PHYSICS IN THE HIGH SCHOOL.

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As the time for the study of physics is limited in practically all American high schools to one year, the diversified uses to which the knowledge gained in this course is to be put, the need for concentration and specialization in this subject to prepare the large percentage of college-going high school graduates for university technical courses, together with the ever-increasing subject matter in this course to be covered, especially in the field of electricity, are some of the causes which have made the thorough and adequate presentation of the subject extremely difficult.

Although four years of language are regularly taught in our high schools, and all admit that physics is just as important as language, boards have refused to consider more than one year being given to this subject, chiefly on account of administrative problems arising from the ever-increasing curricula.

Unless some rearrangement of our high school science courses and the time given to them can be made as suggested in the excellent plan outlined recently by R. A. Millikan and published in the May, 1917, issue of *SCHOOL SCIENCE AND MATHEMATICS*, or until this plan can become formulated and placed in practice, many physics teachers may well consider what improvements they may introduce directly into their methods of presentation of this subject.

Simplification of the course as now presented may do well, for some of the most widely used books today are better as references than as texts, due to the fact that they are too profuse—made so in attempts at simplicity and lucidity—and are written by mature minds which have forgotten the workings of themselves at the ages of seventeen and eighteen. Some of the more recent texts from the press are tending too much in the opposite direction, however, are too nonmathematical, and have sacrificed too many scientific principles to make way for superfluous practical applications and illustrations.

Let the physics omit such formulas as:

$$OF = OC \times 9/5 + 32$$

$$R = K L/A$$

$$PV = K$$

$$\text{and } HP = f s/33,000 \text{ t.}$$

Formulas of this type are seldom really understood by the majority of a class, and their meaning would seldom be recognized

a year later. They are a hindrance to the understanding of the subject by the student and to the application of reasoning principles which the course is supposed to develop. They *may* be understood for the time being, but as such are only instruments to be remembered, and who wishes to have the student draw from his memory tools which will work only if used in the right place in preference to the application of principles which he has studied, had presented in the classroom, and verified in the laboratory? The very mental reasoning processes which a student must use in the solution of any problem carries him through the mathematical operations of the formula which has been generalized in symbols, and in which, if used, he is instructed to substitute, blindly, without any special reasoning whatever. The value of the knowledge of the principles of science lies in the complete understanding of those principles and the significance of their application, and the understanding may be made more complete by the applications to numerous and varied problems than by the single application of the principle to construct an expressionless formula to be used mechanically thereafter. All formulas cannot be eliminated from the course, and this is most certainly not desirable, but many of the above type may be eliminated, and the remainder may better be presented in emphasized lecture and laboratory form than from text assignments.

In simplifying the course the elimination of some material might be considered, yet what to eliminate would be hard to decide. Undoubtedly, in a few years we will be living under the metric system, and then most certainly the study thereof shall not be a part of the subject matter of physics, and thus some relief afforded. Not only would time be saved due to the fact that it would not be necessary to teach this system, but also much waste would be eliminated if students went into the laboratory at the beginning of the year with a thorough understanding of and complete familiarity with the units of weight and measurement which they were to use throughout the year. In after war commerce, when English-speaking peoples will be seeking to supply the markets of the world with manufactured products, the metric system if adopted would prove of great benefit. Arguments from too many points of view have recently been printed¹ to mention any further here. Metric measurements may soon come to be taught in elementary

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arithmetic, eliminating the necessity of time used in this study in the high school.

Every physics teacher who uses any other text than his own, and having as he does his own specialties, can better present them in a clear-cut form by lecture than by any amount or kind of assignment. This applies to the principles of the subject matter, and not to the whole body of it. Other points that the physics teacher should not neglect in his lectures are those which most authors have neglected; the welding together of the parts of the text dealing with different subject matter based upon seemingly entirely different phenomena. There should be unity and complete coherence.

With a view to this accomplishment, the following order for taking up the work throughout the year is suggested. The divisions are not to be made isolated chapters.

- I. Molecular Force and Motion.
- II. Mechanics of Fluids.
- III. Force and Motion, Work and Energy.
- IV. Heat.
- V. Magnetism.
- VI. Electrostatics.
- VII. Current Electricity and Accompanying Magnetic, Heating, and Chemical Phenomena. Induced Currents.
- VIII. Light.
- IX. Sound.

With all respect for coherence, no difficulty in transition should be encountered until the end of the third division, and there certainly is the place for emphasizing the Law of Joule of heat-work equivalent. Heat and magnetism are both molecular phenomena. The electric current has been admirably defined as "an electric charge in motion, whose presence is most usually detected by the magnetic effect which it produces." This one good tie binds permanently V, VI, and VII. The heating effect of the electric current offers a further linkage with the preceding, through the relation between the electrical unit of work, the watt second, and the calorie. The electromagnetic theory of light reaches out to VIII, and the main variation in IX is the fact that there the vibratory motion takes place in the air medium.

If it can be impressed upon the young mind during the period of training in the rudiments of science that the workings of nature are based upon sets of laws which are interlinked and correlated rather than distantly related, then certainly any additional effort put forward to this end will be worth its investment.