PHYSICS in EDUCATION

The report of a conference sponsored by the Fund for the Advancement of Education and organized by the American Institute of Physics and the American Association of Physics Teachers.

THERE are indications that the physics teaching situation in the United States is especially acute at the present time and that it will be even more so in the years to come unless physicists act promptly to expand and intensify their programs relating to physics education. In recognition of this need the American Institute of Physics and the American Association of Physics Teachers, being the two physics organizations most immediately concerned, joined with the Fund for the Advancement of Education in calling a conference in August, 1956, to review the status of their present activities and to consider what further steps might be taken to insure the best use of the good physics teachers now available, to increase the number of competent teachers, and to assist teachers in continuing their education and in improving the quality of their teaching.

Both the AIP and the AAPT have sponsored activities intended to improve the quality of physics teaching at the secondary school and college levels. Through their endeavors to encourage the study and teaching of physics the two organizations are contributing to the larger effort to alleviate the nation-wide shortage of scientific and engineering manpower. The reasons for that shortage are far-reaching and complex. They include the vastly increased federal and industrial activities of the postwar years which have absorbed the bulk of the nation's resources of technical manpower and have drawn large numbers of talented teachers of science from the faculties of high schools and colleges. They also include a variety of economic and social factors that have adversely affected the whole of American education and have led to a prevailing climate of public opinion that has tended to discourage students from choosing careers in either science or teaching. The direct consequences are a dearth of trained science teachers, a declining enrollment rate in the sciences, and an annual crop of new scientists and engineers that falls far short of satisfying existing demands. The problem is national in scope and it is evident that its solution will require the combined and sustained attention of government, industry, education, and the scientific and engineering professions.

Physics education is the primary responsibility of the American Association of Physics Teachers, a national organization devoted to the advancement of the teaching of physics. Now, as in the past, committees of the Association are concentrating their attention and efforts on specific programs aimed at improving the quality of physics education in secondary schools and colleges. At a local level, the regional sections of the AAPT are in many cases in touch with individual school situations and are in a position to make effective contributions through personal contacts with both teachers and students. The American Institute of Physics, a federation of the several societies of physicists in the United States, has a fundamental obligation to advance the welfare of the whole of physics. The AIP, representing the great majority of all American physicists, has acted to meet the emergency in physics education by cooperating with the AAPT and other scientific and technical organizations through specially constituted panels, by informing physicists and the public of the nature and urgency of problems in physics education, and by making its services and its counsel available to the agencies of the federal government in matters pertaining to physics manpower and training. It has become clear that an increase in these activities is needed and that they must be supplemented by a substantial AIP liaison effort designed to strengthen their effect.

The Conference on Physics in Education was held August 8–9, 1956, at the Savoy-Plaza Hotel in New York City. It was largely conceived as a program-mapping conference to advance the recommendations of the NRC-AIP Conference on the Production of Physicists which was held in the spring of 1955 by the National Research Council and the American Institute of Physics at the Greenbrier Hotel in White Sulphur Springs, West Virginia (for the full report of the NRC-AIP conference see *Physics Today,* June, 1955). The interests represented by those who were invited to take part

in the present conference can be seen from the following list of its members:

Participants in the Conference on Physics Education

Henry A. Barton	American Institute of Physics, New York, N. Y.
J. W. Buchta	University of Minnesota, Minneapolis, Minn.
Robert Carleton	National Science Teachers Association, Washington, D. C.
John S. Coleman	National Academy of Sciences, Washington, D. C.
S. Winston Cram	Kansas State Teachers College, Emporia, Kan.
Vernet E. Eaton	Wesleyan University, Middletown, Conn.
Alvin Eurich	Fund for the Advancement of Education, New York, N. Y.
Cuthbert C. Hurd	International Business Machines Corp., New York, N. Y.
Morris Meister	Bronx High School of Science, New York, N. Y.
Walter C. Michels	Bryn Mawr College, Bryn Mawr, Pa.
Leo Nedelsky	University of Chicago, Chicago, Ill.
Eric Rodgers	University of Alabama, University, Ala.
A. L. Samuels *	International Business Machines Research Center, Poughkeepsie, N. Y.
Harvey White	University of California, Berkeley, Calif.
Charles A. Young	Northeast High School, Philadelphia, Pa.
Mark W. Zemansky	College of the City of New York, N. Y.

* Alternate for Dr. Hurd on the second day.

The conference agenda called for summaries of the problems involved in physics education, a review of what physicists are now doing towards their solution, and an estimate of the emerging situation in terms of a practical program for the future.

THE 1955 NRC-AIP conference report, and a number of other studies, have provided a detailed picture of what is now lacking in physics textbooks, courses, and teaching. Students, it is agreed, are developing attitudes of monumental indifference towards the study of physics, which is most often treated as a dull, difficult, and uninspiring subject. Much criticism has been leveled at the elementary physics textbooks used in high schools and colleges on the grounds that they are overly dependent upon outmoded traditions in physics and fail to reflect adequately either the remarkable experimental and theoretical advances of that science or recent ideas on the art of properly communicating the role of physics in the modern world. The fact that relatively few of those who are now teaching high school physics actually chose physics as a major or even a minor course of study in their undergraduate college careers suggests why the majority of teachers might find it difficult to instill enthusiasm for physics in the minds of their students.

It has been argued by some that a background of high school physics is of dubious value to the college physics student, and that in view of the unlikelihood that high school students can hope to receive adequate grounding in physical principles under existing conditions it might be better to forget about physics in the secondary schools and concentrate instead on providing strong undergraduate physics programs in college. On the other side, it is argued vehemently that the student's interest in a particular subject area is most often aroused long before he reaches college. Unless the student is offered an adequate and fair presentation of physics along with other high school subjects, it is maintained, his basic right to develop whatever interest in physics he wishes will have been abridged. It is significant to note in this regard that the great majority of college physics majors studied physics in high school.

In recognition of the crucial role played by the teacher in exciting the curiosity and zeal of his students, the conference urged that an organized effort be made by physicists to encourage and assist *all* teachers of secondary school physics in the task of improving their capacity to provide sound and stimulating instruction in their classes. While it is important that steps be taken to increase the quantity of teachers, it was felt that there is an even more urgent need for improving the quality of those already teaching physics.

Low salaries have often been cited in explanation of the shortage of highly qualified science teachers. In an age when college students are commonly besieged by personnel representatives and showered with job offers even before receiving their degrees it is not surprising to find that the high school teacher possessing a sound knowledge of physics should experience little difficulty in finding a position more remunerative than is teaching. The inducements now offered by other employment are such that only the highest degree of devotion to his calling is likely to keep the well-trained physics teacher from changing jobs. That such loyalty to physics teaching is occasionally found is one of the few really hopeful signs for the future, and it was the strong opinion of those who took part in the conference that far better use should be made of the few outstanding teachers who are still teaching physics.

It is customary for teachers in high schools to be burdened by heavy teaching loads (often in two or more different subjects) as well as by innumerable administrative assignments, meetings, routine duties, and extracurricular chores. It was emphasized that much can be gained by relieving good teachers of some of their less essential duties. More of their time could then be devoted to assisting other teachers who need help or to improving their own knowledge of physics.

Only a well-informed physics teacher can offer the stimulation and wise guidance needed to kindle and sustain the enthusiasm of a gifted student; but to benefit his students and himself by keeping in touch with developments in physics the teacher must be willing to give at least some part of his vacations to sum-

mer study. At the same time, the teacher is under pressure to accumulate credits towards the master's or doctor's degree in order to move into a higher salary bracket in the school system. The regular graduate courses in physics, however, require undergraduate physics prerequisites which the high school teacher generally has not had and consequently he finds no way of receiving credit for professional advancement by studying physics! As a result he most likely will feel forced to take more courses in education instead of the physics he really needs. The creation of summer institutes for high school teachers of science, in which educational institutions have in a number of cases provided graduate credit for studying in special science courses under programs offering scholarship help to those taking part, represents a positive step towards resolving the teacher's dilemma; but credits thus earned are not always transferable to other institutions and, in any event, the summer institutes have so far been able to benefit directly only a small fraction of the nation's high school science teachers. What is needed, the conference felt, is an earnest effort by scientists to convince university science and education departments alike that a broad program should be devised whereby graduate credit might be given to science teachers for studies designed to improve both their understanding of science and their ability to teach it. Until some solution is found, the high school teacher must choose between the sacrificial gesture of studying science for the good of his students or the possibility that he might eventually qualify for a financially-improved position in the school system if he can manage to accumulate enough credits in education.

EVERYTHING possible should be done to stimulate an increase in the number and competence of high school physics teachers. It is only realistic to admit, however, that for the foreseeable future there just will not be nearly enough teachers to meet the demand. High school enrollments are sharply increasing because of basic population growth in the pertinent age brackets and because the average number of years of school attendance per child is increasing. The fraction of high schools equipped to teach science is depressingly low and needs to be drastically increased. In the face of these evidences of greater need, the annual recruitment of science teachers is far too low and has actually declined in the last five years. Every effort must be made to reverse this trend.

The nation's high schools are faced, meanwhile, with an inevitable rise in the student-teacher ratio. In coping with this situation, it will not be enough just to free the time of teachers from other duties. Drastic innovations are called for. The expanded use of films and television, for example, should be resorted to on an emergency basis, and this should be accompanied by a program of evaluation and development, designed to establish such media as reliable and permanent resources serving to extend and supplement the personal contributions of good teachers.

The conference heard, with great interest, a report from Dr. Harvey E. White about an experimental program now in progress in Pittsburgh. Under a four-way partnership including the Fund for the Advancement of Education, the National Academy of Sciences, the Metropolitan Pittsburgh Educational Television station WQED, and a group of participating public schools, Dr. White is giving a televised course in high school physics comprising five half-hour demonstration lectures per week during the 1956–57 academic year. Apart from the immediate benefits expected from the course, it is felt that experience gained in this pilot program can be of immense value in future physics education projects employing modern communication techniques.

MANY scientific organizations, private foundations, government agencies, and industrial firms have sponsored programs or otherwise cooperated in the movement to advance science education. Conferences, committees, and study groups have examined the subject; scholarships have been provided for both teachers and students; summer institutes for high school teachers have been established and supported; steps have been taken to discover and encourage talented students; and communities have been given opportunities to see the fascinations of science fairs and hear the lectures of visiting scientists. The number of groups that have contributed time, money and effort to meeting the emergency in science education is very large, and since for the most part their programs have been conducted separately with only limited intercommunication it is difficult to assess or compare their accomplishments.

In physics, where numerous but scattered activities are in progress, it is little easier to measure advances. There is great need for collating information about various individual programs so that a clearer picture of the total effort in physics education may emerge. Some outstanding aspects of that effort were, however, reviewed at the conference where progress reports were submitted on the work of certain committees concerned with problems in physics education.

The Joint Committee on High School Teaching Materials, sponsored by the National Science Teachers Association, the American Association of Physics Teachers, and the American Institute of Physics, has reviewed several dozen high school textbooks and it was reported that not a single one was felt to be satisfactory. Major complaints were that the books lacked unity and proper emphasis on fundamental physical principles, and that some pedagogical concepts exerted such influence on the texts that their value as teaching aids, as well as the soundness of their physics, was impaired. The committee felt that the primary emphasis in secondary school texts should be placed on problems solving and the clear communication of ideas rather than on any detailed knowledge of isolated facts. Plans are now under way for a series of elementary pamphlets on specific topics in physics (e.g., heat, units and dimensions, etc.) which are intended as resource materials for distribution to high school teachers throughout the coun-

try. Six such pamphlets are to be written initially by members of the committee.

The AAPT Committee on Physics in Secondary Schools has been mainly concerned with the part played by high school physics courses in stimulating student interest in physics. It is also attempting to discover how more high school graduates might be influenced to take college physics. The committee is devising a questionnaire to be circulated among first-year college physics students in an effort to develop meaningful information on the initial factors prompting students to become involved in physics. It is hoped that a clear enough picture will emerge to permit associating particular levels of education with the first discernible sparks of student interest in becoming physicists. This study is being conducted in coordination with the Commission on the Science Teaching Improvement Program (STIP) of the American Association for the Advancement of Science.

The AAPT Committee on Testing is preparing specifications for tests to be used in physics courses. The tests would be prepared and administered by other agencies. The Committee is reviewing, with the cooperation of physics teachers in 162 institutions, what objectives should be the aim of physics courses, how success in achieving these objectives can be tested, etc. Broadly, the Committee's work may be viewed as analytical research on how physics can and should be taught. The planning of courses in relation to mathematics is, for example, under examination. Success in the Committee's efforts should contribute to the alleviation of ignorance, disinterest, and distrust of physics as a profession.

The joint AIP-AAPT Committee on Physics Teaching is advisory in nature. Its members have also represented physics at various national conferences. The largest task of the Committee to date has been to help the National Science Foundation review proposals from colleges for the establishment of teacher improvement institutes during the summer of 1956.

The AAPT Committee on the Preparation of Physics Teachers has been considering a program for visits of carefully selected physicists to smaller colleges. The visitors would lecture, confer with teachers and students, listen in on courses, etc. This would bring new information and ideas to the local department. The visitor would in turn carry away ideas to pass on to other institutions. This procedure has been tried with success in other scientific fields. The NSF has indicated an interest in such a program and the Committee has prepared a plan and application for funds.

The AAPT Committee on Scientific Apparatus for Educational Institutions aims to arrange for the provision of better, more interesting and less expensive apparatus for teaching physics. Dr. W. C. Kelly of the University of Pittsburgh is spending a year surveying the needs. Specifications resulting from the study should assist manufacturers in marketing the most needed apparatus. The study has been financed by the W. M. Welch Manufacturing Company with the understanding that the results will be made public and will be available to *all* manufacturers.

The American Physical Society-AAPT Committee on Cooperation with the High Schools is currently being appointed. Its purpose will be to bring professional physicists all over the country into direct contact and cooperation with high schools. The aim is to get physics into curricula, improve the introduction to physics provided by existing courses, and aid in vocational guidance work and assist the schools in gaining the support of their communities for such improvements.

IN summary, it was the conclusion of the conference that unfavorable public attitudes, high school problems, inadequacies of teacher preparation at all levels, insufficient numbers of teachers and other difficulties combine in threatening to impair the future quantity and quality of physicists in America. The emergency is so serious that measures more effective and rapid than have yet been employed must be taken to combat it. The conference urged the American Institute of Physics to enlist the services of a qualified man to help expedite the work of the Committees, to further the coordination of local-section activities, to administer visiting physicist and other programs requiring time-consuming initiative and attention, to assist in the preparation and distribution of vocational guidance information, and to represent physics at general conferences designed to produce more and better scientists. The Institute was urged to devote its public relations work largely to the support of the same objectives.

These and other recommendations are given formal expression in the following resolutions which were adopted by the Conference.

RESOLUTIONS

I. Be it resolved that it is a primary function of the American Institute of Physics to improve the understanding of the nature of physics and of the work of physicists on the part of the public at large, of high school students, and of college and university students. This conference, therefore, recommends to the Institute that it expand its facilities and increase its efforts in this direction; that it accept increasing responsibility for directing programs of cooperation with high schools and colleges now carried by various member societies.

Specifically, it is recommended that the Institute, with the help of member societies and of their local sections, develop immediately the following activities:

1. a wide public relations program designed to acquaint the public with the actual activities of physicists and the human basis of the activity known as physics;
2. a program under which lecturers and visiting scientists will be furnished to high schools and guided toward greater effectiveness in their contacts;
3. an expanded and more effective organization of student sections;

4. an effort to correlate its work more closely with that of other professional societies, such as the American Chemical Society, the American Mathematical Society, the American Association for the Advancement of Science and County Medical Societies of the American Medical Association.

II. As has been pointed out in an earlier resolution, the AIP, representing the majority of professional physicists, necessarily carries a responsibility for educational activities directed toward the general public, students, and teachers of physics. In order that the Institute may be in a position to fulfill these responsibilities in a manner adequate to the present national scene, this conference urges that the Governing Board of the Institute take immediate steps to set up a staff and to inaugurate a program which will aid and supplement the educational activities of the member societies. It is believed that the appointment of an outstanding person should be the first step and that he should then be supplied with whatever assistance is required. We believe that the hiring of the proper individual will be more difficult than the procurement of funds, hence we urge that efforts to obtain funds be entered concurrently.

III. *Whereas,* the present situation of the physical sciences demands the attention and active support of the scientists in the college and university departments, and

Whereas, in the past those in the college and university departments have not fully cooperated with other groups in alleviating the difficulties

Be it resolved, that the colleges and universities be urged to strengthen the program in the high schools by encouraging teachers in the secondary schools to take specially designed courses in physics which will bring to them the newer developments in physics and enable them to review the basic concepts and principles of physics. To bring the teacher into such physics classes it is recommended that the courses be organized at the level of the teacher's preparation and with his needs in mind; that arrangements be made with the Graduate Schools and Departments of Education which will permit the use of credit in these courses toward the master's degree in Education. The courses should be taught by members of the departments of physics and should receive the active sponsorship of those departments.

The program, now operated successfully in some universities, deserves consideration by other schools and the commendation of the AIP, APS, and AAPT and the consequent prestige that will result. Therefore this conference, in endorsing the resolution, also requests that copies be sent to the governing bodies of the above named organizations, to the heads of the departments of physics and to the deans of graduate schools.