tions, and the researches are assisted by a grant from the Treasury. The income during the past year was above 70,000*l*., an increase of nearly 20,000*l*. over that of the preceding year. The major part of this total is received in payments for work done, and this involves a serious financial liability. Much attention has been given recently to the question of the future of the laboratory, and in particular to its relations with the Department of Scientific and Industrial Research, and a scheme will no doubt be arranged whereby close relations with the department will be established.

PEAT AND ITS USES.

CONSIDERABLE interest attaches to a recent article in *La Nature* on "Peat," in view of the increasing attention being paid to the use of this substance to replace coal in countries in which the latter is absent or difficult to obtain. The author of the article, M. Renié, discusses concisely the distribution of peat-beds in the various countries, the treatment (drying and pressing) of peat and its uses. He does not pretend that it can compete successfully with coal, except where freights for the transport of the latter are excessive. The best solution, he suggests, is to transform it on the spot into energy, and to recuperate the by-products. The drying and mechanical treatment must be carefully carried out so as to render the fuel as homogeneous as possible. The pressing operation increases the specific gravity of dried peat from 0·7 to 1·03. The cost of treating is not high. Ekenberg has shown that peat heated for a short time at a temperature above 150° C. loses its gelatinous consistency, and thus allows of its being dried by compression. The final product is usually converted into briquettes without the addition of a "binder."

Peat in the agglomerate form has not, however, proved satisfactory in practical use, and to get over the difficulty the use of peat in powdered form has been proposed, a factory having been opened at Bäck (Sweden) to carry out a process invented by Ekelund, which is kept secret. Special grates have to be used for burning powdered peat, and in steam-raising in boilers large grate areas and closely spaced bars, together with modification of the furnace draught, are necessary.

In connection with the use of peat for steam-raising, the following quantities of steam are raised from 1 kilo of the following:—Compressed peat, 4·3 kg.; "half"-coke, 6·6 kg.; coal, 7·4 kg. Peat can be carburised for the extraction of coke and volatile products, a Ziegler continuous-type furnace being generally used in Germany and Russia. Peat coke can be used for metallurgical purposes, and the "half-coked" peat for steam-raising. Particulars of the process are given in the article. It is also possible to extract ammonia water and tars, the latter giving, on distillation, light and heavy oils and phenol. The yield of methyl alcohol is about 3·7 kg. from a ton of peat, and 3 kg. ammonia sulphate and 9 kg. of acetate of lime.

Peat is successfully used in Sweden, in combination with a gas-producer, for working engines of the "waste-gas" type. From one ton of peat 2000 to 3000 cubic metres of gas, giving from 1200 to 1400 calories per cubic metre, are obtained. As the author points out, special care is needed in purification.

Peat is advantageously used as a litter, owing to its deodorising properties, while during the war the Germans have employed it extensively as a substitute for absorbent cotton for bandages. Its antiseptic properties are well known. E. S. HODGSON.

SCIENCE AND INDUSTRY.[1]

FOR the past three years war and the consequences of war have dominated our thoughts and compelled our actions. May we not hope now that the time is coming when we shall reap the fruits of the heroic efforts of those who have died that England might live? How can we best learn the lessons of this terrible time and turn the experience we have gained to the future welfare of our country? The question is much too wide and far-reaching to be dealt with in a single lecture, and it is beyond my powers to attempt to handle it in a general manner. I wish to deal only with one aspect.

We realised at a very early date that science was to be an important factor in success, and while against the heroism of our men all that the science of our foes could do proved unavailing, it was clear that bravery and self-sacrifice without the aid which science could bring would fail to give us victory. Let me remind you of some few of the methods in which scientific investigation has aided our cause; they are so obvious as to need little more than a passing reference.

Take flying, for example. Every part of a modern aeroplane is the product of a highly specialised science. In the machine itself, to combine strength with lightness, to select the right material for each part, to design the wings so that they may bear the greatest weight and offer the least resistance to the motion, to give the body ample strength to withstand the shocks of alighting, and yet not weight the machine unduly—all these points and many others have been the subject of long and difficult scientific examination.

At the National Physical Laboratory there are five wind channels continually in use to test on models all the various factors on which the aerodynamic efficiency of a machine depends. Two of these channels are 7 ft. in diameter and nearly 80 ft. in length; in one wind speeds up to sixty miles an hour can be obtained. The model is attached to a specially designed balance, or dynamometer, and the forces it experiences in various positions relative to the wind are measured; from these data the behaviour of the machine in flight is determined. Here Mr. Bairstow and his colleagues have worked out the practical conditions of stability of motion and determined by many ingenious devices the constants which occur in the theory. That theory was first given in a general form by Bryan, the theory of the disturbed motion of a body moving in three dimensions, under gravity, the thrust of the propeller, and the resistance of the air. The quadratic which gives the energy in terms of the six co-ordinates and velocities corresponding to the six degrees of freedom of the body contains twenty-one constants. Conditions of symmetry reduce these in number; the air channel experiments afford the means for determining their values, and thus predicting the properties of the machine. The work at Teddington would have proved of little value without the corresponding full-scale experiments brilliantly carried out at Farnborough by two Cambridge men, E. H. Busk and Keith Lucas, who gave their lives for the cause, and now continued by two other Cambridge men, Farren and George Paget Thomson. The name of Busk is, I trust, to be commemorated in Cambridge by a scholarship founded in his memory by friends who admired his powers and loved the man.

But it is not only in the structure of the aeroplane that science has done its part. The engine brought problems of the highest complexity, which are being

[1] From the Rede Lecture, delivered at Cambridge on June 9 by Sir Richard Glazebrook, C.B., F.R.S.

solved by patient application and earnest endeavour. Large powers are needed; the various parts move at great speed, hence strength is essential, but the weight must be kept down; at the same time endurance is necessary; risk of untimely failure must be reduced and the pilot made as secure as possible. Here the metallurgist has been at work, producing alloys little heavier than aluminium, yet comparable in strength with steel, and suitable for many new demands, and in this field Dr. Rosenhain, of the National Physical Laboratory, has arrived at many important results.

Or consider the instruments the pilot needs to determine his height, his speed, or the direction in which he is moving to enable him to drop his bomb at the right moment, or to sight his gun on his enemy as the two planes come within range. Cambridge, as represented by Horace Darwin and Keith Lucas, has done yeoman service in these various fields, while in all our many discussions on theory we have profited by the great knowledge and the clear thinking of our Chancellor—Lord Rayleigh, president of the Advisory Committee for Aeronautics.

Again, turning to another subject, consider the science involved in the manufacture of a big gun and its ammunition, or in the calculation of the trajectory of its projectile. Many gun problems are not new; artillerists had long realised the importance of experiment and calculation, the manufacturer to test his steel and determine the safe stresses to which it could be subject, the gunner to measure the resistance to the motion of the shell to plot its trajectory, determine its time of flight for various ranges, set his fuse, and design his sights so that his shooting might be accurate. But the long-range gunnery of our modern ships and the high-angle fire required for anti-aircraft work, have each introduced new difficulties. and in solving these Cambridge men, such as Littlewood, Hill, Richmond. Herman, Gallop, and Fowler, have been well to the fore, while for anti-aircraft work the Bennett height-finder in one of its many forms is in general use in the Allied Armies.

One striking feature has been the development of methods of accurate workmanship. With some few exceptions all the gauges for munitions pass through the National Physical Laboratory. About 400,000 have been dealt with in the last eighteen or twenty months. At first we were in despair. The limits of accuracy which the inspection department fixed were extremely narrow—in some cases only three ten-thousandths of an inch. Rejections were very numerous; to supply the requirements appeared impossible, but now gauges are examined at the rate of about 10,000 a week, and some 80 per cent. pass as a matter of course. Some firms get practically all their gauges through. Careful scientific examination of the causes of error, improved methods of manufacture, and a firmer grasp of the essentials have produced this change; the standard of manufacture has been gradually improved, and results at first thought unattainable have been realised.

Physics and engineering would afford many other instances, such as improvements in means of signalling, wireless telegraphy, sound-ranging, and weather prediction.

Chemistry and the biological sciences have contributed more than their full share, and though I cannot claim to speak with first-hand knowledge of the achievements of medical science, I must mention some facts for which I am indebted to the kindness of Surg.-Gen. Sir Alfred Keogh and Col. Webb, who informs me that the annual admission ratio for all causes other than wounds in action in France is approximately 428 per 1000. In the following campaigns the corresponding ratios were:—

Egypt, 1882	2276
Nile, 1884–5	557
Dongola, 1896	892
Nile, 1898	955
South Africa	843
China, 1900–1	933

In France the annual admission ratio

For typhoid fever is ... .. 0·9 per 1000.
And for the whole typhoid group of diseases ... ... 2·4 ,, 1000.

In South Africa the annual admission ratio

For enteric fever was ... ... 130 per 1000.
And for enteric fever *plus* other continued fevers ... ... 204 ,, 1000.

The figures speak eloquently of the triumphs of medicine, and the wonderful results achieved by the devotion of doctors and nurses.

The war has brought home to us, in a way that only an event of its magnitude can do, the dependence of the modern world on science and the advancement of natural knowledge; the need, then, is that when peace comes we should use this great power to the full to repair the ravages of war.

A distinction is often drawn nowadays between pure science and industrial science. I saw somewhere recently a protest against the use of the latter term. Science is one, and industrial science—so-called—is the application of the discoveries of pure science to the problems of industry. Huxley wrote long ago:—"What people call applied science is nothing but the application of pure science to particular problems." It is essential that we should remember this, and strive here in the first place for the advancement of pure science.

Scientific investigations we may divide into two classes: those in pure science which are directed solely to the advancement of natural knowledge, the discovery of Nature's laws, and those which have for their aim the application of these discoveries to the processes of our everyday life in art, or commerce, or manufacture. There is no need to lay stress in this room on the paramount importance of the first class. The Cavendish professor, speaking recently in London, said truly: "The discoveries in applied science may produce a reformation; those in pure science lead to revolutions."

The Röntgen rays, as Sir J. J. Thomson recently pointed out, were studied first as one means whereby we might hope to learn something of the nature of electricity. They are now the surgeon's trusted guide, telling him how to direct his knife and restore his patient to health and strength. Pasteur's work commenced in an inquiry into the crystallographic differences of certain chemical substances, leading him to the result that certain kinds of chemical fermentation are due to the action of living organisms which are not born spontaneously in the fermenting material, but are derived from infection. Lister seized on this and applied it to medicine and surgery. The medical statistics of the war will show, when they can be prepared, something of what the world owes, measured in lives saved for future work, to these two discoveries; the amount of pain the sufferers have been spared is immeasurable.

Lord Moulton, in his preface to "Science and the Nation," refers with special pleasure to Dr. Rosenhain's essay on modern metallurgy. The foundation of this work rests on Sorby's application of the methods of petrographic research to investigate the properties of meteorites, and on the study of the thermo-electric properties of metals due to Seebeck, Peltier, and

William Thomson. Petrographers had been in the habit of examining the structure of rocks by cutting the sections thin enough to be transparent, and examining them under the microscope. Sorby in 1861 found it was not possible to examine metals thus, and developed the art of polishing the surface and etching it with suitable chemicals, thus bringing out the internal structure. Its application to engineering problems passed unnoticed until the method was independently revived by Osmond in France, and Martens in Germany. Seebeck discovered that when in a circuit of two metals a difference of temperature exists between the junctions, an electric current is produced in the circuit. The strength of this current is a measure of the difference in temperature, and this discovery was applied many years later by Le Chatelier to construct a thermocouple for the measurement of temperature in metallurgical processes. Applying these two instruments of research, metallurgists have now a clear idea of the structure of the more important metals and alloys used in industry, and of the manner in which the properties which fit them for their various uses are related to that structure. The intensive study of pure science, the determined effort to hand on still brightly burning the lamp lighted for us by those who have gone, is perhaps the best contribution which Cambridge now can make to our national welfare.

The great discovery is usually small in its beginnings; it does not at first strike the imagination. The seeds from which the revolution is to come lie hidden in the ground, and the tiny sprout which first appears seems but of small importance. Few besides some students in the universities realised the wide-reaching scope of Maxwell's theory of the electromagnetic field, when it was first published; few, again, picture, when they read of the early experiments of Hertz and Lodge, the future marvels of wireless telegraphy, even in the short years that have passed since Lodge delivered his Royal Institution lecture. The successful applications of science to industry attract a wider notice and gain a fuller recognition. It is given to but few men to carry through the revolution that their own discoveries have produced. James Watt and Kelvin were such men. Pasteur and Lister saw, in some degree, the fruit of their labours. Faraday, on the other hand, died at Hampton Court in the receipt of a Civil List pension. The work of making the discoveries of science available to promote the prosperity and advancement of a nation appeals to others than the great discoverers, and is usually best left in other hands. Let me explain what I mean, even at the risk of some repetition, for I have recently spoken and written more than once on this subject, and, indeed, the applications of science to industry have been the work of the National Physical Laboratory since the twentieth century began.

Speaking at the opening of the laboratory in 1902, his Majesty—then Prince of Wales—said:—"The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce," and these words still express our aims.

Various writers have pointed out recently that in this process three distinct stages are generally required. We need

(1) The work of the man of science in his laboratory.

(2) The investigations which go on in a laboratory of industrial research, developing new processes or introducing new products.

(3) The works laboratory proper, controlling the quality of raw materials, or of finished products.

I have spoken already of the work of the student of science in his university or college. Before dealing with the laboratory of industrial research, let me devote a few words to the works laboratory proper.

It is necessary, as I have said elsewhere, to maintain the standard of the output, to secure that the proper grade of material is supplied to the works, to check the instruments in use, and to test the product in its various stages of manufacture. The days are gone by when successful manufacture could be carried on entirely by rule of thumb, trusting to the skill of some trained workman for the success of each delicate operation, when the hereditary instinct passed down from father to son was sufficient to produce each year practically the same results. New processes come which appear likely to improve production or to reduce its cost; the works laboratory serves to test these. New products are suggested, which may or may not have the advantages claimed for them; this can be investigated in the works laboratory, and all these investigations and tests must go on in the works themselves under the eyes of men familiar with the process of manufacture in its every stage.

A distinguished Trinity man, Mr. Michael Longridge, when recently, addressing, as president, the Institution of Mechanical Engineers, traced the process by which during the latter half of last century England became the leading industrial nation, and concluded thus:—

"And as the mechanical engineer was responsible in no small measure for the transformation, so he must be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defence of the people against their enemies now depend. He became, and he remains, a trustee of the British Empire. How did he discharge the trust? By humbly seeking knowledge to turn the gifts of Nature to the use of man? By invoking the aid of science to develop the discoveries of the men who had prepared the road to his success? By caring for the welfare of the thousands who were spending their waking hours in his factories? By giving them a fair share of the profits of his business? I think we have the grace to-day to answer 'No.' I think we are willing to confess that our heads were turned by elation at our prosperity, that we were obsessed by admiration of our own achievements; too confident of the sufficiency of our limited knowledge; too contemptuous of the few who tried to throw the light of science on our path; too eager for wealth, and the social influence it could buy in the new state of society; too careless of the needs and aspirations of the 'hands' who helped to make the rapid accumulation of large fortunes possible. And what has been the consequence? For every lapse from the ideal—and there is an ideal even of industrial polity—Nemesis Adrasteia, sooner or later, exacts retribution."

The lesson has now been learnt with more or less completeness, and now each modern engineering works possesses its own laboratory and utilises the teaching of science at each stage of its processes. Cambridge can supply the men who will do this work.

But there is another need. The step between the university laboratory and the works laboratory is a long one. Discoveries do not leave the man of science in a form which can be at once assimilated by the engineer, the shipbuilder, or the manufacturer. Some means are needed to make them available to such men to secure the advantages which come from the growth of knowledge by which alone they may keep in the forefront of their trade. The problem has recently been discussed in a paper by Dr. Mees published by the Department of Scientific and Industrial Research, and by Dr. Rosenhain in a lecture, delivered at Glasgow, on "The National Physical Laboratory: its Work and Aims." For the industrial research laboratory the plant, etc., must be so planned that it is possible to carry out the necessary operations on a scale comparable with that required in works, and, moreover, the man who carries through the investigation must be not only acquainted with the latest scientific advances in his subject, but must know what is possible in works, and must mould his solution of the problem to harmonise with these possibilities. The undertaking is often more complex than that of the pure man of science. It is one which needs a special laboratory, a special equipment.

As examples of such a laboratory, both of which happen to be at works, I may instance the research laboratory of the Badische Anilin- & Soda-Fabrik, in which the commercial production of synthetic indigo was worked out, or the laboratory of the General Electric Co. of America at Schenectady, where in numerous instances the discoveries of modern electrical theory have been turned to practical use. The Coolidge tube the most powerful source of X-rays which we possess, is one product of this laboratory. Such also are some branches of the Bureau of Standards at Washington, the Materialprüfungsamt at Gross-Lichterfelde, near Berlin, and, in some aspects of its work, the National Physical Laboratory and the research institutions for glass, pottery, fuel, etc., which are coming into existence as part of the work of the Department of Scientific and Industrial Research.

Thus, the task of an institution like the National Physical Laboratory differs from that of either a university or technical college laboratory or a works laboratory. In the first place, it is not educational; every member of the staff is, it is true, learning continually, yet he is not there to be taught, but to be asked questions and to find the answers. Its functions are primarily to encourage and initiate the applications of science to the problems of industry. It is, in the words of the Order in Council, an institution for the scientific study of problems affecting particular industries and trades. The staff devote themselves solely to this work; their whole time and energy are given to it. They have no educational duties; they are free from the responsibilities of the classroom and the burden of students' exercises. The senior members of the staff joined avowedly with the purpose of applying science to industry; they are prepared to make it their life-work. The juniors retain their posts for some time; thus all acquire a store of experience of the highest value, with a unique knowledge of the technical aspects of industry which it is difficult to gain in any other way. The laboratory has, I trust, acquired the confidence of the technical industrial world, and problems are brought before the staff with the knowledge that they will be handled in a confidential manner by men trained to deal with them. In such an institution it is possible to specialise as to both staff and equipment in a manner which can scarcely be done in a laboratory attached to an educational institution. The whole staff are engaged in applying science to industry; equipment is provided for this purpose only. The needs of the student and the educational value of the apparatus have not to be considered.

I would not advocate that work such as I have outlined should, as a rule, find a place in a university laboratory, but a university has its own task in connection with these laboratories, which, believe me, are a necessity if science is to be freely applied to industry. The universities and technical schools must provide and train the staff, not in the application of science, but in methods of investigation, in the knowledge of scientific truths, in the power of observation, the capacity to interpret the observations they make, and the experimental results they obtain, and, above all, in the desire to discover the truth and apply the consequences fearlessly to their daily work.

Nor is this all. No doubt the number of men engaged in the application of science to industry must increase, but if we are to reap the full advantages science can give, steps must be taken to ensure a wider appreciation of the value of her gifts, the greatness of her powers.

Some knowledge of the meaning of ordinary scientific terms, of the usual everyday processes of Nature —both chemical and biological—of the cause of the simple natural phenomena, and of the general scope and methods of scientific inquiry should be the possession of each undergraduate before he leaves Cambridge to take up his life-work elsewhere. "It is essential," as Prof. Keeble writes in his contribution to "Science and the Nation," "that our statesmen and administrators, our teachers and our poets, know something of the work and method and beauty of science." But how is this to be secured? Mr. Wells, in a recent review of the volume, is severely critical because the authors have not answered this question; the criticism is undeserved, it seems to me, because the authors did not set out with this object. "The time seemed propitious," says the editor, Dr. Seward, "for emphasising a particular aspect of the general question of the interdependence of many phases of national prosperity and a just appreciation of the value of pure science." Still, the question needs an answer. We look forward with some eagerness to the report of the committee, of which Sir J. J. Thomson is chairman, which is dealing with the place of science in education.

Meanwhile, it may not be out of place to hazard some few remarks. I will quote again from the president of the Institution of Mechanical Engineers, who, after pointing out that the education of an engineer must be varied to suit the capacities of different minds, writes thus:—

"And my complaint. It is against the obstinacy of our two most famous universities in retaining Greek as a compulsory subject in their examinations. This reacts upon our public schools, and is a serious handicap on those who, intending to deal with the concrete rather than the abstract in their future lives, yet wish to find their levels in the social life and moral discipline of these two universities. The English public-school boy can generally be relied on to face difficulties, lead men, and keep his hands clean in business. Engineering cannot afford to lose him to satisfy those who rule Oxford and Cambridge in this matter."

To insist on the retention of Greek in the Previous Examination is to close Cambridge to many of those who would profit most by its lessons, who would carry the rich benefits three years' residence here can give to places where at present they never penetrate, and who themselves, in not a few instances, would add to the lustre and the glory of our university.

The study of Greek is not really advanced by its compulsory character. Lord Bryce, in a recent article addressed in the first instance to a classical audience, writes, after a reference to the very few who retain a competent knowledge of Latin and Greek beyond an early age:—"Let us frankly admit the facts. Let us recognise that the despotism of a purely grammatical study of the ancient languages needed to be overthrown," and he continues:—"What is the chief aim of education? How should the mental training fitted to produce the capacities which go to make an educated man begin? First of all by teaching him how to observe and by making him enjoy the power of observation. The attention of the child should from the earliest years be directed to external Nature. His observation should be alert and it should be exact. Along with this he should know how to use language, to know the precise difference between the meanings of various words apparently similar to be able to convey accurately what he wishes to say."

Then, after distinguishing between the world of Nature and that of man, he discusses how the time available for education is to be divided between these two spheres, urging the need for plenty of knowledge of both to produce a capable and highly finished mind. "No man," he says, "in our day can be deemed educated who has not some knowledge of the relation of the sciences to one another and a just conception of the methods by which they respectively advance." He presses strongly the importance of literary studies because of the service they render to us for practical life, for mental stimulus and training, and for enjoyment, and as an introduction to his views on the claims of the classics, he writes:—"A word must be said on the practical aspect of the matter as it affects the curricula of schools and universities. I do not contend that the study of the ancients is to be imposed on all, or even on the bulk, of those who remain at school until eighteen or on most of those who enter a university. It is generally admitted that at the universities the present system cannot be maintained—we shall effect a saving if we drop the study of the ancient languages in the case of those who, after a trial, show no aptitude for them. For the schools, the problem is how to discover among the boys and girls those who have the kind of gift which makes it worth while to take them out of the mass and give them due facilities for pursuing their studies at the higher secondary schools, so that they may proceed thence to the universities and further prosecute them there. Many of you, as leaders, know better than I how this problem may be solved; solved it must be, if the whole community is not to lose the benefit of our system of graded schools."

And in this connection let me quote a few words from a recent letter in NATURE by Mr. M. D. Hill, an Eton master of twenty years' experience. He writes:—"The boys who are best at classics are also best at science. . . . Every intelligent boy must be given equal opportunities in science and languages in the widest sense of the word until he is old enough to show which line of study he can most profitably follow."

Here is a problem which the university must attack at once. I have already pointed out what seems to me the first step towards its solution. Cambridge must open her doors wide to every son of our great Empire who can show that he will reap benefits from studying within her walls any branch of knowledge for which she offers opportunities; this step should be taken without delay. Lord Bryce has indicated, I think, the lines for our future development. Let me briefly outline how they appear to me to run. The university must remain the home of ancient learning, but the course pursued to secure this end must not be such as to demand that Latin and Greek should remain the principal part of the school tasks of all boys. It must train men to be leaders in all walks of life, and not least in industrial pursuits, and this not by undertaking the technical training of the men who go out hence into the world, but by laying a broad foundation of the scientific principles and laws on which technical knowledge, be it of theology, medicine, or law, or of the more modern branches of applied science, must rest. And lastly, but most important of all, it must produce the leaders in every branch of science.

For the highest work of all, be it literary or scientific, the course is fairly simple. Men in whom are implanted the thirst for new knowledge, the power of discovery, the keen logical insight to follow the right path and avoid the wrong, will come to the front helped by the traditions of the past, the enthusiasm and devotion of the teachers, the generosity of our founders and benefactors. Funds, it is true, will be needed, and must be supplied. A man whose researches may produce a beneficial revolution, whose discoveries may prove of untold benefit to mankind, should not depend for a scanty livelihood on the proceeds derived from his yearly cycle of tutorial lectures. Means must be found to increase the endowments of the university for pure research, and funds so expended will in time produce a full harvest.

Let me, however, endeavour to say something as to the steps to be taken to give science its due place in the education of every man. Have we attacked this question in the right manner? and by "we" I mean teachers of science generally.

It is nearly forty years since the present Chancellor asked Sir Napier Shaw and myself to help in his work at the Cavendish Laboratory. Practical physics as a branch of study for undergraduates generally was almost non-existent. Maxwell had inspired a few of the leading mathematicians with the desire to work at the laboratory, but the organised classes were small and their organisation was incomplete. Elsewhere Carey Foster had classes at University College, Balfour Stewart at Manchester; Kohlrausch's book had been published and translated into English some few years previously. Shaw had worked in Berlin under Helmholtz. We commenced the endeavour to systematise the teaching, to devise experiments to illustrate and "prove" fundamental laws and principles, to teach students the reality of many things of which they read in books, and show them that effects do follow their causes in the manner there described.

Laboratory notebooks were written. In due course (in 1885) Glazebrook and Shaw's "Practical Physics" appeared, and, I am glad to say, after more than thirty years of life, is vigorous still. It has been followed by many similar books, and has, I trust and believe, done much useful and important work. A man who is to develop into a physicist must have an intimate knowledge of the existing methods of physical investigation. Measurement is so important a factor in many branches of knowledge that an acquaintance with the fundamental methods of measurement, and skill in using instruments and apparatus, are of the highest value for large classes of men.

But for the great majority the mental food thus offered affords but little nourishment. The teaching of practical physics on these lines fits in with our examination system. Problems can be set and questions asked admitting of definite and precise answers the value of which an examiner can easily assess in marks. A sum in arithmetic is classed as a physical problem because the term "specific heat," or "electrical resistance." is used in stating the question. "Our examination system," says Principal Griffiths, "has endeavoured (but, thank Heaven! unsuccessfully) to kill the soul of science in the rising generation. There is, however, a stirring among the dry-bones, and we are awakening to the fact that science must be taught as if we believed in it for its own sake, that we must teach it as a disciple preaches his religion, and that we must refuse to be bound by the fetters in which tradition has entangled us. If we are to succeed, we must make science a living reality to our pupils, and cease to regard it merely as a convenient machinery for the manufacture of conundrums." We do not really so regard it, any of us teachers, but our methods of teaching and examinations tend to produce this impression. It is clear, I think, that a plan which is excellent for men who intend to specialise in science is not the one best suited to give to all—"some knowledge of the relation of the sciences to one another and a just conception of the means by which they advance." For the limited class an exact knowledge of the elements is essential. If this exact knowledge is required from all, the majority find the process dull; they get no further than the elements, and when the dreaded examination is over they forget even these, and have no further interest in the subject. Natural science, like Latin and Greek, disappears from their lives.

And so, if this be at all the correct view, an important task for the university is to develop a new method for the ordinary teaching of science, not merely to require that science should be taught, but to discuss and determine how this can best be done, and then to train and send out into the world men capable of doing it. The method will not lend itself easily to "the process of controlling education by examination with a limited time," and if a test of the pupil's knowledge is required, some other plan for this purpose must be devised.

One of the consequences of the war will be a greater appreciation of the value of science. Let us in Cambridge be ready to take advantage of this and help to strengthen our country by raising up a generation which realises to some extent what science has done, and how real progress in nearly every walk of life is inseparably bound up with the advancement of natural knowledge, which in the past the university has done so much to promote.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. F. H. Jackson, of Peterhouse, has been approved for the degree of Doctor of Science.

LONDON.—The Senate has resolved to institute for external students a B.Sc. degree dealing with the administration and management of urban and rural lands and estates, and a scheme with the necessary syllabuses and regulations is in course of preparation.

OXFORD.—Mr. J. J. Manley, the curator of the Daubeny Laboratory, has been elected to a fellowship at Magdalen College, Oxford, for the prosecution of special researches in physics and chemistry. Mr. Manley's talents as a teacher of practical chemistry have long been recognised by several generations of pupils, a list of some 500 of whom has been recently printed. Among them we note the names of Prof. Soddy and of many well-known younger science teachers. Mr. Manley is widely known for his interesting observations on the anomalous behaviour of delicate balances and by his ingenious devices for increasing accuracy in weighings. A re-investigation of Landolt's work on the apparent change of weight during chemical reaction was the subject of a more recent paper in the *Philosophical Transactions*, and he has lately succeeded in constructing platinum resistance thermometers of a sensitiveness greatly in advance of any that had previously been made. Magdalen College and Mr. Manley are equally to be congratulated on this election, which promises to be of considerable service to the cause of physical and chemical research.

On June 19 the annual report of the delegates of the museum was presented to Convocation. The report directs attention to the fact that the members of the staff and other workers in the museum departments on war service have been further increased. The death in action of Mr. Geoffrey Smith, demonstrator in zoology, is recorded; and details are given of the handing over of a large part of the museum buildings for the use of the Royal Flying Corps. Separate reports from the various scientific departments are added, all of them giving evidence of much activity in spite of the present adverse conditions. The report of the curator of the Pitt-Rivers Museum includes an especially long list of valuable donations.

At the same meeting of Convocation, decrees were passed allowing, under certain conditions, that candidates in the science and other honour schools should be examined in part only of their subjects, and empowering the examiners to award distinction to those who have attained a high standard therein. This provision will apply solely to those whose regular course of study has been interrupted by war service.

The extremely valuable collections of Arachnida, containing more than 1000 types, with the library, notebooks, drawings, and papers in connection therewith, bequeathed by the late Rev. O. Pickard-Cambridge, were gratefully accepted, and ordered to be deposited in the University Museum, and placed in the charge of the Hope professor of zoology, Prof. E. B. Poulton.

THE Maharaja of Benares has founded a gold medal, to be known as the "Lady Chelmsford Medal," for award annually to the best student of the Lady Hardinge Medical College for Women, Delhi.

TWO "British Dyes" open research scholarships, each of the yearly value of about 60*l*., are offered in connection with the Huddersfield Technical College. They are tenable for one year, with the possibility of renewal. Applications must reach the secretary of the college by, at latest, July 6.

TWO scholarships in naval architecture, each of the value of 90*l*., have been founded by Col. Smith Park, C.B., of Glasgow, for students of the University. The scholars are required to have remained at a secondary school until they have obtained the higher grade leaving certificate, which admits to the University courses for graduation in arts or science.

THE debate in the House of Lords on Tuesday, June 12, dealing with the future policy of the Board of Education so far as it has been foreshadowed in the speeches of Mr. Fisher, was chiefly notable for the views expressed in protest against a too early or undue specialisation in the schools, whilst demanding that science should find its due place in the scheme of education, especially in the great public schools, as a subject of vital importance for the effective training of the citizen, so as to enable him to take a sound view of the questions which arise in modern life. The events of the war, intimate and contingent, have made it plainly clear that training in the facts of science and the inculcation of the scientific habit of mind are essential to the national well-being. The purpose of the schools is, as Lord Haldane well put it, not to make of their pupils Latin or Greek scholars, or men of science, but to make them men, and to develop their humanity in the best and broadest sense. In short, their business is so to train their pupils as to give them a liberal outlook in preparation for such specialised teaching in the classics or in the various branches of science, pure or applied, or in other departments of knowledge, as the universities can offer, or as the various professions may require. In no other way can the public schools ensure the generous training of all their pupils, and especially of those who aspire to take a prominent part in public affairs, or shake themselves free of the incubus of conflicting external examinations. Indeed, not until the older universities cease to retain compulsory Greek as an essential feature in the examination for their most valuable scholarships will it be possible for the public schools to give to science its rightful place in their curriculum. It is now seen to be essential that in the treatment of