a speaker to be so felicitious in the choice and treatment of his theme. We trust that our readers will pardon us for saying, that by the kindness of the lecturer we were able, at the close of his discourse, to distribute the number of *Science* in which it was printed.

We are inclined to think that the custom which puts the president's address in the evening is unwise. It is usually an elaborate essay, depending for its interest more on its matter than on its style; though, in this, style and matter were both excellent. Sometimes, as at the present session, very close attention must be given by ordinary listeners if they would seize the points of the discourse. Why should this lecture be given in the evening, when everybody is tired, when the gas augments the solar heat, and when many are impatient for the social entertainment which is to follow? Why should it not be delivered at a morning session?

So far as the daily newspapers came under our eye, there seems to be a great falling-off in their abstracts of the papers. The reporters seem to be in despair as to what to select from the superabundance of material, and in many cases their choice is hap-hazard. Indeed, it is very difficult for any one to determine from the programme what will be of most interest, or exactly when particular papers will be read. Some 'sifting' or 'grinding' committee seems indispensable to eliminate such papers as are for any reason inappropriate to these gatherings. There should be a survival of the fittest, and the rest should disappear.

We trust the day will come when it will be considered the mark of a bad education to read or speak indistinctly in public, — when bad utterance will be as great an offence against the usages of good society as bad grammar or bad spelling. More than one speaker in Philadelphia has thwarted his own purposes by his low, inarticulate, or suppressed vocalization. Instead of awaking an interest, he has smothered it. Why should college professors speak so poorly as many of them do?

So far as our observations go, the most useful meetings of the sections appear to be those in which a discussion is provoked upon some interesting question, not necessarily on a new point. For example, such debate as took place in the mechanical section, on instruction in mechanics; or that in the physical section, on thunderstorms; or as that proposed in the chemical section, on the best methods of teaching chemistry, — are valued by all who are present, more, even, than elaborate papers which can hardly be appreciated until they are printed.

The 'special committees' of the association did not appear in a very efficient aspect, when the long list of them (eleven in number) was called Monday morning, with but one written and two oral responses. We may also add, that better modes of promoting the work of the association can be devised than these 'general sessions,' which consume the best hour of the morning, and really accomplish very little good.

The number of members enrolled as present, up to Tuesday morning, was 1,157; and many more have since arrived. The members of the British association have been received with great cordiality; and every proposal to continue the friendly relations which have been fostered this summer, and all proposals looking toward an international scientific congress, are received with great favor.

As a whole, we are sure that the Philadelphia meeting is one of the best, if not the very best, which has ever been held.

COLLEGE MATHEMATICS.[1]

PROFESSOR EDDY announced as the subject of his address, the present state of mathematical training in our colleges; its aims, its needs, and its relations to education and to scientific research. It is an article of faith firmly held and oft expressed by the undergraduate, that higher mathematics is a study which can be thoroughly mastered only by exceptional geniuses. One very bad feature in this state of things is, that this sentiment respecting mathematical study is not confined to undergraduates, but is largely shared, not only by the faculties in general, but by the instructors and professors of mathematics as well.

There are various reasons which have led mathematical teachers to this opinion, besides the ill success that has attended their efforts with their pupils. It must be admitted that, too often, the instructors themselves have not become engrossed in their studies, perhaps not even interested in them. That we have in this country no large body of men whose life-work has been, day by day, directed in the line of mathematical investigation, is evident to all. The paucity of important mathematical investigations emanating from this side of the Atlantic is proof of it. But even where the professorial chair is filled by an eager and brilliant mathematician, he often feels the hopelessness of initiating his pupils into this all-absorbing realm of thought in the few brief months at his disposal. Thus it has come to pass, that the study has been used simply as a form of mental discipline or intellectual gymnastics: the object sought

[1] Abstract of an address to the section of mathematics and astronomy of the American association for the advancement of science, at Philadelphia, Sept. 4, by Prof. H. T. Eddy of the University of Cincinnati, vice-president of the section.

was not to learn how to use this the most splendid instrument of intellectual research yet devised by the wit of man.

There is an underlying consciousness running through the whole scheme of education based upon classical study, that the objects of such study are not in themselves of vital importance to the student, but that their value is chiefly to be found in the reflex influence upon the person submitting to its discipline. Pretend to deceive ourselves as we may upon this point, the undergraduate feels this with every breath of his young life. Professor Eddy did not take the position that classical study is in itself a delusion, nor that the ancient languages and philological science are not most worthy and inspiring objects of study for those who really intend to know something of them, or for those whose tastes and capacities fit them for their pursuit; but that this demoniacal spirit of study for the sake of discipline, which possesses our colleges, must be cast out before they can rightly train classical scholars, or stand where they should stand in the forefront of higher culture in the liberal arts: and this by the introduction of a spirit of study very different from the disciplinary spirit,—a spirit which, for the lack of a better name, we may call the scientific spirit; a spirit of sincere and earnest inquiry after knowledge.

There is apparently no reason why the spirit which so largely animates scientific study should be confined to that kind of study, for it is not the nature of the study which determines the spirit in which it shall be pursued. Mathematics is a case very much in point in this regard. The truth is, young men of spirit will not shirk hard work, if they are convinced that by it they can open up any fair field of knowledge which appears desirable. And the speaker said, that, under such influences, he had seen students gain, during the first half of their college course, such familiarity with those branches of higher analysis which are the common groundwork of modern investigation in analytical mechanics and mathematical physics, as to have really open to them the literature of these subjects; and this not in isolated instances merely, but with class after class. It is popularly supposed, as before stated, that the number fitted by nature for mathematical study is small. Such, Professor Eddy has been convinced against his preconceived opinions, is not the fact. It is a study as much sought after, and pursued as eagerly, as any other branch of liberal study; provided only that the teachers thereof are themselves men who have a live interest in the subject, are capable, patient, and apt at giving instruction.

Professor Eddy then discussed somewhat more in detail the scope of mathematical instruction in college. The geometry of Euclid, which should be relegated to the schools, has long held a part of honor in the mathematics of the college course. The cause for this is easily seen. It is a subject which lends itself, more readily than any other branch of mathematics, to the form of discipline in vogue. It certainly is a matter of vastly more importance as a piece of mathematical training, to have the student of Euclid acquire the habit of discovering for himself the demonstration of new propositions, than that the study of Euclid should be made a huge memoriter exercise, as is usually done in college. The clear apprehension of geometrical relations, aside from the language describing them, is of the first importance, and may be cultivated by any work which deals with such relations.

Several other mathematical subjects could well be covered before entering college. These are the elementary parts of algebra, the numerical solution of plane triangles, the practical use of logarithmic tables, and the elementary ideas of analytical geometry. The field would then be cleared, so that the training in all those forms of analysis which are distinctively modern, and which must needs be taught by men in sympathy with its methods, would fall within the years of the college course.

Objection may be made to the amount of mathematical preparation which it is here proposed to put into the schools.

But what ought the actual scope of mathematical instruction to be during the college course?

It seems superfluous to say, that, without the mastery of the infinitesimal calculus, any mathematical culture of importance is hopeless; and that a knowledge of its methods, accompanied by facility in their employment, is absolutely essential to the understanding of the exact sciences.

Calculus is not omitted from the scheme of study of any classical college in this country; but it is hardly too much to say, that, so far as any real knowledge of it is concerned, it might as well be omitted from them all.

The text-books in use are of such very elementary and defective character, that no sufficient knowledge of the subject can be obtained from them. They are constructed on the plan of omitting almost every thing which may present any special difficulty. It has been in effect assumed by those imbued with the disciplinary spirit, that a knowledge of this subject could be conveyed to the student by daily recitation upon its principles and developments. This is as useless an attempt as to try to prepare an army for the battle-field by a daily lecture instead of a daily drill, or by explaining tactics instead of practising them. The important processes actually employed in calculus are not so very numerous, nor are they especially difficult to acquire. No real use, however, can be made of its methods until these are acquired. It must often happen that the full significance of such processes is not apprehended until long after they are employed with dexterity. Certain it is that such dexterity and familiarity conduce wonderfully to their correct comprehension.

The daily marking system is perhaps the most characteristic and most pernicious expression of the college disciplinary spirit. How have the evils of that system been intensified in our larger colleges by the wholesale manner in which the work is done! The work of recitation and instruction can, no doubt, often be advantageously combined; but what is the probability that valuable instruction will be commu-

nicated during the hour to which the exercise is confined, when the number of students in the recitation-room is thirty, forty, or even fifty? What a perversion of the purposes of the noble endowments for higher education, to expend almost the entire energy of the teaching force of the many institutions which adopt this system, in a daily effort to weigh with minutest accuracy the fidelity with which assigned tasks have been committed to *memory!* The most diverse views may be entertained as to whether the college course can embrace analytical mechanics, or the theory of determinants (now so universally used), or whether it can omit vector and quaternion analysis. When, however, it is known that in a small western college graduating less than a dozen annually, we have now had for years volunteer classes, pursuing all these and other subjects annually, with success, the possibility of including them in a college curriculum must be acknowledged.

In conclusion, Professor Eddy wished to call for reform in our mathematical teaching. Let it not be so conducted that he who has neither taste for the study, nor special knowledge of it, stands on an equal footing as a teacher with the man of real mathematical insight. Now is a favorable time for revising our estimates of what can and ought to be done in this field. Higher mathematical culture has commenced a new and fruitful growth in this country in various places; and an association of the mathematicians of this country might be of service for the purpose of concerted action in improving the mathematical training in our colleges.

WHAT IS ELECTRICITY?[1]

ALL Professor Trowbridge hoped to do was to make his audience ask themselves the question with more humility and a greater consciousness of ignorance. We shall probably never know what electricity is, any more than we shall know what energy is. What we shall be able, probably, to discover, is the relationship between electricity, magnetism, light, heat, gravitation, and the attracting force which manifests itself in chemical changes. Fifty years ago scientific men attached a force to every phenomenon of nature: thus there were the forces of electricity and magnetism, the vital forces, and the chemical forces. Now we have become so far unitarian in our scientific views, that we accept treatises on mechanics which have the one word 'Dynamik' for a title; and we look for a treatise on physics which shall be entitled 'Mechanical philosophy,' in which all the phenomena of radiant energy, together with the phenomena of energy which we entitle electricity and magnetism, shall be discussed from the point of view of mechanics. What we are to have in the future is a treatise which will show the mechanical relation of gravitation, of so-called chemical attracting force, and electrical attracting force, and the manifestations of what we call radiant energy. We have reduced our knowledge of electricity and magnetism to what may be called a mechanical system, so that in a large number of cases we can calculate beforehand what will take place, and we are under no necessity of trying actual experiments. It is probable, for instance, that the correct form of a dynamo-machine for providing the electric light can be calculated and the plans drawn with as much certainty as the diagrams of a steam-engine are constructed. We may congratulate ourselves, therefore, in having a large amount of systematic knowledge in electricity: and we see clearly how to increase this systematic knowledge; for we have discovered that a man cannot expect to master the subject of electricity who has not made himself familiar with thermo-dynamics, with analytical mechanics, and with all the topics now embraced under the comprehensive title of 'physics.'

Out of all the theories of electricity, the two-fluid theories, the one-fluid or Franklin theory, and the various molecular theories, not one remains to-day under the guidance of which we are ready to march onward. We have discovered that we cannot speak of the velocity of electricity. All that we can truly say is, we have a healthy distrust of our theories, and an abiding faith in the doctrine of the conservation of energy.

It is one thing to become familiar with all the applications of the mechanical theory of electricity, and another to make an advance in the subject so that we can see the relations of electrical and magnetic attraction to the attraction of gravitation and to what we call chemical attraction. To this possible relationship, Professor Trowbridge wished to call attention. The new advances in our knowledge of electrical manifestations are to come from the true conception of the universality of electrical manifestations, and from the advance in the study of molecular physics. When we let an acid fall from the surface of a metal, the metal takes one state of electrification and the drop of acid the other: in other words, we produce a difference of electrical potential. On the other hand, a difference of electrical potential modifies the aggregation of molecules. The experiments of Lippman are well known. He has constructed an electrometer and even a dynamo-electric machine which depend upon the principle that the superficial energy of a surface of mercury covered with acidulated water is modified when a difference of electrical potential is produced at the limiting surfaces. The manifestations of what is called superficial energy, — that is, the energy manifested at the surface of separation of any two substances, — and the effect of electricity upon the superficial energy, afford much food for thought. There have always been two parties in electricity, — one which maintains that electricity is due to the contact of dissimilar substances, and the other party which believes that the source of electrical action must be sought in chemical action. Thus, according to one party, the action of an ordinary voltaic cell is due to the contact, for instance, of zinc with copper; the acid or solution of the cell merely acting as the connecting

[1] Abstract of an address before the section of physics of the American association for the advancement of science, at Philadelphia, Sept. 4, by Prof. JOHN TROWBRIDGE of Harvard college, Cambridge, vice-president of the section.