the best. It is as Carlyle has said of the tragedy of ignorance:

It is not because of his toils that I lament for the poor; we must all toil, or steal (howsoever we name our stealing), which is worse; no faithful workman finds his task a pastime. The poor is hungry and athirst; but for him also there is food and drink; he is heavy laden and weary; but for him also the Heavens send Sleep, and of the deepest; in his smoky cribs a clear dewy heaven of Rest envelopes him, and fitful glitterings of cloud-skirted Dreams. But what I do mourn over is that the lamp of his soul should go out; that no ray of heavenly, or even of earthly knowledge should visit him; but only in haggard darkness, like two spectres, Fear and Indignation bear him company. Alas, while the Body stands so broad and brawny, must the Soul lie blinded, dwarfed, stupefied, almost annihilated? Alas, was this, too, a Breath of God, bestowed in Heaven, but on earth never to be unfolded?—That there should one Man die ignorant who had capacity for knowledge; this I call a tragedy were it to happen more than twenty times in the minute, as by some computations it does. The miserable fraction of Science which our united Mankind, in a wide Universe of Nescience, has acquired, why is not this, with all diligence, imparted to all?

Mr. President: Assured as I am of the loyal support and cooperation of the board of regents, faculty, students, alumni and citizens of this great state of Kansas, at the same time realizing the full weight of its responsibilities, and conscious of my own limitations and weakness, and pleading for both charity and patience, I accept the high office of president of the Kansas State Agricultural College. May He who marks the sparrow's fall take us all into His keeping and guide our thoughts aright.

PHYSICS TEACHING IN THE SECONDARY SCHOOLS OF AMERICA[1]

WE understand the present fully only in the light of the past. Hence, if we would grasp the meaning of the present situation so clearly as to be able to see the way out, we must first study the history of science teaching in America.

Mathematics has had a long and an honorable academic career. But the natural sciences are relatively new as subjects of formal instruction in schools. Although physics appears to have been taught to freshmen at Harvard for two fifteen-minute periods a week as early as 1670, the sciences do not appear on the list of subjects required or accepted for entrance to college until the year 1870, when Harvard added the elements of physical geography to its list. Physics appeared in 1876. The demand for popular and useful studies had led the academies to introduce the sciences of geography, natural philosophy and astronomy early in the nineteenth century. The colleges did not recognize these, however, till about fifty years later.

When we remember that the academies were founded in response to a popular demand for an education that should train boys and girls so that they might be useful members of the community, we see: (1) That the sciences were brought into the schools for their practical utility; (2) that the colleges followed the schools in their recognition of the value of science after an interval of about eighty years, and (3) that science was introduced into the schools in response to a demand on the part of the people who supported the schools and in spite of the colleges.

In order to make clear the subsequent development, I shall consider largely the subject of physics, partly because physics has been more prominent in the schools; partly because I am better able to follow its changes with sympathy; and also because I believe that the history of physics is typical of that of the other sciences. Let us then glance at the methods of teaching physics in 1876 when that science

[1] Address delivered at the conference of the University of Illinois with the secondary schools of Illinois, November 19, 1909.

made its début among the subjects required for admission to college.

We can get a very good idea of what was taught under the name of physics by examining some of the books used for texts like Comstock's or Wells's "Natural Philosophy," or Rolfe and Gillett's "Handbook of Natural Philosophy." This latter work was the one specified for use in preparing for the entrance examination at Harvard, so we will use it for purposes of comparison.

The Rolfe and Gillett contains two hundred and thirty pages, exclusive of the appendix which was not required. The modern texts, Millikan and Gale, Adams, Mann and Twiss, contain, respectively, 482, 478 and 456 pages; on the average, an increase of over 100 per cent. In like manner the number of numbered paragraphs in the required portion of the Rolfe and Gillett is 351; that in the modern texts just mentioned is 614, 560 and 416, respectively, an average increase of about 50 per cent. It thus appears that the amount of subject matter that has been crowded into the course has been very materially increased. It is a noteworthy fact, however, that this increase consists in the addition of new topics rather than in the change of old ones for new, *i. e.*, the old course given in 1876 contained only the necessary elements of any course, because modern developments have failed to displace them.

The first great change that has taken place since physics became a college entrance subject has been this great increase in number of topics considered necessary for the course. The present course is acknowledged on all sides to be badly overcrowded. Can any teacher make twenty or more pupils master or even learn thoroughly and clearly understand 614 numbered paragraphs, each containing, by reason of being numbered, a new idea or principle, in 180 forty-minute periods? This means just eleven minutes and 43.6 seconds to a paragraph—and this interval must include all the discussion, problems, experimental demonstrations, quizzes and laboratory work. Is it a wonder that teachers who attempt this do not succeed? And this without reference to the content of the paragraphs. Under such conditions it is far less remarkable that 70 per cent. of the applicants fail on the written examination of the College Entrance Board than it is that 30 per cent. pass.

Are the college entrance requirements responsible for this overcrowding of the time allotted to the course? This is a leading question and it may be answered by either yes or no, according to the interpretation put on it. If you treat it as a legal question, as a question of whether "it is so stated in the deed" or not, the answer will be an unequivocal no. The early Harvard requirements and the definition framed by the National Educational Association and that issued by the College Examination Board have never contained any syllabus of topics required. Hence this superabundance of topics is not written in the deed and the college requirements are not to blame. There is one exception to this statement and that is New York University, which has issued a syllabus of required topics. This syllabus is a model of logical arrangement, but is at least twice as long as any syllabus for a one-year course in physics should be.

Well, then, if the college requirements are "not guilty" in the documentary sense, what has been the source of the congestion? It is, of course, impossible to lay all the blame on any one thing, because the conditions under which this overcrowding has developed have been so complex. All will agree, however, that the first cause is to be found in the fact that the science itself has made such rapid progress since 1876. This development of the science has been paralleled by a remarkable growth of the spirit of scientific research and a large increase in the number of specialists in physics who are devoting their entire time to investigation in this field alone. Add to this the attitude of the universities toward research in that they demanded research work of their physicists as a prerequisite to academic promotion, and you have all the elements necessary to crowd more and more subject matter into the preparatory course. The teachers in the schools caught the spirit of the universities, and all hands turned to a well-intentioned but, as it has proved, a futile effort to introduce into the elementary course as much of the precision, the rigor and the abstraction of the research laboratory as was possible. The highly specialized science of physics became king and the abilities and needs of the pupils were lost sight of.

This development was fostered by text-book writers, publishers and apparatus dealers. Every new text had to go its competitors one better in the matter of being "up-to-date," in order that the publishers' agents might have new "talking points" with which to allure the unwary superintendent or school-board member. No publisher would print a book that did not contain accounts of all the recent discoveries and a few more, because the publishers had found out that teachers would turn down a book because it did not contain X-rays or wireless telegraphy, ions, electrons or radium. Up-to-date-ness was considered the first virtue.

Another example of this increase in the amount of subject matter may serve to leave this first point clear in mind. The 1888 edition of Gage's "Introduction to Physical Science" contains 340 pages and 321 numbered paragraphs. Under the pressure of up-to-date-ness, Gage wrote an enlarged book called the "Principles of Physics," and the latest revised edition of this book, 1907, contains 529 pages and 562 numbered paragraphs. Thus we see that, although the abilities and tastes of the pupils have remained fairly constant, and although little effort has been made to prepare them for the work by teaching more elementary physical science in the grammar schools, the amount of subject matter that we are trying to teach them in the same time has increased from 50 to 60 per cent. This increase alone is enough to make it impossible for the teacher now to do thorough work, without regard to the nature of the topics added or to the content of the subject matter. This one thing is enough seriously to have impaired the efficiency of the science work.

Nevertheless, this increase in the amount of the subject matter is by no means the only factor that has been at work in rendering the science teaching less effective than it might be. When we compare the subject matter taught thirty years ago with that in the modern texts as to content, we find again a marked contrast.

Thus by comparing the topics under "a" in the index of the Rolfe and Gillett with those in the index of the latest of the new texts, that of Adams, I find but two topics in the former not treated in the latter; and thirty in the new book not found in the old. The old topics omitted are *annealing* and *artesian wells*. The most important new topics introduced are *aberration, chromatic and spherical; absolute temperature, absolute units, acceleration, air thermometer, alternating currents, ammeters, astigmatism, Atwood machine*. These few give an idea of the sort of things that have been added. A similar proportion holds for the rest of the indices.

It will be noted that the topics omitted in the new book are of the "practical" type—annealing and artesian wells, while most of those added in the new book treat of unfamiliar subjects not likely to be met with outside the physics laboratory—spherical aberration, absolute temperature, absolute units, air thermometer, Atwood machine—topics of a highly specialized type demanding the use of abstract, difficult, and to the pupils, unusual ideas for their mastery. When we recall that the teacher has just 11 minutes and 43.6 seconds in which to make each topic clear to a class of twenty or more, we need not be surprised that the students find the subject unintelligible, and that they carry away only a rather confused jumble of words in the place of clear, definite and usable ideas.

Because these technical topics are unfamiliar, the student does not see their use or value—and many of them are useless to the majority of the pupils—so they have no significance to him, and hence he has no motive that impels him to study them with enthusiasm.

An example may help to make this point clearer. In the early editions of Gage the problems are of this type: "What amount of work is required to raise fifty tons of coal from a mine two hundred feet deep?" "Twelve hundred foot-pounds of energy will raise a one-hundred-pound boy how high, if none of it is wasted?" In the most recent books we find problems like this: "How much work is done in lifting a 10 kg. mass vertically 180 cm.? Give the answer in kilogrammeters, in ergs and in joules." "What force in dynes will lift a mass of five kg.? How many ergs of work are done in lifting a mass of 5 kg. 20 cm.?" "A pull of one dyne acts for 3 seconds on a mass of one gm. What velocity does it impart?" Or again, in the Rolfe and Gillett, Newton's second law of motion is stated thus: "A force has the same effect in producing motion, whether it acts on a body at rest or in motion, and whether it acts alone or with other forces."

The modern text states this: "Rate of change of momentum is proportional to the force acting, and takes place in the direction in which the force acts." If we did not understand Newton's law, but were trying to learn it for the first time, which of these statements would be the more intelligible? Which would leave us with the clearer and more usable idea? The latter statement has been introduced for the sake of greater rigor; but taking it simply as an English sentence, have we gained in rigor by making the student memorize the statement that a *rate of change* takes place in a certain *direction?* This statement of the law is what Carl Pearson in his "Grammar of Science" calls a metaphysical summersault. And have we not thereby converted the old and valuable "science of things familiar" into a "nescience of things familiar"?

Hence the second important fact in the development of the teaching of science is that we have not only added to the number of topics to be learned, but have also changed the content of the old topics so as to render them almost, if not entirely, unintelligible to beginners. Any one who has taught classes of teachers in a summer school, or has visited elementary classes in physics, must have noticed that many of the "laws and principles" of physics, as they are expounded in the modern texts, are none too intelligible to many of the teachers themselves. How then can we expect to have the pupils leave their work with clear, definite, usable ideas? This change in the content of the ideas presented, or of the point of view from which the phenomena are now presented, would alone account for the decrease in the success and efficiency of physics teaching in the past decade. Elementary physics has lost much of its pragmatic value and become somewhat rationalistic because of its devotion to various and sundry "absolutes."

But besides the increase in the amount of subject matter and the "absolute" unintelligibility of some of it to beginners, there is a third great and important fact in the history of physics teaching in America. This fact is that the method of presenting the subject has changed in several important ways. We can get a good idea of the condition of physics teaching in the secondary schools in the seventies from two bulletins that were issued by the National Bureau of Education in 1880 and 1884, respectively. The first was edited by Professor F. W. Clarke, of the University of Cincinnati, and it contains reports concerning the teaching of physics and chemistry from 176 public and 431 private secondary schools. From a study of this report it appears that in 1880 there were but four of the 607 schools giving a full year of work in physics with laboratory experiments by the pupils. Fifty-three were giving full year courses with experiments by the teacher. One hundred and thirteen were giving courses in physics with no experiments at all—merely text-book recitations. The rest had courses for part of a year only, but almost all had some physics.

It is not necessary to make any comment on the difference between this situation and the present one, where practically every school has its laboratory work by the pupils. This change from practically no individual laboratory work to laboratory work for everybody means, as every science teacher must see at a glance, a tremendous advance. It is also clear that the college entrance requirements have been of the greatest assistance in hastening this progress. Beginning in 1886 with the Harvard requirements, and followed up in 1897 by the definition of the unit requiring laboratory work by the committee on College Entrance Requirements of the National Educational Association, the colleges have contributed all that in them lay toward the acquisition of this very valuable asset for science teaching. A detailed account of how the college requirement was framed and how it has been altered has been given by Professor E. H. Hall, of Harvard, in his book on the "Teaching of Physics," and more recently in his contribution to SCIENCE for October 29, so that we need not pause for this now. Suffice it here to point out that physics teaching owes a great debt of gratitude to the colleges generally, but to Professor Hall and Harvard in particular, for this acquisition of laboratories for physical science in the schools. By the introduction of the laboratory work the teaching of science has been enormously benefited; and, had the teachers held the subject matter of the course down to the comprehension of the pupils, there would doubtless be no cause for complaint now.

The second of these bulletins from the bureau of education was edited by Professor C. K. Wead, of the University of Michigan, and deals largely with methods of instruction. It contains replies to a circular letter issued by the bureau, a discussion of these replies, a number of reports on physics work abroad, some valuable suggestions on teaching of physics, and a list of forty-seven topics and forty-two experiments, which were regarded as fundamental for every elementary physics course. It is interesting to note that this list, issued in 1884 by the U. S. Bureau of

Education, contains three quarters of the topics on the list of the North Central Association which was issued in 1908. It is not seriously different from the truly celebrated Harvard description list of 1886, or the list of experiments in the new College Entrance Board's requirements. The report also shows that twenty-five of the thirty secondary schools reporting expressed themselves as regarding laboratory work as necessary. This shows a great advance between 1880, when the Clarke bulletin was issued, and 1884. Thus laboratory work was being introduced rapidly before the college pressure was applied in 1886, and the reports show that it was of a kind to possess significance to the pupils —done with home-made apparatus and "kitchen utensils."

This report contains much valuable advice which has not been followed in the subsequent course of events. Thus, p. 116: "Above all, it should be taught in each kind of school for the benefit of those who will go no further." Again, p. 117:

> The weight of opinion is decidedly that the first teaching should be inductive. . . . The progress of the student following this method is so slow, if measured by the usual examination tests, as to discourage a faint heart. . . . When pushed to the extreme just indicated (to learn everything for himself) the method breaks down; for quantitative experiments are mostly beyond the reach of high school boys, and yet very few principles or laws can be established without them. . . . If to reason accurately on physical facts be of any value to the student, is not a conclusive disproof of an hypothesis (provided he originated it) more valuable than the incomplete proof with which he must usually remain contented when he learns the accepted hypothesis? . . . Consciously or not, we must use inductive methods all our lives in ways where we can not avail ourselves of the principle of the division of labor, depending on others. The professional opinions of the physician and lawyer, all our judgments of men and our opinions on common matters of life must be largely the result of inductive reasoning. Another reason for introducing inductive training into the schools is that, in the opinion of many teachers, more of physics can be taught so as to be remembered in this way than in any other. . . . The use of text-books of the ordinary kind, however accurate and clear, is inconsistent with, perhaps almost fatal to, the scientific method in schools.

Again, p. 103:

> The difference between certainty and probability or conjecture, between truth and opinion, is one which the educator would not fail to make felt. . . . To keep the scholar in an atmosphere of real or apparent certainty, when in after life three fourths of his intellectual occupation will be to deal with uncertainties, is as foolish as it would be to keep him out of the water until he has learned to swim.

Thus in the matter of facilities for presenting the subject of physics, substantial progress has been made in the acquisition of the laboratory; but in the matter of knowing how to treat the subject, we have made little progress—many think we have gone backward.

Somehow most of the students regard the subject matter as so much "stuff" that has to be gone over, and speak of the laboratory exercises as so many "stunts" that have to be performed in order to get credit. The work as a whole lacks significance to them, so that they do not, as a rule, work at it with initiative and enthusiasm. The present condition was sized up so aptly by President Remsen in his address before the American Federation of Teachers of the Mathematical and the Natural Sciences in Baltimore last year, that I can not refrain from quoting him:

> A battle that has long been waging has been won—the battle for the recognition of science in the courses of study in schools and colleges. . . . Now science is recognized; we have laboratories everywhere and laboratory training is regarded as indispensable. It is therefore fitting to ask: What are we doing with our facilities? What results are we obtaining? When the battle was on, men lost their heads—men must lose their heads in order to fight. We thought that if only we could

get laboratories, the problems of education would be solved. Is this true? Are we doing the best that is possible with what we now have? Do the results obtained justify the equipment and time devoted to scientific study? I am not qualified to answer these questions for the schools; but speaking for the colleges, I may say that in my opinion the results are frequently quite unsatisfactory. The reason is that we have not yet learned how to deal with the subject. It is not hard to teach chemists chemistry, but it is very hard to teach beginners something that is worth while about chemistry in one year.

The leading facts of the past history of science teaching and the present problems are now before you.

We have not yet learned how to deal with our subject. It is not hard to teach physicists physics, but it is very hard to teach beginners something that is worth while about physics in one year.

It is essentially an educational problem, and, again quoting President Remsen's address:

Pedagogical problems are hard to solve—it is very difficult to get sound conclusions. How can we tell whether the scientific training is more effective than that of the older type? This is a problem that can not be solved by sitting down and thinking about it; it can be solved only by research and experiment. I do not myself know whether scientific training as now conducted is producing the results hoped for. Yet I am convinced that scientific training, when properly conducted, may be of the greatest value as an educational force. This is quite a different thing from saying that that particular thing now known as science training is of great value. It all depends on how it is done. I have been experimenting to find out how to teach chemistry, and it is the most difficult experiment I have ever tried.

"The problem can not be solved by sitting down and thinking about it;" nor, may I add, can it be solved by getting up a perfect list of experiments, or, by writing a text that shall be the most logical, accurate and rigorous in the world. "The problem can be solved only by research and experiment and it is the most difficult experiment I have ever tried." Progress in the future depends, then, on our applying to our teaching problems the methods of our subjects; for surely no one needs to tell a body of science teachers what the words research and experiment mean. How, now, shall we go about it?

The first step is to define specifically the problem we are going to try to solve. The problem as stated above, namely, to give the pupils something worth while, is too vague to permit of scientific experiment, because it offers no method of testing the work for the purpose of finding out whether we have succeeded. What do we mean by "something worth while," and how shall we test the pupil to find out whether he has acquired it? Those of our parents who studied physics in the sixties and seventies testify now that they acquired from their school work in physics an investigating attitude toward problems, and clear enough ideas of some of the more important principles to have helped them considerably ever since. But such evidence as this comes rather late, and, while it is interesting and throws some light on the subject, it is not the sort of evidence that science demands. The problem must be more specific and the results of the experiments must be more definite. We must therefore seek a more definite statement of the problem, and this necessitates first a decision as to what the purpose of the teaching is to be.

The number of purposes for teaching physics that have been suggested and defended in the past thirty years has been large. Two, however, have been rather more fundamental than the others, so we will confine our attention to these. The first in the public mind at present is the one given in the report of the Committee on College Entrance Requirements of the National Educational Association, to which the College Entrance Board gave until this year a protecting shelter. It is thus written in the deed: "To the end that the pupil may gain a comprehensive and connected view of the most important facts and laws of elementary physics." This purpose leads to the very specific question: Do the pupils get such a view under the current system of instruction? This question can be answered—nay, is answered, with perfect definiteness on all the examination papers written by the pupils. Need I tell a body of physics teachers what the answer is? How many papers each year convince you that the writers have either a comprehensive or a connected view of the most important facts and laws? For myself, I do not hesitate to answer; very few; and, as a college teacher who must build on the comprehensive and connected view implanted by others, I must confess that I am seldom able to discover it. In some few students it is there, but in the great majority it is not.

Under these conditions it seems perfectly fair to question whether the present habits of teaching are sound and to try to find out what is the matter. Two sources of trouble have already been pointed out. In our efforts to make the view comprehensive, we have overcrowded the course to the point where we have but eleven minutes forty-three and six tenths seconds to a topic. In our efforts to make it connected, logically connected, we have become rationalists and resorted to the "absolute," thereby making much of it unintelligible. One scientific experiment would consist in reducing the subject matter, forsaking the absolutes, and then testing all along for the clearness of view gained. Another would consist in presenting the same topic to several different classes by different methods to see if some previously unintelligible topics might be made intelligible if differently treated. Numerous other experiments will at once suggest themselves, all aimed at finding the best way of "giving a comprehensive and connected view" of such facts and principles as were introduced. In this matter there is no royal road to success. Each teacher must find out for himself how best to succeed with his particular class.

The second important purpose of teaching science does not seem to have received much attention of late. It has not been a protected commodity like the other. Its statement is best given in a report of a committee on teaching of elementary physics that was presented to the British Association for the Advancement of Science in 1874.

They have assumed as a point not requiring further discussion that the object to be attained by introducing the teaching of physics into general school work is the mental training and discipline which the pupils acquire through studying the methods whereby the conclusions of physical science have been established. They are, however, of opinion that the first and one of the most serious obstacles in the way of the successful teaching of this subject is the absence from the pupils' minds of a firm and clear grasp of the concrete facts and phenomena forming the basis of the reasoning processes they are called upon to study. They therefore think it of the utmost importance that the first teaching of all branches of physics should be, as far as possible, of an experimental kind. Whenever circumstances admit of it the experiments should be made by the pupils themselves and not merely by the teacher, and though it may not be needful for every pupil to go through every experiment, the committee think it essential that every pupil should at least make some experiments himself.

For the same reasons, they consider that the study of text-books should be entirely subordinate to attendance at experimental demonstrations or lectures, in order that the pupils' first impressions may be got directly from the things themselves and not from what is said about them. They do not suppose that it is possible in elementary teaching entirely to do without the use of text-books, but they think they ought to be used for reviewing the matter of previous experimental lessons rather than in preparing for such lessons that are to follow.

It will be noted that the purpose herein set forth is the one favored by most of the contributors to Professor Wead's bulletin just reviewed. It seems to have been the prevailing idea prior to and at that time, 1884. As stated above, our parents tell us now that they actually did get from their study of physics an inquiring attitude of mind, and the ability to attack and solve problems. One of the correspondents in Professor Wead's bulletin states that the introduction of physics in his school has had the effect of quadrupling the number of boys that go to high school! That the purpose we have been discussing is fast becoming the teaching purpose of science at the present time, no one who has followed closely the trend of recent educational thought can seriously doubt. And if this is so, a large and interesting array of definite problems that can be answered only by experiment presents itself. The main question now is not—Has he gained a comprehensive view? but—Has he acquired a certain power? It is no longer—What does he know? but—What can he do? No longer—How much can he reproduce? but—How well can he produce?

We already have some data concerning the way the present system of teaching is serving this second purpose. Such data are obtained by setting original problems on examination or in the laboratory. And here again such data as I have collected have led me to the belief that none of us are succeeding over well at this. Nor need we expect to succeed so long as we follow mainly the didactic methods that have been found useful in other kinds of work. Power in solving problems is acquired only by solving problems under the spur of an inner motive of wonder, not by listlessly listening to a description of how some one else has solved them.

We have here a wide and important field for educational research. We know comparatively little about the most efficient means of developing power of solving problems. Mighty few of our texts treat the subject with a questioning attitude or in a way to develop this in the pupil. Open any text at random and read the heading of a new paragraph. Thus:

> In 1686 Sir Isaac Newton formulated three statements which embody the results of universal observation and experiment on the relations which exist between force and motion. The statement of the first law is, etc. A machine is a contrivance for the transference of energy, or both the transference and transformation of energy at the same time; it is therefore an instrument for doing work. It is an accepted belief among men of science that all space is filled with something so rare and subtle that it can not be weighed or indeed perceived by any of our senses, and to this all-pervading medium the name of *ether* has been given. (This last is the first sentence in the subject of light.)

Surely such treatment does not tend to develop power of solving problems in the pupils. But fortunately the teachers do not always follow the text: some let the text follow them. When this is the case, much may be done toward developing power of solving problems and initiative among the pupils. Yet such cases are the exception rather than the rule. Each of us can, however, find out how to do it if only he will recognize the fact that his daily task is a daily problem, requiring study and experiment for its solution, and then attack that problem resolutely and continue experimenting and carefully testing results until they are satisfactory.

In order to summarize the distinction I have been trying to make in the last few pages, let me again quote from Professor Wead's bulletin:

> If the thing to be aimed at is to make them pass a good examination as soon as the subject is read, the best means will be to put a text-book into the hands of every one, and require certain parts of it to be learned, and to illustrate them

in an experimental lecture with explanations. The lecture may be made very clear and good; and this will be an attractive and not difficult method of teaching, and will meet most of the requirements. It fails, however, in one. The boy is helped over all the difficulties; he is never brought face to face with nature and her problems; what cost the world centuries of thought is told him in a minute; his attention, clearness of understanding, and memory are all exercised; but the one power which the study of physical science ought preeminently to exercise, and almost to create, the power of bringing the mind into contact with facts, of seizing their relations, of eliminating the irrelevant by experiment and comparison, of groping after ideas and testing them in their adequacy, in a word of exercising all the active faculties which are required for an investigation in any matter—these may lie dormant in the class while the most learned lecturer experiments with facility and explains with clearness.

In what has been said I have dealt only with the most evident of the problems now before the physics teachers—namely, the problem of how to teach so as to leave the pupil with an added power to achieve. I have given it as my frank opinion that we are not oversuccessful in this at present, have urged that scientific experiment in teaching offers the only means of finding out how to become more successful, and have suggested several working hypotheses as possible guides to such experimenting. The subject has, however, only been grazed by what has been said. No mention has been made of the contributions that physics teaching might make to the social efficiency of the community; nor has the problem of making the physics contribute its share to moral education been considered. The questions as to why America does not contribute her just quota to the number of the world's greatest scientists have not been discussed. These larger problems of science will have to be left for future discussion. Their solution, like that of the problem that has occupied our attention, is waiting for the scientific experiments in education, which alone can lead us to a satisfactory conclusion.

C. R. MANN

THE UNIVERSITY OF CHICAGO

THE EIGHTH ZOOLOGICAL CONGRESS

THE preliminary announcement of the eighth International Zoological Congress is just issued and of it we make the following abstract. The congress meets at Graz, Austria, on August 15–20, 1910, under the presidency of Hofrat, Professor Ludwig von Graff, who was elected to the position at the Boston Congress in 1907.

At 9 A.M., on Monday, is the registration, followed by a meeting of the permanent committee of the congress and an inspection of the university. At 3 P.M. are the general formalities of opening, with addresses of welcome, presentation of delegates, formation of sections and the like. At the close of the session the members go to the Heimwald, where there will be an informal gathering in the restaurant.

On Tuesday and the following days the general sessions are at 9, with sectional meetings at 2 in the afternoons, and on Tuesday and Wednesday there are lantern lectures on Styria and the Dalmatian coast. From 4:30 on there are small excursions to the beautiful places in the surrounding mountains. On Friday evening the congress proper ends with a banquet to the congress.

On Saturday the congress goes on an excursion to the Erzberg and Leopoldstein See and on Sunday to Trieste, where the Austrian Zoological Station forms the chief object of interest. If possible the beautiful Imperial Castle of Miramar (associated in the minds of Americans with the unfortunate Maximilian of Mexico) will be visited.

From Monday, August 22, to Saturday evening, there will be an excursion in one of the steamers of the Austrian Lloyds down the Dalmatian coast, stopping at Rovigno, Pola, Sebenico, Traú, Spoleto, Lesina, Lissa, Meleda, Ragusa and Cattaro. Ample time will be allowed at the latter place for a trip