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THE RELATIONS OF COLLEGES TO SECONDARY SCHOOLS IN RESPECT TO PHYSICS

THE interesting meeting of physicists which was held at Worcester from the seventh to the tenth of September, as a part of the twentieth-year celebration of Clark University, was almost unique in the amount of attention secured, from a body consisting mainly of university or college teachers, for questions relating to the best methods of teaching physics and the proper relations of school physics to college physics. The credit for this, as for the many other successful features of the meeting, was largely due to Professor Webster, who arranged for a number of conferences to consider such questions as the following, proposed by himself, and took a leading part in the resulting discussions:

1. What can be done to give the public a greater knowledge of physics?
2. What is the object of teaching physics in school and college?
3. How shall we increase the popularity of physics in the schools?
4. Shall physics be taught as if all students were to be potential physicists?
5. Shall physics be taught with more mathematics or less?
6. Is it desirable that physics and mathematics be taught by the same teachers in the schools?
7. What proportion of time must be devoted to dynamics?
8. Is a course of descriptive physics alone without mathematics or laboratory work desirable?
9. Is it desirable that the college prescribe a course in physics?
10. Can the colleges be got to prescribe a course in physics for all students?
11. What is the proper function of general physics in the curriculum of the college of liberal arts?

12. How shall physics be taught to engineering students?

13. How can the student be induced to get a more catholic view of general physics?

14. Has the introduction of courses in pedagogy been justified by the results?

15. Is there any reason that theoretical physics should languish in America?

16. Is the importation of professors of physics from Europe necessary and desirable?

No formal action was taken at any of these conferences; but at the second the nine propositions given below[1] were presented, and at the last conference a majority of those present signed the statement which follows the propositions.

1. That, while the amount of academic attainment in physics which the prospective school teacher of this subject should have can not be definitely fixed, it may be usefully, if somewhat vaguely, indicated as the state of advancement at which, if the man were to be a candidate for the doctorate, he would naturally begin the special research intended for his thesis.

2. That this preparation should include an elementary knowledge of the calculus and some acquaintance with the general facts, principles and laboratory methods of chemistry.

3. That school authorities should not be content with the appointment of a well-trained and competent teacher. They should see to it that the good teacher has good tools and good conditions for his work, a well-appointed laboratory, an equally well-appointed lecture room and relief from unnecessary manual labor.

4. That this relief of the teacher from unnecessary manual labor will require, as a rule, the services of a man of all work, sufficiently skilled to use well the elementary tools of the mechanic, sufficiently permanent in his place to know thoroughly the building in which he works and its equipment, sufficiently teachable and willing to make him a cheerful helper to the teachers of physics and chemistry in whatever assistance they may with reason ask of him.

5. That the school teacher, so trained and so equipped, should have all the liberty in the method and scope of his teaching which is consistent with the general consensus as to good practise, this consensus to be reached, in the case of schools which have close relations with the colleges, by painstaking, sympathetic and persistent efforts on the part of all concerned to come to an understanding with each other for the purpose of promoting their common interest, the best attainable instruction in science for the youth of our country.

6. That the examination by means of which the attainments of school pupils are estimated in their candidacy for admission to college should include a laboratory test.

7. That colleges which accept but do not require physics as a part of the preparation for admission should so arrange their elementary teaching of physics as to make an important distinction between those who have and those who have not passed in physics at admission.

8. That, accordingly, such colleges should maintain a physics course substantially equivalent to the physics courses of good secondary schools.

9. That colleges should require of the schools no quantitative treatment of kinetics, or the behavior of matter undergoing acceleration.

The undersigned, without committing themselves to approval of all the propositions given above, commend them to the serious consideration of college and school teachers of physics and express the hope that they may be made the subject of discussion at the coming meeting of the American Association for the Advancement of Science.

A. G. Webster (Clark University), C. L. Speyers, Norman E. Gilbert (Dartmouth College), W. E. McElfresh (Williams College), A. P. Wills (Columbia University), C. Barus (Brown University), J. C. Hubbard (Clark University), F. A. Waterman (Smith College), E. A. Harrington, Ernest C. Bryant, A. de F. Palmer, Jr. (Brown University), Norton Adams Kent (Boston University), Guy G. Becknell, Robert H. Goddard, Louis P. More (University of Cincinnati), James E. Ives (University of Cincinnati), R. W. Wood (Johns Hopkins University), E. F. Nichols (Dartmouth College), A. Wilmer Duff (Worcester Polytechnic School), C. H. Andrews (Worcester High School), C. A. Butman.

In explanation and support of these propositions[2] I gave an informal talk, the

[1] The ninth was at first in a somewhat different form from that here printed.

[2] I make these propositions entirely on my own responsibility and must not be understood to represent in this action any other member of the Harvard Department of Physics.

substance of which, with some added documentary matter, is here set down. My excuse for narrating at such length the history of college entrance requirements in physics is my belief that college men, as a rule, know very little of this history and are therefore not in position to understand fully the present condition of physics in the schools or the possibilities of improving and utilizing the work there done.

In 1886 the Harvard University catalogue contained for the first time, in its statement of the alternative requirements in physical science for admission to the freshman class, the following:

A course of experiments in the subjects of mechanics, sound, light, heat and electricity, not less than forty in number, actually performed at school by the pupil.

In 1887 a pamphlet with the title "Descriptive List of Experiments in Physics," giving detailed descriptions of apparatus and detailed directions for forty exercises to meet this requirement, was issued by Harvard.

In 1889, in response to complaints from the schools that the pamphlet just described was too restrictive, a new edition was published giving forty-six exercises, of which the candidate might omit any six.

In the year 1897–98 the Harvard catalogue contained for the first time an amended statement of the requirement in elementary physics, much longer than the original statement and with less exclusive emphasis on the laboratory work of the pupil. As this statement is still in force at Harvard, and as the influence of Harvard on the teaching of physics in schools is frequently spoken of as deplorable, it may well be given here, lengthy though it is. It reads thus:

A course of study dealing with the leading elementary facts and principles of physics, with quantitative laboratory work by the pupil.

The instruction given in this course should include qualitative lecture-room experiments, and should direct especial attention to the illustrations and applications of physical laws to be found in every-day life. The candidate will be required to pass a written examination, the main object of which will be to determine how much he has profited by such instruction. This examination may include numerical problems. It will contain more questions than any one candidate is expected to answer, in order to make allowance for a considerable diversity of instruction in different schools.

The pupil's laboratory work should give practise in the observation and explanation of physical phenomena, some familiarity with methods of measurement, and some training of the hand and the eye in the direction of precision and skill. It should also be regarded as a means of fixing in the mind of the pupil a considerable variety of facts and principles. The candidate will be required to pass a laboratory examination, the main object of which will be to determine how much he has profited by such a laboratory course.

The candidate must name as the basis for his laboratory examination at least thirty-five exercises selected from a list of about sixty described in a publication issued by the university under the title "Descriptive List of Elementary Exercises in Physics." In this list the divisions are mechanics (including hydrostatics), light, heat, sound and electricity (with magnetism). At least ten of the exercises selected must be in mechanics. Any one of the four other divisions may be omitted altogether, but each of the three remaining divisions must be represented by at least three exercises.

The candidate will be required to present a note-book in which he has recorded the steps and the results of his laboratory exercises, and this note-book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes. These exercises need not be the same as those upon which the candidate presents himself for the laboratory examination, but should be equivalent to the latter in amount and grade of quantitative work.

The note-book is required as proof that the candidate has formed the habit of keeping a full and intelligible record of laboratory work through an extended course of experiments, and that his work has been of such a character as to raise a presumption in favor of his preparation for the examination. But much greater weight will be given to the laboratory examination than to the note-book in determining the candidate's attainments in physics. Experience has shown that pupils can make the original record of their observations entirely presentable, so that copying will be unnecessary, and they should in general be required to do so.

This course, if taken in the last year of the candidate's preparation, is expected to occupy in laboratory work, recitations and lectures, five of the ordinary school periods, about fifty minutes in length, per week for the whole year. With few exceptions exercises like those in the descriptive list already mentioned can be performed in a single school period, but for satisfactory results it will often be necessary to repeat an exercise. Two periods per week for the year should be sufficient for the laboratory work proper. If the course is begun much earlier than the last year of the candidate's preparation, as it well may be, it will require more time.

A new edition of the Harvard "Descriptive List" was issued in 1897. It contained sixty-one exercises, though the laboratory requirement was now reduced to thirty-five exercises.

The arrangement of exercises in the new list was peculiar, optics being interpolated between two divisions of mechanics. This was part of an attempt to encourage the performance of elementary laboratory experiments by pupils in the early years of the secondary school course or even in the grammar school.

A third edition of the list, with many changes in details but no fundamental alterations, appeared in 1903, and this, with possibly slight typographical corrections, is the current form of this familiar document.

In 1897 a committee on physics of the science department of the National Educational Association was appointed to assist in the work of the association's general committee on college entrance requirements. The make-up of the physics committee was as follows:

E. H. Hall (chairman), Harvard University.

H. S. Carhart, University of Michigan.

R. B. Fulton, University of Mississippi.

C. L. Harrington, Sachs' Collegiate Institute, New York.

Julius Hortvet, East Side High School, Minneapolis.

C. J. Ling, Manual Training School, Denver.

E. L. Nichols, Cornell University.

E. D. Peirce, Hotchkiss School, Lakeville, Conn.

Fernando Sanford, Stanford University.

B. F. Thomas, Ohio State University.

Edward R. Robbins, Lawrenceville School, Lawrenceville, N. J.

This committee evolved five general propositions which, without substantial change, were in 1890 commended by the departments of secondary and higher education of the National Educational Association and recommended to the colleges of the country "as offering a basis for the practical solution of the problems of college admission" in physics. These propositions were:

1. That in public high schools and schools preparatory for college physics be taught in a course occupying not less than one year of daily exercises, more than this amount of time to be taken for the work if it is begun earlier than the next to the last year of the school course.

2. That this course of physics include a large amount of laboratory work, mainly quantitative, done by the pupils under the careful direction of a competent instructor and recorded by the pupil in a note-book.

3. That such laboratory work, including the keeping of a note-book and the working out of results from laboratory observations, occupy approximately one half of the whole time given to physics by the pupil.

4. That the course also include instruction by text-book and lecture, with qualitative experiments by the instructor, elucidating and enforcing the laboratory work, or dealing with matters not touched upon in that work, to the end that the pupil may gain not merely empirical knowledge, but, so far as this may be practicable, a comprehensive and connected view of the most important facts and laws in elementary physics.

5. That college admission requirements be so framed that a pupil who has successfully followed out such a course of physics as that here described may offer it toward satisfying such requirements.

But the general committee on college entrance requirements insisted on having more detailed recommendations from the physics committee. Accordingly I, knowing that various members of this latter body, if body it could properly be called with its parts separated by hundreds or even thousands of miles, held strongly to various opinions concerning details, at last sent to the general committee as my personal suggestion the titles of the Harvard "Descriptive List," at the same time notifying every other member of the physics committee of my action and asking each to make any suggestion of his own in the same way. To my surprise only one other member of the committee sent any recommendations of his own. Professor Carhart sent a number, which, however, were probably not intended as a complete alternative for the Harvard list. The general committee printed both sets of suggestions, with some introductory paragraphs of which one only need be given here:

OUTLINE OF LABORATORY WORK IN PHYSICS FOR SECONDARY SCHOOLS

At least thirty-five exercises, selected from a list of sixty or more, not very different from the list given below. In this list the divisions are mechanics (including hydrostatics), light, heat, sound, and electricity (with magnetism). At least ten of the exercises selected should be in mechanics. The exercises in sound may be omitted altogether; but each of the three remaining divisions should be represented by at least three exercises.

This paragraph, too, with the list which followed, became a part of the matter recommended to the colleges of the country in 1900 by the departments of secondary and higher education of the National Educational Association.

In 1901 the "Definition of Requirements," issued by the recently established College Entrance Examination Board of the Middle States and Maryland, contained the following statement:

The requirement in physics is based on the report of the committee on physics of the science department of the National Educational Association.

It is recommended that the candidate's preparation in physics should include:

(a) Individual laboratory work, comprising at least thirty-five exercises selected from a list of sixty or more, not very different from the list given below.

(b) Instruction by lecture-table demonstrations, to be used mainly as a basis for questioning upon the general principles involved in the pupil's laboratory investigations.

(c) The study of at least one standard text-book, supplemented by the use of many and varied numerical problems, "to the end that the pupil may gain a comprehensive and connected view of the most important facts and laws in elementary physics."

The list of titles of experiments which follows this passage in the original context is precisely the same as that numbered from 1 to 61 in the report of the National Educational Association and in the Harvard "Descriptive List."

All this may seem to be a record of easy and triumphant progress, during the years 1897–1901, for the physics course under discussion. Perhaps the ease was too great for the triumph, if such there was, to last. Criticisms and complaints soon began to be heard. At a meeting of the New England Association of Colleges and Preparatory Schools in October, 1901, President Hall, of Clark University, pronounced a sweeping condemnation of the kind of physics teaching which had come into the schools through the influence especially of Harvard College. This was the more significant, rather than less, by reason of the fact that President Hall had during the early years of the Harvard "Descriptive List" expressed approval of its character. In spite of an early prepossession in its favor, he had become entirely dissatisfied by its working in the schools, as he understood the results of that working. Nor did he long remain alone as a pronounced critic and opponent of the system of physics teaching under discussion. Professor Woodhull, of Teachers College, Columbia University, as the spokesman, no doubt, of a considerable proportion of the physics teachers in middle state schools, took a similar position. More conspicuously still, Professor Mann, of the University of Chicago, proclaiming in no uncertain tones the need of a "new movement among physics teachers," undertook to organize against the prevalent system the discontent of physics teachers throughout the country and to formulate proposals for a change. Many committees were accordingly appointed, many *questionnaire* circulars were issued, much cogitation of replies was gone through—with what result may appear later in this history.

Indeed, so active has been the fire of criticism and of condemnation directed during the last six or eight years against the influence of colleges on the school teaching of physics that, in representing the large share held by Harvard in this influence, I am making something in the nature of a confession. Nevertheless, there are several reasons for believing that the influence in question has not been altogether bad and that the present condition of physics in the schools does not need to be reformed altogether. Some of these reasons I will give.

1. The college requirement of laboratory work by school pupils has done much to make the school teaching of physics in this country a respected profession instead of a mere incidental occupation, as it used to be, for some teacher whose main work lay in another field. There are now in this country several large and vigorous associations of physics teachers. To one of the largest and best of these, the Eastern Association of Physics Teachers, I have the honor of belonging, as an associate member. I attend its meetings regularly and believe I am right in saying that, on the whole, it is fairly well satisfied with the college requirement in physics as maintained and administered by Harvard. That is, where the Harvard plan has been longest on trial and has had the most direct and powerful influence, it is better liked than in other parts of the country.

2. European countries are gradually establishing in their secondary schools courses of laboratory work closely resembling those given in the schools of this country, and complimentary references to American practise in this respect are frequent in the writings of European teachers, some of whom freely declare their indebtedness to American precedents.

3. The "new movement among physics teachers," mentioned above, has had remarkably little revolutionary effect, less, indeed, than I think it should have. To justify this statement I will give a brief account of the recent movement for the revision of the physics requirement of the College Entrance Examination Board.

Early in 1908 a committee was appointed to make this revision. Its membership was: Henry S. Carhart, University of Michigan; A. D. Cole, Vassar College; A. W. Goodspeed, University of Pennsylvania; John W. Hutchins, High School, Walden, Mass.; Flavel S. Luther, Trinity College, Hartford; C. R. Mann, University of Chicago; C. A. Perkins, University of Tennessee; Frank Rollins, Stuyvesant High School, New York City; Wallace C. Sabine, Harvard University (chairman); H. L. Terry, inspector of schools, Madison, Wis.

Late in the year this committee made a majority report to the general board of revision of the College Entrance Board, and two members, Professor Mann and Mr. Terry, made a minority report. The following quotations from the minority report will show what impression the majority report made on those who had been active in the "new movement" and will be a fitting introduction to the next stage in this history:

We dissent from the report of the majority for the following reasons:

The underlying principle of the report of the majority is that physics is essentially a science of accurate measurements—the only such subject in the high school course—and hence it is the duty of physics to lay great stress on accurate quantitative work in order that the high school pupils may get somewhere in this course an insight into such work.

. . . .

Your minority is convinced that physics as a science of exact measurements belongs wholly in the college, and that physics in the high school should not give such prominence to the science of accurate measurements nor make use of the abstract and unusual system of absolute units. We respectfully urge that high school physics should teach the student how to organize his experience with physical phenomena in such a way as to get clear conceptions of some of the larger laws of physical nature. In this process experiments and to some extent quantitative work are necessary; but such highly refined quantitative work as is now generally demanded should not be insisted on, and all such work should be done in terms of the familiar engineers' units like the pound-weight and the foot-pound instead of the dyne and the erg.

Your minority wishes also to point out that your committee on this physics requirement is not a representative committee.

. . . .

We therefore are convinced that the report of the majority does not represent the consensus of opinion of the ablest secondary school teachers as to the present needs of physics in the high school; but that it is simply a statement of the current habits of teaching physics—habits that have been developed under the influence of ideals of college physicists rather than because of an appreciation of the ideals of the high school pupils.

. . . .

In view of this, your minority wishes to make the following recommendations to your board:

1. That the board of review increase the size of its physics committee by appointing or getting appointed in such a way as it may elect six or more physics teachers from various sections of the country who are recognized as successful and experienced teachers of physics and who are at present actively engaged in teaching physics in secondary schools. This would insure a representative committee.

2. That the report of the majority and the minority, together with similar reports of the North Central Association of Colleges and Secondary Schools and of the Physics Club of New York, be referred back to this more representative committee for full and complete discussion.

The board of revision, instead of following strictly the first recommendation made by the minority of the original committee, appointed a new committee consisting solely of six physics teachers in secondary schools, and to this committee it turned over the whole, I believe, of the matter mentioned in the second recommendation, as given above. The membership of the new committee was: N. Henry Black, Roxbury Latin School, Boston (chairman); W. M. Butler, Yeatman High School, St. Louis; Winthrop E. Fiske, Phillips Academy, Exeter, N. H.; Daniel E. Owen, Penn Charter School, Philadelphia; Frank B. Spaulding, Boys' High School, Brooklyn; Willis E. Tower, Englewood High School, Chicago.

In April, 1909, this committee made its report to the College Entrance Board. This report was in part as follows:

In submitting this report, we desire to call attention to the following points:

1. The report has received the unanimous approval of the committee.

2. We recommend that the College Entrance Board no longer undertake the marking or examination of the laboratory note-book[3] (see form of certificate recommended in lieu thereof).

3. We urge upon those who prepare the examination questions that these be so planned that students who have received fair preparation on

[3] I am informed by the chairman of the committee that this recommendation was due to the difficulties experienced by the College Board in receiving and transmitting the great number of note-books it has hitherto undertaken to deal with.

this work as here outlined may reasonably be expected to pass.

GENERAL STATEMENT

1. The unit in physics consists of at least 120 hours of 60 minutes each. Time spent in the laboratory shall be counted at one half its face value.

2. The course of instruction in physics should include:

(*a*) The study of one standard text-book, for the purpose of obtaining a connected and comprehensive view of the subject. The student should be given opportunity and encouragement to consult other scientific literature.

(*b*) Instruction by lecture-table demonstration to be used mainly for illustration of the facts and phenomena of physics in their qualitative aspects and in their practical applications.

(*c*) Individual laboratory work consisting of experiments requiring at least the time of thirty double periods. The experiments performed by each student should number at least thirty. Those named in the appended list are suggested as suitable. The work should be so distributed as to give a wide range of observation and practise.

The aim of the laboratory work should be to supplement the pupil's fund of concrete knowledge and to cultivate his power of accurate observation and clearness of thought and expression. The exercises should be chosen with a view to furnishing forceful illustrations of fundamental principles and their practical applications. They should be such as to yield results capable of ready interpretation, obviously in conformity with theory, and free from the disguise of unintelligible units.

Slovenly work should not be tolerated, but the effort for precision should not lead to the use of apparatus or processes so complicated as to obscure the principle involved.

3. Throughout the whole course special attention should be paid to the common illustrations of physical laws and to their industrial applications.

4. In the solution of numerical problems, the student should be encouraged to make use of the simple principles of algebra and geometry, to reduce the difficulties of solution. Unnecessary mathematical difficulties should be avoided and care should be exercised to prevent the student's losing sight of the concrete facts, in the manipulation of symbols.

The "appended list" of laboratory exercises which "are suggested as suitable" contains fifty-one titles, mostly one-line titles, without any details of method. The great majority of these are practically equivalent to titles found in the list, with sixty-one titles, originally adopted by the College Entrance Board or to combinations[4] of such titles. The new titles to which, apparently, nothing in the original list explicitly corresponds are the following:

15. Efficiency test of some elementary machine, either pulley, inclined plane or wheel and axle.

16. Laws of the pendulum.

17. Laws of accelerated motion (if by this is meant a laboratory study by the pupils of falling bodies and not the comparison of masses by acceleration-test and the action and reaction, of the old list).

23. Cooling curve through change of state (during solidification).

38. Magnifying power of a lens (if this means more than is implied in the shape and size of a real image formed by a lens, of the old list).

39. Construction of model of telescope or compound microscope.

41. Magnetic induction (unless this is covered by the telegraph sounder and key, the electric motor and the dynamo, of the old list).

45. Electrolysis (which apparently means something additional to the study of a single fluid voltaic cell and study of a two fluid voltaic cell, titles taken from the old list to the new).

47. Resistance measured by volt-ammeter method.

50. Study of induced currents (if this means more than the dynamo, of the old list).

51. Power or efficiency of a small electric motor (if this means more than the electric motor of the old list).

The report in question gave also a syllabus of "topics which are deemed fundamental and which should therefore be included in every well-planned course of elementary physics." As this syllabus covers nearly four type-written pages and seems to include nearly everything that one would expect to find in the table of contents of a

[4] For example, where the original list had *elasticity: stretching; elasticity: bending; elasticity: twisting*, this new list has *Hook's law*.

general school text-book of physics, I shall not reproduce it here.

This report, made unanimously by a committee of six school teachers of physics, was accepted *in toto* by the College Entrance Board and now stands as the extended definition of the physics requirement of that board. I here repeat the opinion which I have expressed earlier in this paper, that the revision, left at last entirely to experienced school teachers of physics, has made no revolutionary change in the requirement, and that we are therefore justified in concluding that such teachers do not condemn as bad, on the whole, the influence of college requirements on the school teaching of physics.

It would be quite a different thing, however, to express for myself or for school teachers the opinion that the present state of physics in the schools is satisfactory, except as a temporary stage of development under difficult conditions. Many teachers, especially those new to the kind of work required, have too little knowledge of their subject, many school boards are unwilling or unable to give the teacher proper facilities and needed assistance, many college men are out of sympathy with school men and take too little account of what they accomplish. Finally, we have thus far attempted, in my opinion, to cover too wide a field in school courses, or, at least, we have attempted one part of this field which is impracticable with an ordinary class in a school course, the region of dynamics, or kinetics. Seven or eight years ago I raised the question, "Should we, therefore, give up the attempt to teach this part of physics in school courses, or the early courses in college and content ourselves with giving, in mechanics, the statical aspect only?" and said, "I fear that many teachers will answer this question in the affirmative, but I am not yet ready to do so." Now, after years of further experience and observation, I have come to the point of making proposition 9 in the early part of this paper. I have been brought to this point partly by what I have heard in the debates of the Eastern Association of Physics Teachers, partly by the opinions expressed by other associations of teachers with the encouragement of Professor Mann and Professor Woodhull, but largely by my own experience and observation of pupils. Here, it seems to me, rather than in its assault on the general character of college requirements in physics, the "new movement" has found a vulnerable place and has indicated a way of improvement.

When the physicist looks at the familiar formula,

$$\text{force} = \text{mass} \times \text{acceleration},$$

notes its simplicity and lets his mind enter for a moment the vast regions of illumination and power which it opens up, he is only too apt to overlook the aspect which this law takes for the beginner in physics in this country. Let me, therefore, write down several of the forms in which the youngster is asked to recognize and use it:

$$\text{force (dynes)} = \text{mass (grams)} \times \text{accel. (cm. per sec. per sec.)},$$
$$\text{force (poundals)} = \text{mass (pounds)} \times \text{accel. (ft. per sec. per sec.)},$$
$$\text{force (gms.-wt.)} = \text{mass (grams)} \times \text{accel. (cm. per sec. per sec.)} \div g (= 981),$$
$$\text{force (lbs.-wt.)} = \text{mass (pounds)} \times \text{accel. (ft. per sec. per sec.)} \div g (= 32+).$$

Even without adding to these the form which many engineers would insist on, *force (lbs.-wt.)* = *mass* × *acceleration*, in which the mass of a one-pound weight is called $(1 \div g)$, we see that the difficulty is a serious one. Are we justified in putting it in the way of school pupils who, in the great majority of cases, will never have occasion, after their academic days, to use the acceleration formula in any shape, and who will find in the other regions of physics plenty of interesting and useful matter to occupy their attention during that small part of their school course which can be devoted to this subject? And would not college teachers of physics prefer to have boys come to them from the schools well grounded in the elements of static mechanics, without kinetics, than to have them come with a very uncertain knowledge of both?

EDWIN H. HALL

CAMBRIDGE, MASS.,
September 23, 1909

THE INTERNATIONAL CONGRESS OF RADIOLOGY AND ELECTRICITY

An international Congress of Radiology and Electricity is to be held in Brussels from September 13 to 15, 1910, under the patronage of the Belgian government and the French Physical Society. This is the second conference on the subject, the first having been held in Liège, in the autumn of 1905. The second conference, like the first, has on the honorary committee some of the leading scientists in Europe and America who are working along the lines included in the subjects of the conference. The list includes among others Madame Curie, Lord Rayleigh, Sir W. Ramsay, Sir J. J. Thomson, Sir O. Lodge, Sir Wm. Crookes, Professors Lorentz, Rutherford Langevin, Arrhenius, Lenard, Goldstein, H. Poincaré, Planck, Righi, Schuster, Zeeman and certain eminent physicians.

The congress has for its chief purpose the bringing together of a number of scientists capable of discussing the fundamental problems arising out of the phenomena of radioactivity and ionization; of agreeing upon a standard terminology; of presenting reports embodying a summary of our knowledge on the various divisions of the subject; and of showing the medical and therapeutic applications of the phenomena. The conference is therefore of concern to physicists, chemists, biologists and medical practitioners.

The officers of the American committee are at present Professor Carl Barus, Brown University, Providence, R. I., chairman, and Professor G. F. Hull, Dartmouth College, Hanover, N. H., secretary, to whom inquiries may be addressed.

The provisional program of the conference is as follows:

FIRST SECTION—TERMINOLOGY AND RADIOMETRY

Terminology.—Fundamental notions; ions, electrons, corpuscles, etc. Unification of notations.

Radiometry.—General methods of measurement; apparatus, units.

Measurement of radioactivity; supports of the radioactive body; its influences, standardization. The establishment of a unit of radiation. Applied radiometry.

SECOND SECTION—PHYSICAL SCIENCES

A. *Theories and Fundamental Hypotheses.*—The ether, its manifestations, its properties, its relations to matter. The electric and magnetic field, electrons and ions; formation and properties. Magnetic and electric properties of bodies; metallic conductivity, electrolysis; dielectric phenomena; magnetism. Contact electricity. Thermo-electricity. Electro-capillary phenomena.

B. *Radiation.*—Generation. Emission, absorption; phenomena of radiation. Observation and analysis of radiation. Spectroscopy. Physical and chemical effects of radiation, phosphorescence. Electro-optics and magneto-optics, the Zeeman effect. Applied radiology, apparatus.

C. *Radioactivity.*—Radioactive bodies; enumeration and distinctive characters of the methods of separation. Radioactivity of matter in general. Properties of radioactive substances. Radioactive transformation; emanation, induced activity, etc. Atomic disaggregation. Radioactive constants.

D. *Atomistics.*—Number, charge, mass and velocity of particles. Molecular and atomic structure; valency. Colloids; Brownian movements.

E. *Cosmical Phenomena.*—The atmospheric electric field; its origin, variations of electrical potential of the atmosphere; ionization of the atmosphere. Observatories for atmospheric electricity; organization. Systematic registry of atmospheric electricity. Atmospheric radioactivity; atmospheric precipitation. Distribution of radioactive substances on the surface and in the interior of the earth. Terrestrial magnetism. The aurora borealis and magnetic storms. Solar radiation; variability of the field of this radiation, its heterogeneity and influence on terrestrial phenomena. Solar magnetic fields.

THIRD SECTION—BIOLOGICAL SCIENCES

A. *Biology Proper.*—Under this schedule are to be included all communications relative to the