

mitting these rays; solids also conduct, though the conductivity obeys different laws and only lasts for a short time. The conduction through solids very closely resembles the phenomenon called "electric absorption," a well-known example of which is the residual charge of a Leyden jar.

I have here some experiments which illustrate the effect of the Röntgen rays on solids. In the first of these we have a lead cylinder with a thin base made of aluminium. At the bottom of the cylinder there is a thin layer of solid paraffin; on the top of this, and sticking to it, there is a large leaden disc, over which paraffin has been poured, so that the disc is entirely embedded in the paraffin (Fig. 6). This cylinder rests on the aluminium window in the iron chest containing the coil and the tube, this window being very much smaller than the lead plate in the paraffin. I now connect the lead plate to one pair of quadrants of a highly charged electrometer, and then connect the two pairs of quadrants together and with one of the poles of a battery of 200 small storage cells, the other pole of which is connected with the iron chest, and so with the earth. I now disconnect the quadrants from the battery, and then the quadrants from each other. There is now very little movement of the spot of light reflected from the mirror of the electrometer. When we turn on the Röntgen rays, however, the spot of light begins to move, and though the movement is small compared with that which occurred in the experiment with air, it is quite decided. The rapidity with which the spot of light moves soon, however, begins to decrease, and after a short time becomes almost

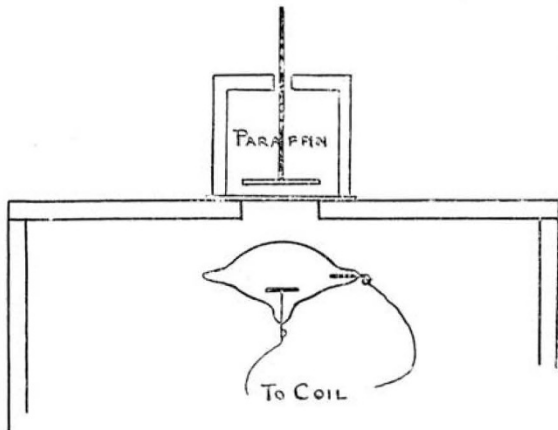


FIG. 6.

inappreciable. I now discharge the lead plate by connecting it and both pairs of quadrants of the electrometer to earth for a short time, then keeping one pair of quadrants connected with the earth, and leaving the other connected with the lead plate, we see that when the rays are off there is a very slight movement of the spot of light in the opposite direction to the original deflection; this is due to the leaking out of the "residual charge." This movement is, however, greatly increased as soon as the rays are turned on, and continues until we get quite a large deflection; "the residual charge," or polarisation in the paraffin, has then been enormously increased by the rays. The conductivity of the paraffin under these rays resembles in its properties that of the insulating sheath of a telegraph cable. In testing the resistance of such a sheath, the current passing through it does not remain constant, it rapidly falls off in intensity; and if after the electromotive force has been applied for some time it is removed, and the inside and outside of the sheath connected with the terminals of a high-resistance galvanometer, a current flows through the galvanometer, and this current is in the opposite direction to that which originally flowed through the sheath.

Ebonite shows the effect of the Röntgen rays in increasing the conductivity even better than paraffin. I have here a plate of ebonite about 1 mm. thick, coated on both sides with tinfoil. I put this on the aluminium window, and on the top of the ebonite plate I place a lead disc, which is much larger than the aluminium

window; the object of this disc is to prevent the Röntgen rays from striking against the wire connected with the disc, and so discharging the disc through the air. That it is effectual in doing this, is proved by there being no leak when the rays are on, and the wire (raised to a high potential) disconnected from the disc. If we now repeat with this plate of ebonite the experiments we previously tried with the paraffin, we get similar but decidedly larger results. I may mention that different specimens of ebonite vary considerably in the magnitude of this effect. There is one variation of the preceding experiments which is of some interest. I will charge up the ebonite plate without putting the Röntgen rays on at all; on discharging, you see that the electrometer indicates that the "residual charge" is coming out. I keep discharging the disc until the residual charge is almost inappreciable. I now for the first time put on the rays, and you see that the residual charge or polarisation, which could not previously be detected, now becomes quite marked. These experiments show how greatly the properties of bodies are modified by the Röntgen rays, and show that by their discovery physical science has received an agent which promises to be of the greatest service in investigating some of the properties of bodies which are now most urgently pressing for explanation.

#### LONDON UNIVERSITY COMMISSION BILL.

THE second reading of the London University Commission Bill was agreed to by the House of Lords on Thursday last. A full report of the debate upon the Bill was given in the *Times* of Friday, and the following abridgement of it will show the favourable feeling that exists for the appointment of the Statutory Commission to deal with the reconstitution of the University.

The Duke of Devonshire moved the second reading of this Bill. He said: As I made a short statement of the circumstances that have led to the introduction of this Bill when I moved for leave to introduce it, it will not be necessary for me to detain your lordships for any long time on this occasion. The opposition to the Bill, of which I indicated the possibility, has manifested itself in the form of a statement purporting to proceed from two bodies entitled respectively the University Defence Committee and the Gresham Commissioners' Scheme Amendment Committee. It is not stated how those committees are composed, and whilst I have no doubt that they fairly represent those parties who are known to be opposed to legislation on those lines, I do not think it will be contended that the body of opinion which is represented by those committees can be compared for a moment, either in weight or as regards scientific or educational experience, with that body of opinion which in various ways has given expression to its adoption of the principles upon which this Bill is founded. I think that in moving the second reading it may be sufficient if I say that, in my opinion, the arguments which are brought forward in this case do not establish any reason why the Bill should not be read a second time. There may be some points which are referred to in that case which may be worthy of attention in Committee, and I think that some of the statements may be eminently deserving of the attention of the Statutory Commission if it should be appointed under this Bill. Lord Davey has expressed his willingness to accept the position of chairman of this Commission if it should be appointed, and I trust that before the Bill leaves your lordships' House, or at all events as soon as there appears to be any possibility or probability of its being passed through the other House, I shall be in a position, in conjunction with him, to state the names of those gentlemen who it is proposed shall form the entire Commission. With this explanation I beg to move that this Bill be read a second time.

Lord Herschell: As I have the honour to be Chancellor of the University of London, it is only natural that I should desire to say a few words on the present occasion. The objections to the measure may, I think, be put under two heads. It is alleged that the scheme of the Commission of which Lord Cowper was chairman, even when subjected to the scrutiny and modification of the proposed Statutory Commission, would involve two consequences—that it would lower or tend to lower the standard of the degrees, and that it would be unfair or tend to unfairness towards those students who sought to obtain a degree without having been connected with any college or collegiate instruction. The opponents to the scheme, both in the statement they have

recently made and in previous statements, always seem to me to assume that those will be the consequences. Their statement is founded upon assumption rather than any proof or evidence. If the members of the Senate shared the view of the opponents of the scheme that the consequences which they assumed would, in fact, necessarily result, I venture to say that the Senate of the University would have been found in the front rank of opposition to the scheme, and if they support the scheme it is not because they are indifferent either to the standard of education or to the interests of the external students, but because they believe that the present work of the University may be made even more valuable than it has been without any such risk as the opponents of the scheme consider must necessarily attach to it. The fear seems to be that the scheme which has been proposed would give the teachers in London schools and colleges more power in the direction of examinations and course of study than they possess at present, and that a likely consequence of their obtaining that greater power would be a lowering of the standard of education at the University. But here again we are not without experience. First let me say that the high standard that has been maintained has been largely due to the examiners. Who have the examiners been who have thus maintained the standard of the examinations? They have very largely consisted of the teachers of the London schools and colleges. That is a matter of experience which is of much more value than any mere assumption. There is a very large consensus of opinion amongst these teachers, who have had much greater experience than can be claimed by any body of graduates, in favour of the proposed changes. The Royal Commission have impartially considered the views of those who are in favour of the scheme and of those who are opposed to it, and they have arrived at the conclusion that the scheme is one which is likely to be of public advantage and will be detrimental to no one. I only desire further to remark that I think that the scheme of the Cowper Commission, although on the whole an admirable one, is susceptible of improvement in its details, leaving its general principles untouched. The very object of appointing the Statutory Commission is to carry out those recommendations, and that the details should be looked at by a body of able men, and that the weight and force of the objections raised to those details should be fully considered and, where necessary, modified. I know that some of the opponents of the present scheme desire to create another University in London alongside of the University of London. That is a question that has been considered by men of great weight and authority, who have very largely pronounced against the proposal. The House of Commons has emphatically pronounced against it, and I believe that the country has also pronounced against it in an equally emphatic manner. Under these circumstances, I believe the best hope for the solution of this question and for the increase, even, of the valuable work which the University of London has done, lies in the direction proposed by the noble Duke.

Earl Cowper, speaking as chairman of the Commission that considered this question, said that when the work of that body first began he was prepossessed in favour of the Gresham scheme, because he thought everybody would admit that, if there was to be a second University, that scheme would have been at least as good as any other which could have been devised. But he found that the large majority of his fellow Commissioners were of a contrary opinion, and as the evidence proceeded he became more and more convinced that the great bulk of opinion throughout the country, and more particularly in the metropolis, was not in favour of a second University, but in favour of one. He could not help feeling pretty sure that everybody who went through the voluminous mass of evidence would gradually come to the same conclusion as that at which he had arrived.

Lord Playfair said that he introduced a Bill last year for the purpose of converting the present London University into a teaching University, and as the noble Duke had accepted the Bill he would strongly urge that the Government should take the matter up in earnest, considering the enormous amount of support which they now had in regard to the scheme. This scheme had been under the consideration of educationists for a whole generation. Three times the Convocation of the existing London University had met and discussed the principles of this Bill, and by increasing and finally by an overwhelming majority had pronounced in their favour. The minority of the Convocation, and individual graduates in the country, refused to accept their defeat, and were still alarmed at the proposed

changes in the constitution of the present University. At the basis of their opposition was the fear that the new University might lower the value of degrees, and thus lessen the honour in which the existing graduates were now held. This fear did not seem to be shared to any extent by graduates who had the highest degrees. They had never had it explained why an organised teaching University should think it to their interest to lower the value of the degrees. One would say that their interest was to keep up the degrees to the highest value, and he thought the graduates, when they considered the question, would gradually come to this view. London was the only large town—he would not say the only capital—which did not possess an organised teaching University. It was a most melancholy fact—a fact that was a disgrace to the metropolis, that, although the towns of great population possessed organised teaching Universities, the London University did not yet do so. It was impossible that the London University, with its present powers and its present charters, could constitute a teaching University in accord with the science of the time. Teaching by verbalism was more and more going out in science. Lecturers were of far less importance than experimental work in laboratories. For this purpose well-equipped colleges were absolutely necessary, and the object of the University would be to raise itself continually up to the level of science. The object of this scheme, for which educationists had been agitating for so many years, was to produce this result. The Bill would provide a system of education capable of raising itself continually to the heightening and advancing state of knowledge. It did not provide the means, however; but if they erected an organised University of which Londoners and the people of this country would be proud, he was perfectly sure that the funds would not be lacking. He would give one instance of why they should have that confidence. The late Royal Commission appointed a small committee, consisting of Prof. Burdon-Sanderson and himself, to consider the scientific part of the report; and they recommended the foundation of research laboratories for chemistry and physics, independent of the existing colleges, but open to any of the graduates who showed the power of advancing the boundaries of science by original researches. Their recommendation was adopted after some hesitation on the part of their colleagues, because they thought they were asking too much, for no funds were in view for building and equipping such laboratories or for maintaining them when equipped. The generosity of one scientific manufacturer—Mr. Mond—had already founded these laboratories, which two years ago looked so hopeless of accomplishment. Like results would follow in regard to other recommendations of the Commission. He would like to point out how important it was that a large community like that should put itself into the position of having organised University teaching as other places had. They were doing nothing in this country at the present moment compared with what was being done in other countries for the promotion of higher University education. After the Franco-German war the French Institute had a most interesting discussion upon the question, “Why did our late crisis produce no great people in this country?” and the universal feeling in the Institute was that France had not sufficiently attended to her higher University education. Renan, in summing up the whole debate, said:—“It is German science that won the day at Sadowa and Sedan. The German national spirit is a product of the German Universities, and the German Fatherland is a product of that spirit.” Inspired by these views France, since the war, had spent nearly 100 millions of francs in equipping her higher colleges, so that they might suffice for modern scientific requirements; and it now spent annually about as much as Germany in higher education. Germany had not stood still. When she acquired Strasburg as a result of the war, she spent upon that small town no less than £711,000 sterling in the building of a new University and its scientific laboratories, and annually voted above £50,000 sterling for their maintenance. The future competitions of the world would not be determined by armies and navies alone, but would be mainly governed by the intellectual development of the people. In the presence of these facts, surely England could not allow its great capital to remain the only large town, either in the United Kingdom or abroad, which had no means by which organised University teaching could be given to her people.

Lord Reay said that the main purpose of the Bill was to put an end to an anomaly. London had a variety of institutions in which University education was given, but which had not the power of conferring degrees; and, on the other hand, London had an examining Board unconnected with the teaching institutions. The institutions had no crown to their edifice; the University had no foundation. The object of the scheme of the last Royal Commission was to constitute a corporate body out of these scattered fragments, and recognition was given on well-defined and broad lines to University teaching wherever it existed. The aim of the Bill was not merely educational. It had a much wider bearing. What was the cause of the increased expenditure on higher education on the continent? It was the consciousness that wealth and military power were insufficient; that higher education must provide the intellectual capital which agriculture, industry, and trade required. If we were to hold our own in this race we must use the same means. A London University would not be a mere local institution; it would eventually be an Imperial institution, profiting all classes throughout the Empire. The progress of the Bill was anxiously watched by scientific men at home as well as abroad. There was, indeed, practical unanimity among all those who had the higher interests of the country at heart that failure to give London a teaching University would be nothing less than a national disgrace.

Lord Kelvin felt that the reasons already put before their lordships for accepting the Bill were overwhelmingly strong, and he only wished to intervene because he had been mentioned as one apparently partially opposed to the provisions of the Bill. As a member of Lord Cowper's Commission he joined with Sir George Stokes and Mr. Weldon in a note expressing a preference for a separate teaching University. They had some doubts as to whether or not the functions of a teaching University could practically be added to the duties so well performed by the University of London of examining for degrees and conferring degrees upon students who had not had the benefit of instruction in colleges of universities in any part of the world. They felt the gravity of the objection that might be held to establishing another university—a rival university—beside the University of London; but when it seemed, as it did then seem to them, hopeless that the University of London could be got to undertake the duty of organising and carrying on a teaching University, they felt that the paramount object of having a teaching University in London should not on that account be given it. On his own behalf, and, he believed, on behalf of his colleagues in the note, he could say they would only have been too glad to have accepted what was now proposed by this Bill. Their doubts and hesitation had been completely set aside by what had passed. Personally he thoroughly approved of the Bill. He believed that an immense addition to the usefulness of the existing colleges in London would result from the passing of the measure. It was an anomalous state of things that there was no teaching University in London. It was not only London, but the United Kingdom, and, indeed, the whole world, that would benefit by the passing of the Bill, and therefore his desire was strong and evident, not only that the Bill might pass speedily through their lordships' House, but that it would be taken up by the House of Commons and made an Act of Parliament before the close of the present Session.

The Earl of Kimberley said that some years ago he had the honour to be President of University College, and at that time there was put forward a scheme for a separate University such as Lord Kelvin thought might be the only alternative. He then felt it would be a great misfortune if there were set up two rival universities in London, and therefore, he need hardly say, how greatly he rejoiced that they had arrived at last at a point where they seemed to have in view a conjunction of teaching and examining in the University of London. He was glad to see the noble Duke had inserted in the Bill the clause that the Commissioners were to see that provision was made for securing adequately the interests of collegiate and non-collegiate students respectively. That ought to reassure those who had placed themselves in opposition to the Bill, because an impartial Statutory Commission such as the noble Duke intended to appoint would be perfectly able to see that the statutes of the University were so framed that there would be no chance of any portion of the University work being impaired by a wrong administration of its powers.

The second reading was then agreed to.

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#### SCIENCE FOR SECONDARY SCHOOLS.

THE Reports of the United States Commissioner of Education are known to be the most valuable publications on educational statistics and methods in the English language. The Report (1892-93), just distributed, may appear to be somewhat belated, but the contents are so instructive and exhibit so many special features, that the delay of publication may be forgiven. There are two volumes, running altogether into 2153 pages, and the amount of information contained in them is marvellous. Taking the volumes in order, we find in the first elaborate tables of statistics referring to the schools of the United States, and statistics of illiteracy for each of the States and for Europe. Then follow surveys of the educational system of Belgium, the elementary schools of Great Britain, the systems of education developed in the British Colonies, the French educational system, and a most instructive chapter on developments in the teaching of geography in Central Europe. The chapter on child-study, which practically concludes Part I. of the first volume, contains a number of interesting contributions from leading American representatives of this modern movement.

The second part of the first volume is devoted entirely to reports which were called forth on the occasion of the World's Columbian Exposition. Among these reports are detailed criticisms of American educational methods, by eminent French and German educationists. There is a survey of medical instruction in the United States, as presented in the reports of two French Commissioners appointed to make a special study of the subject, and an English version of a report on American technological schools, prepared by Prof. Riedler, of the Royal Polytechnicum at Charlottenberg. The remainder of the first volume is taken up with papers read at the Library Congress held during the Columbian Exposition, and notes on the educational exhibits.

The second volume contains the third and fourth parts of the Report. Prof. Hinsdale contributes to it a series of rare documents illustrative of American educational history, and there is incorporated in it the report of the Committee of Ten, appointed to take up the important subject of courses of instruction in secondary schools, and papers relating thereto. The chief interest for us in the volume lies in this valuable educational document.

The Committee, which was appointed by the National Council of Education, organised conferences of leading teachers of the principal subjects which enter into the programmes of secondary schools in the United States. Each of nine subjects was considered and reported upon by a conference consisting of ten members, who were selected on account of their scholarship and experience. Among the subjects discussed were four concerned with groups of sciences; viz. (1) mathematics; (2) physics, astronomy, and chemistry; (3) natural history (biology, including botany, zoology, and physiology); (4) geography (physical geography, geology, and meteorology). As a result of the conferences, a great number and variety of important changes in the scope and method of science teaching were recommended. All the conferences on scientific subjects agreed that laboratory work by the pupils was the best means of instruction, and dwelt upon the great utility of the genuine laboratory note-book; and they all declared that teachers of science in schools need at least as thorough a special training as teachers of languages or mathematics receive.

The most important recommendations made by the scientific conferences are summarised in the following pages. But all who are interested in scientific education should read the entire reports, for each is so full of suggestions and recommendations, that it is impossible to present adequate abstracts of them.

On one very important question of general policy, which affects the preparation of all school programmes, the Committee of ten, and all the conferences organised by it, were absolutely unanimous. Among the questions suggested for discussion in each conference was—"Should the subject be treated differently for pupils who are going to college, for those who are going to a scientific school, and for those who, presumably, are going to neither?" This question was answered unanimously in the negative by all the conferences; so that we have the fact that nearly one hundred eminent teachers agree that every subject which is taught at all in a secondary school should be taught in the same way and to the same extent to every pupil so long as he pursues it, no matter what the probable destination of the pupil may be, or at what point his education is to cease.