annually through the agency of research chemists, methodically trained in technical schools. German manufacturers know the value in dividends of the services of trained research chemists; Irish and English manufacturers do not.

SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, February 25.—Prof. H. L. Callendar, F.R.S., president, in the chair.—Prof. J. **Perry**: Telephone circuits. The author published a paper in the Proceedings of the society in 1893 showing how voltage v and current c are attenuated along a telephone or submarine telegraph line, a line with resistance r, capacity k, inductance l, and leakance s per unit length; currents are of the form $\sin qt$. When lq/r is considerable the mathematical expressions become simple. It was pointed out that the introduction of l is of great benefit. The author now points out that k may be made negative by the use of inductance leaks to earth, and l may be made negative by the use of condensers in series with the line. To introduce l, as Mr. Pupin has done, by inductance coils at equidistant places on the line, or to introduce the other properties mentioned by placing other contrivances at equal distances, is a mathematical problem of great complexity. Contrivances placed close together have the same effect as the continuous distribution of properties, but there is considerable expense; the problem is to find how far apart the contrivances may be placed so that the effect produced shall still be beneficial. Mr. Pupin has given a rule for the spacing of his coils, but practical men dispute its accuracy; nobody has given a rule for other contrivances; the object of the author is to give an easy method of calculation which is practically correct, and can be used when the contrivance is any network or other combination of resistances, inductances, and capacities—some being leaks to earth—and it may include transformers, motors, and generators. Suppose there are contrivances at the equidistant places A, B, &c., m miles apart in a cable which has the above-mentioned properties r, k, l, and s. There is a contrivance the terminals of which are A and A_0, another the terminals of which are B and B_0; between A_0 and B there is m miles of cable. Let the currents in the line at A, A_0, and B be c, c_0, and C. Let the voltages at these points be v, v_0, and V. The assumption on which the whole method is based is that $V/C = v/c = \rho$. This is practically true everywhere in a long line except near the ends. Now whatever be the nature of the contrivance, we can calculate v_0 and c_0 from v and c. It is also known that

$$V = v_0 \cosh mn + \frac{r + lqi}{n} c_0 \sinh mn,$$

$$C = c_0 \cosh mn + \frac{n}{r + lqi} v_0 \sinh mn,$$

when

$$n = \sqrt{(r + lqi)(s + kqi)}.$$

Putting V/C or ρ equal to v/c, we have a quadratic to calculate ρ, and therefore V and C, and the problem is solved. Taking $c = \sin qt$ and calling it 1, then $v = \rho$. Whatever the contrivance may be, we find that $V = \alpha + \beta\rho$ and $C = a + b\rho$, where α, β, a, and b are given in value; they are usually unreal quantities of the form $M + Ni$, where i is $\sqrt{-1}$. Solving for ρ, and finding C, we have two answers which are reciprocals of one another. If $\frac{1}{2}(a + \beta)$ be called P, and this is very easily evaluated, then

$$C = P \pm \sqrt{P^2 - 1}$$

Examples of the use of the method are given, some showing that the detached contrivances produce much the same and others very different effects from what might have been expected from a study of the cable with continuous properties. It was shown that a line may have contrivances somewhat far apart which will tune it to a musical note merely, so that it acts almost like an ohmic resistance, but which will not transmit well the currents of other frequencies, and that for the commercial transmission