Physical Science Study Committee

A Planning Conference Report

THE newly formed Physical Science Study Committee, directed by Jerrold R. Zacharias, Elbert P. Little, and Francis L. Friedman, held its first major planning conference on December 10, 11, and 12, 1956, at the Massachusetts Institute of Technology. The committee met to discuss and plan improved and modernized courses in physical science for secondary schools, under a program sponsored by the National Science Foundation. In attendance were forty-eight committee members,* representing more than a dozen universities, government agencies, and commercial laboratories.

The conference began with the presentation and discussion of syllabi prepared by the Bell Laboratories, the Cambridge, and the Cornell groups. Agreement was reached on the range of subject matter to be taught and on the guiding principles in its teaching. All agreed that the subject matter must be studied further before deciding how to apportion it among classroom, laboratory, and student participation. A broad outline of the course was agreed upon; several member groups accepted parts of it to work out in more detail.

Results of the conference indicate that the program has now progressed from the preliminary to the working stage.

General Aims of the Program

The program is aimed at the twenty-five or so percent of the student population who are now taking physics in high school. It is not specifically intended to prepare students for college physics. Its cultural purposes are: (1) to build a good scientific background in a section of the population (which, hopefully, will increase in size) and (2) to develop a physics course that emphasizes the essential intellectual, aesthetic, and historical background of physical science.

The program will initially concentrate on physics, interweaving chemistry when needed (for example, in the discussion of the structure of matter or of the kinetic theory of gases). A course combining physics and chemistry will be prepared later for use as a two-year high school course.

Specific Objectives

In teaching the physical sciences, certain objectives must be kept in mind and subject matter must be organized so as to bring these objectives into evidence. The following considerations point up some of these objectives:

1. *The Unity of Physical Science*
   Physical science, in interpreting the world around us, cannot be divided into many independent fields because the phenomena it covers are interrelated.
2. *Regularities*
   In discovering this interrelation, the observation of regularities in physical phenomena is necessary before laws covering the phenomena or models underlying them can be formulated.
3. *Many Independent Arguments for One Law*
   In establishing physical laws, many independent arguments should be used to help show the solidity with which the laws themselves are founded.
4. *Deduction of Phenomena from Laws*
   From laws established to correlate one set of phenomena or more, we can deduce many other physical conclusions. We can make many deductions from the laws to show their power and scope. Even a simple physical law, such as the law of refraction, can be extended from a few cases to many more complex cases. Certain laws like the conservation of energy apply to a very large range of phenomena.
5. *Limitations of Physical Laws*
   Physical laws are established over a range of phenomena and within a range of accuracy; thus established, they are not subject to further modification. True, the range over which a physical law is valid may extend to include new phenomena; but it must be emphasized that the range is usually limited.
6. *Models*
   Models often provide a possible explanatory background for observed phenomena and suggest relations among them, which can then be investigated. When investigations reveal the limitations of laws or models previously established over a limited range, there may be established new physical laws and new models that extend the range of applicability to new phenomena. A new model thus replaces the old one but it must be stressed that it *includes* it.

Coverage

After considerable discussion, the committee agreed that physics would be more meaningful to the student and its unity would be stressed if the presentation of the subject matter were focused toward one goal, and that this goal ought to be *the atomic picture of the universe.* This does not preclude specific goals for single parts; for example, the Newtonian picture of the uni-

* For those present, see list at end of this report.

verse can still be taken as the goal of mechanics. The atomic picture will show physics as an open field of knowledge where much has still to be done, rather than as a closed discipline. On the other hand, to show the coherence and power of physical ideas, certain narrower fields must be explored deeply, slowly, and thoroughly. The two fields of optics and waves and of mechanics will be given intensive treatment. Such intensive treatment cannot be given throughout the whole range of physical phenomena and indeed certain parts of the usual high school physics course must be omitted to save time for an intensive treatment of these two fields.

Tentative Chronological Outline of the Course

I. *The Universe and Other Things*
- Sizes and numbers
- Structure of universe
- Atomic structure of matter
- Molecular interpretation of chemistry
- Size and number of atoms

II. *Light and Waves*
- Rectilinear propagation
- Reflection
- Refraction
- Corpuscular and wave models
- Wave phenomena
- Mechanical waves
- Interference
- Measurement of wavelength

III. *Mechanics*
- Inertia
- Impulses and momentum
- Mass; force; kinetic energy
- Universal gravitation from planetary motion
- Conservation laws
- Kinetic theory of gases
- Coulomb's law; forces in electric and magnetic fields
- Induction on moving conductors

IV. *Atoms*
- Discreteness
- Electron charge
- Nuclear model of atoms
- Size, charge, mass of nucleus

In this order the emphasis moves naturally from the kinematic to the dynamic description of phenomena.

Aids to Learning

Plans for the program include the development of several integrated learning aids. The most important at present are listed below:

1. An outline for the course, designed to integrate the use of a textbook, films, film strips, demonstration material, and wall charts.
2. A textbook embodying the topics and philosophy of this study.
3. A list of questions carefully planned to lead the student forward from where the course leaves him.
4. A program of laboratory work.
5. Monographs supplementing the course by presenting omitted subjects and enlarging others.

Other items which are planned for development include: a manual for students with a glossary; questions for an examination on the course; a manual for teachers; a resource book for teachers; and a bibliography and list of references.

The Role of Monographs

It is hoped that many students will want to deepen and extend their knowledge, and will want to examine some fields and applications that will be omitted from the course. Consequently a variety of monographs will be prepared. Some monographs may explore entirely new fields; some may go deeper in fields explored in the course. For example, controversy played an important role in the evolution of science. Monographs describing famous controversies and their significance in relation to their times will make it possible to tie science with history. Controversy may also add interest to the basic course.

Collaboration

It was the consensus of those attending the conference that to be successful the program must be developed in collaboration with secondary school teachers and officials, publishers, film distributors, scientific apparatus makers, and a variety of writers. Interested people with suitable skills are being recruited.

Physical Science Study Committee

Conference Participants, December 10–12, 1956

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