some part of the meaning of a term is determined arbitrarily; either by public opinion for general use, or by the individual reasoner, if he wishes to use the term for some special purpose of his own. For this does not imply that there ever was a formal contract as to the meanings of terms. The fact that terms do not mean the same to people of different nations is enough to show that the determination of the meaning by each nation is, in part at least, essentially arbitrary. It is also, I think, clear that there is a part of the meaning of some terms at least which is not arbitrary, when once the arbitrary part has been settled. There is a slight ambiguity about my use of the word "definition," which, however, when once noted, need cause no confusion, as the context will always show in which sense I am using it. Commonly a "definition" denotes an assertion which determines the arbitrary part of the meaning of a term; but when I speak of "the definition" as opposed to "the import" of a term, I mean not this assertion itself, but that part of the meaning of the term which it determines. This explains how it is that I do not regard "the definition" of a term (as opposed to its import) as a *thing*. Even if it is clearly conceived in the mind it is only an abstract idea; but the point is that it is not necessary that it should be conceived at all. Thus it is not necessary that a definition by connotation should be "of something," if that means that the term should have denotation. Even if the term has any denotation, *i.e.* if the mind grasps it as denoting a thing or idea, this denotation must, in a symbolic argument, be regarded as merely "accidental clothing."

Just as some part of the meaning of a term is arbitrary and some part not, so in any system of logic some part of the system is arbitrary and some part not. Now, either the denotation or the connotation of a term may be laid down arbitrarily, but *the connection between the two is not arbitrary*. One cannot arbitrarily lay it down that "such a thing possesses such attributes." If, therefore, a definition is to be an arbitrary assertion, it must only lay down either the denotation or the connotation of a term, and not parts of each. It would, of course, be logically permissible to use the word "definition" in a different sense, but then definitions would not be arbitrary assertions. This is exactly what is done if the assertion "Two straight lines cannot inclose a space" is called a definition by denotation; and therefore, in my system of logic, I cannot admit it to be a definition. This is one of the arbitrary features of my system. But it is not arbitrary when I say that in such assertions as "Nothing can both be and not be," and "Twice two is four," there is nothing absolute at all. The truth of these assertions is determined entirely by the arbitrary parts of the meanings of their terms. Miss Jones says: "If definitions were purely arbitrary, as Mr. Dixon holds, what would prevent my saying that *Four* ($1+1+1$) means *twice two* ($1+1$) + ($1+1$)?" Precisely; this is exactly the point. *There would be nothing at all to prevent it*. Boole actually did this very thing, as his law of indices in his mathematical analysis of logic. According to his law $a^{1+1+1} = a^{(1+1)+(1+1)}$.

There remain one or two minor points to be answered. As to induction, I think Miss Jones's view is substantially the same as mine. Of course it is possible to set out an inductive generalization in a syllogistic form as Miss Jones does; only the whole of the induction is then contained in the assumption of the major premiss—the syllogism itself is in no sense inductive.

If Miss Jones thinks the truth of the formula $(a+b)^2 = a^2 + 2ab + b^2$ is deduced by generalization from a single concrete instance, how does she explain the fact that sometimes $(a+b)^2 = 0$, as in Grassmann's "Aeuessere Multiplication," and sometimes $(a+b)^2 = a+b$, as in Boole's logic?

I see nothing to differ from in the paragraph about S and P; except perhaps that if I define such a term as "metal" by denotation I do not say "This and all other things like it in certain respects" are metal. That would be mixing up denotation and connotation in one definition. I say only "This, and this, and this, . . . are metal."

The explanation of the point about the mathematical truths is simply that I do not consider the assertion "Two straight lines cannot inclose a space" as a mathematical truth at all, if "straight line" is defined by denotation. I certainly believe it to be true, but its truth is not of the same nature as that of the assertion "Twice two is four," or even "*Cogito, ergo sum*"; it is neither a truism nor a necessary truth, in my senses of those terms, but can only be established by induction.

EDWARD T. DIXON.

Trinity College, Cambridge, February 19.

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The Value of Useless Studies.

It is rather surprising that Prof. Ayrton should indulge in covert sneers at Universities for devoting themselves to useless studies. It certainly ill becomes one whose life is bound up with electrical science, which is of such recent growth that nobody can pretend to forget how it owes its origin to those who studied it while useless. If Universities do not study useless subjects, who will? Once a subject becomes useful, it may very well be left to schools and technical colleges, to patent-mongers, and the trade. Mr. Bury is, on the other hand, mistaken in two respects. That a subject is useless is hardly worth considering as a recommendation for its being made *compulsory* on students. There are too many useless subjects for that. The great objection to compulsory Greek is that it is the principal stumbling-stone in the way of any literature being studied by ordinary University students. The Bible produced very little effect until it was read in translations; and the danger of a pagan revival, if ancient literature were studied without the obstruction of difficult languages, is the best reason for insisting on these languages in a Christian University. The second mistake of Mr. Bury is that it is any part of the business of a University to *teach*. Universities should certainly give facilities for students to *learn*. It is the business of the students to learn. If they are so ill prepared that they have not acquired the art of learning, they should go to a college or school or private teachers, and get taught; for teaching is the business of these institutions and persons. The business of Universities is to advance culture and knowledge, and to afford students an opportunity of learning how to do this. Prof. Ayrton, by omission rather than by commission, seems utterly unable to appreciate the value of literature for its own sake. How can all this fierce toil he extols so justly advance a lot of savages?

GEO. FRAS. FITZGERALD.

Trinity College, Dublin, February 13.

The Nickel Heat Engine.

IN trying Mr. Smith's experiment on the rotation of nickel (NATURE, January 28, p. 294), I find my disk has a more complex action.

It will be remembered that the nickel is mounted on a vertical axis, and has the poles of an electro-magnet put near two points, A and B, 90° apart. Let C be any point in the larger arc, and suppose heat is applied to A.

I find that at first the disk moves in the direction ACB with a hesitating, uneven motion; it revolves several times, and almost develops into a steady rotation, when it beats back, oscillates for a while, and goes off with a brisk even spin in the direction BCA. After about two minutes this fails, and a new start is attempted the opposite way, but there is little more movement, until time has been given for cooling.

It makes no difference at which pole the heat is applied. The disk is 50 mm. diameter, rather less than 1 mm. thick, and is covered with lamp-black.

W. B. CROFT.

Winchester College, February 12.

THE UNIVERSITY OF LONDON.

PROBABLY before this letter is in type the Charter of the Albert, or, as it is now to be called, the Gresham, University, will have been presented to Parliament. What will be its ultimate fate remains to be seen. But I have sat through a long night's debate in the House of Commons to see a Government turned out in the small hours of the morning on a University question. I do not suppose that the proposed Charter will raise an issue of that importance. But I think that the Government may not be unmindful of past history, and, in what is probably the last session of a moribund Parliament, may not be willing to push very vigorously what is perhaps the crudest scheme of University organization which has ever been proposed in this country.

Before Parliament takes so serious a step as founding a new educational institution, the question may fairly be asked, On what ground is it necessary? Everyone knows that we have a University in London which is a State institution; and one may not unreasonably inquire,

In what respects is it inadequate to its duties ; and, if so, why cannot its defects be remedied without beginning the work all over again ?

To neither inquiry has, it seems to me, any very satisfactory reply at present been given. The reason perhaps is that beside the ostensible reasons for the Charter which are put forward, there are others in the background which are less conveniently avowable, and which therefore it is anything but easy to meet.

Of the former, the most important is that the existing University does not teach. This is an undoubted fact. If, however, it were provided with a body of Professors, as has often been suggested, it might teach just as much as Oxford and Cambridge do. That defect is clearly, then, not irremediable. But, on a little further investigation, it turns out that something more than teaching is meant. What is desired is that the teachers shall also have the control of the examinations. What is wanted is to introduce into London the teacher-examination system, which is said to be the distinctive feature of Universities in Germany. To quote an able article in the *Standard* of January 19 :—

"There must be a Teaching University in order that the teachers might control the studies, and the degrees be a recognition, not of mere knowledge (which might or might not be superficial), but of sound intellectual training."

Now, I have discussed this position at some length in the pages of *NATURE*, and I need not repeat what I have already said. But it may be pointed out that, though the teacher-examiner system once obtained to some extent in the British Isles, it has almost entirely been abandoned. As Lord Sherbrooke used to remark, "Teachers no longer sample their own goods." Their doing so led, I think it cannot be doubted, to serious abuses, the possible nature of which is sufficiently obvious. Even in the English Universities, some of the Colleges practically had the entire control of the education of their undergraduates ; but they deliberately abandoned this exclusive privilege, and handed over the business of testing the performance of their pupils to their respective Universities ; in other words, they intrusted the business of sampling their goods to those who had nothing to do with their manufacture. The Scotch Universities most closely approximated to the German system ; but here, again, external examiners have been introduced, who undoubtedly were intended to act as a check upon the Professors and their teaching.

It can thus, I think, be shown to demonstration that the system which obtains in Burlington Gardens is not really so anomalous as it is made to appear. The teacher-examiner cry is, then, of the nature of a reaction ; and though to a certain extent I am not without sympathy with it, I am not sure that, on the whole, it is not a mischievous reaction.

Now, when a great institution like the University of London is attacked, one attaches naturally some importance to the quarter from which the attack comes. I quite admit that the University, perhaps from an excessive sense of its own dignity, has rather allowed the case against it to go by default, and has done little in its own defence. But the world outside may judge for itself. I am prepared to contend that there is no examining body in the world which does its work in a more efficient and conscientious way. Its examination rooms are crowded ; it commands the services as examiners of the most distinguished teachers of the country ; and whether in science, law, or medicine, amongst those who have successfully submitted to its ordeals are to be found the names of some of the most distinguished men of the time. It seems clear, then, that the attack on the University would not come from either the students or the public. It can hardly be doubted that the latter is more than satisfied. When parents allow their sons to embark in

University studies, they like to get something tangible as a result ; and in a degree at Burlington Gardens they undoubtedly do get something the value of which is generally accepted.

The complaint comes, however, from the teachers ; and this not in the provinces, but in London alone. Their case was put before the Commission by Prof. Lankester in a very striking and able way. I do not doubt that his evidence has produced a very powerful effect. But having studied it, I am bound to say that, having been a graduate, an examiner, and a member of the Senate of the University, I cannot accept all he says as giving a fair account of the inner working of the system. The burden of his complaint is that the teacher is unreasonably fettered in giving the best and most modern kind of teaching by the restrictions imposed upon it by the University. In so far as there is ground for the complaint, I think it admits of remedy. But I cannot refrain from remarking that the provincial teachers who send candidates to the London examinations—and who, I suppose, are not, on the average, less competent and enthusiastic than their London colleagues—do not, as far as I can ascertain, in any way sympathize with their complaints. On the other hand, Prof. Lankester was for ten years an examiner in the University, and when he last left office I am much mistaken if he had not succeeded in moulding the curriculum in his subject practically into entire accordance with his own views. And even under the system as it exists I observe in his evidence that he admitted to Sir William Thomson, that "a teacher may, with judiciousness, of course, and common-sense in his teaching, teach the best that he knows."

I cannot keep feeling, then, that in the outcry raised by some of the London teachers there is something a little unreal. The existing system neither works so badly, nor is it in itself so bad, as it is represented to be.

The Privy Council, however, appears to have thought differently, and has set itself to the task of creating a Teaching University for London. And this is what Parliament is asked to sanction. The fatal objection to the scheme is that the title is a misnomer ; the proposed University is, as I have already pointed out in *NATURE*, in effect, no more a Teaching University than the existing institution.

It is perfectly clear that by a Teaching University is meant, by those who understand what they are talking about, a University of the German type, governed and administered throughout by the professorial body. If I understand his views, this is the solution of the difficulty which Prof. Karl Pearson desires. I am far from saying that I am opposed to the establishment of such an institution. It would certainly be an interesting experiment, and it might be a great success. It might be created out of University College standing alone ; and for my own part I have always wondered that that distinguished place of study has never sought such a transformation. It would, of course, require a profound reconstruction of its constitution, and the total elimination of what may be called the lay element in its government. Or it might be effected, though with more difficulty, if University and King's Colleges could be induced to fuse. Prof. Lankester contemplated such a possibility ; but it is probably as hopeless as to try to get anything but an emulsion out of oil and water.

The organization of such a Teaching University is not without its drawbacks, and I am not at all sure that London would be the best seat for one. The system is only a success in Germany because Universities are very numerous, and the number of students in each for the most part not very large. The essence of the system, as I understand it, is the close personal contact of teacher and student. Each gets saturated, so to speak, with the other ; at the end of the curriculum the Professor knows, or thinks he does, all that the pupil has acquired, and

gives him his degree accordingly. I paint the picture in its most attractive colours. And for pupils of a certain type I believe the system to be excellent. But for the large majority I am not so sure; and I think that under such a system a little independent examination would often act as a considerable surprise both to teacher and taught.

It seems to me that the fact is often lost sight of that education in all its forms is rather a tedious business. What the teacher has to deal with are not merely the enthusiastic few who march with joy alongside their instructor, and scarcely see the obstacles that bestrew the path, but the large mass, headed at the best with stolid industry in front, to tail off with incorrigible straggling behind. Here the discipline of the examination-room, backed by parental wrath at failure, seems to me well-nigh indispensable. Even in such cases as these, no doubt personal contact with the teacher can do much; but then the classes must be small. The limit is soon reached when the individual powers of the teacher, however energetic, are reduced to a vanishing quantity. I have found myself that in a class of forty I reached the extreme limit on which I could hope to produce any effective direct impression. Frankly, I do not believe that for large classes, such as might be expected in London, the teacher-examiner system has any merit at all. I think myself that, if the teacher directs and organizes the teaching to the best of his powers, he may, with distinct advantage, leave the testing of the results to other hands. I know that this is what I should prefer myself; and I speak with the experience of a man who has spent, and not wholly without success, some of the happiest years of his life in the work of teaching.

But I certainly agree that the teacher should have something to say in the business of examining. He does, in London, already have a good deal to say as a matter of fact, but very indirectly. I would remedy this by giving all teachers of University rank a definite status in the University.

The bare statement of the fact that the University of London is merely an examining body does very inadequate justice to the work it has accomplished. It has undoubtedly stimulated and disciplined the studies of vast numbers of persons whom the older Universities would never have touched. And it has reacted on the teaching given in London and elsewhere by insisting on a progressively high standard. The educational influence has been consequently far-reaching, and in my judgment not small. This is effected by the schedules or syllabuses which are prescribed by the Senate and from time to time are varied as the progress of instruction in each subject makes change desirable. It is notorious that by this means the University of London has compelled the teaching bodies which send it candidates to develop the efficiency of their methods of instruction.

I am quite prepared to admit that in theory the machinery by which this result is brought about is not perfect. But in practice, like so much else in this country, it works tolerably well. In some of the evidence given before the Commission it is almost implied that the Senate draws up the schedules itself. But, having been both an examiner and a member of the Senate, I know something of the process. Generally speaking, it is something like this. An examiner finds that an existing schedule is scarcely in touch with the best current teaching. He communicates his opinion to the Senate, and suggests alterations. The Senate generally calls to its assistance one or more of the past examiners in the subject, and also any persons of acknowledged competence whose judgment will probably lead them to a right decision. The result is that, if the alterations proposed by the examiner are found to meet with general approval, they are adopted. In time the process is repeated; and probably no year ever passes without

something of the kind being done. Practically, the work is well done, and the general esteem in which the degrees given at Burlington Gardens are held appears to me a tolerable proof of the fact.

It is evident that what I have described is accomplished by what may be called semi-official means. I should prefer myself to have it done by a more definite organization. If Faculties were constituted in the University, the most experienced teachers might meet to settle the schedules in the best possible way. Even then some would probably not be wholly satisfied; but they would have at least the opportunity of explaining their views to their fellow-teachers, and, if reasonable, it is improbable that they would not meet with some recognition.

Another very important result would flow from the organization of the Faculties. One of the absurdest things about the proposed Charter is that, apart from medicine, except University and King's Colleges, it ignores the existence of any other educational institutions which either at present exist, or are certain hereafter to be created, for the educational needs of so vast a city as London. A great evil at the present time is the isolation of such institutions. They do not recognize each other's existence or work in any way in conjunction. If their teachers, under the *agis* of the central University, could be brought together to confer on educational matters, it can hardly be doubted that instruction in London would be better organized, gaps filled up, and wasteful overlapping obviated. All this might be done without any interference with the autonomy of the separate institutions, and by men exchanging ideas in conference and discussion.

There is one point on which the new Charter has been attacked with which I do not in any way sympathize. The inclusion of King's College in the proposed University is objected to on the ground of its being a denominational institution. But in Australia and Canada the association of denominational Colleges with the Universities is found a simple and effective solution of difficulties which for a long time will probably be insuperable in any other way. One of the most interesting things in the history of English Universities in modern times has been the removal to them of Nonconformist Colleges. For my part, I can see no possible objection to their being admitted ultimately to full University privileges. If the new University is to be accepted, it is idle to object to the admission of King's College, or to demand that it should abandon its characteristic features as the price of admission.

To sum up the position. The present University is denounced because it fetters the teaching and is not in touch with it: this turns out to be rather a matter of form than of fact. To remedy this a new Examining University is to be created, on much the same lines as that already existing, which in its turn is to be allowed to go on exactly as before. Surely, in the whole history of the reform of institutions, nothing so futile was ever proposed.

The real academic need of London is left perfectly untouched. This is the organization of the higher University teaching. I am more and more convinced that a distinction ought to be drawn between what may be called ante-graduate and post-graduate study. The former, leading up to the ordinary Bachelor's degree, may very properly be left to the Colleges. More than this, without a vast increase of endowment and staff, I do not see how they can accomplish. I regard a student who has taken his Bachelor's degree as having learnt the technical language of his study. He may then, in a considerable number of cases, devote himself to original inquiry. And this the University of London encourages him to do, as examination is no longer compulsory for the Doctorate. It may be, and in fact is, obtained by original work embodied in a thesis. I confess I should like to see the University of

London provided with a body of superior Professors, who would not merely add to its distinction by their own labours and public instruction, but would guide the studies and researches of the young graduates. With the right men for Professors, and such picked students as the vast area of London would supply, I do not doubt that the reputation of the University of London would at no distant date rival that of any in the world. I hope Prof. Karl Pearson will forgive me if I appropriate in this connection a portion of his letter in the *Academy* of December 19:—

"The professorships ought to be the best in England, and the chief posts, at any rate, might remain in the gift of the Crown; the laboratories and libraries ought to be the best equipped in the Kingdom, and the University ought to draw students and investigators, not only from the five millions of London, but from the Greater Britain over the seas. Such a University would not only be able to retain in London men like Burdon-Sanderson, Seeley, Gardiner, Sylvester, and Lankester, but it would bring others there."

With the main idea expressed in these words with so much enthusiasm I most heartily agree. But I think those understand their countrymen and the possibilities of things best who would use, as I would, the existing University as a foundation. It has deserved well of the State; it has done its appointed work in the past well: instead of abusing it, we should strive to remove its defects, and give it higher work to do.

Two possible objections to my proposition may be considered. It may be said that such professorships are not wanted in London because such professorial teaching is supplied by Oxford and Cambridge. My reply is, that only a small portion of the population pass through those Universities, and London would draw from a much larger field. Again, it may be objected that the Professors of the existing teaching institutions in London would object to the creation of posts of a superior grade. On the other hand, such posts might stimulate ambition; they would be the prizes of the academic career. To object to them seems to me as reasonable as for a stuff-gownsmen to object to the existence of judges, or for a curate to that of bishops.

The depletion of London of its most distinguished teachers, which continually goes on, is a real loss to its intellectual life. Dr. Dollinger says:—

"The force which moves the world, that which brings on the important crises in the history of mankind, is not to be found in material interests and passions, but in the great ideas which it is the business of Universities to work out."

Why should London, of all places in the world, dismiss from its midst, as it has long continued to do, those whose gift it is to open up most successfully new territory in the unknown world of knowledge? Yet the depletion goes on. Not one of the five officers of the Royal Society is at the moment resident in London. The President attends its meetings from Glasgow, and the Senior Secretary from Cambridge.

I must say a word about Gresham College. The promoters of the Albert University, whose untiring energy would be invaluable in a better cause, have, no doubt, done a clever thing in securing the adhesion of this obsolete institution to their scheme. Years ago I attended one of the prelections with two friends. The Dean of Manchester favoured, very unwillingly, an audience composed of ourselves and a few casual passers-by, whipped in apparently by the beadle, with a demonstration of Euclid I. 47, in the Latin tongue. Yet the institution which had descended to this mere husk of formality had once, if tradition is to be believed, been one of the most famous seats of learning in the world, and Francis I. is said, in emulation of it, to have founded the Collège de France in Paris. I believe the present Gresham Professors

are not quite so sleepy as they were; but the contrast between the two rival institutions is more than melancholy. That Gresham College can nowadays clothe its dry bones and live is more than doubtful. It is, no doubt, only too glad to undertake the "teaching" department of the new University, which proposes to carry on its examining work in the empty building in Basinghall Street.

Kew, February 20.

W. T. THISELTON-DYER.

A PRELIMINARY STATEMENT OF AN INVESTIGATION OF THE DATES OF SOME OF THE GREEK TEMPLES AS DERIVED FROM THEIR ORIENTATION.¹

MR. LOCKYER has made out I think quite satisfactorily that the Egyptian temples were so oriented that the rising or setting of some conspicuous star on or near the axis of the temple, and visible from the adytum, would give warning of sunrise; and he applied to me for particulars of Greek temples for the purpose of seeing if there was any analogy, and the comparison appeared to promise a favourable result. Mr. Lockyer had found, before he had proceeded far in these studies, that he had been anticipated to a considerable extent by Herr Nissen, of Bonn, who has published several articles on the subject in the *Rheinisches Museum of Philologie*, and has brought within his scope both the Egyptian and the Greek temples. There is room, however, in the inquiry for a distinct work on the Greek temples, and especially with the help of more exact measurements of the orientation angles than Herr Nissen has made use of; as he appears to have contented himself with magnetic bearings—which are liable to considerable local variations, which are sufficient in an inquiry like the present to vitiate many of the conclusions that may be founded on such measurements—and there is a want of recognition of the influence of an elevated horizon. I had taken, in several instances, astronomic observations with a view to the more exact orientation of different temples, but something more is wanted even in the case of most of these—namely, the apparent altitudes of the mountains in the directions of the axes of the temples. I wish also to add that, but for Mr. Lockyer's suggestion, I should probably not have carried the inquiry further than I already had done.

The great value of the inquiry lies in this: that it offers a means of determining, within tolerably close limits, the date of the foundation of a temple—not, perhaps, in most cases (although in some I believe it does) of the very structure which we now see, but of an earlier foundation on the same site. The key to the chronology lies in the movement of the stars with reference to the local horizon, owing to what is called the precession of the equinoxes. The object the ancients had in using the stars was to employ their rising and setting as a clock to give warning of the sunrise, so that on the special feast days the priests should have timely notice for preparing the sacrifice or ceremonial, whatever it may have been:

"Spectans orientia solis
Lumina rite cavis undam de flumine palmis
Sustulit," &c.

The inquiry, even in its present state, is sufficient to establish a very high probability that the principle is a true one. There is nothing vague about it. It has to be kept within very severe limits, and it holds good nevertheless.

No stars can be accepted except from among the brightest, unless conspicuous star groups may have been used instead. Again, of single stars, only such can have been used for orientation in Greek temples which during

¹ Being the substance of a paper read to the Society of Antiquaries on February 18, 1892.