PHYSICS in the PUBLIC HIGH SCHOOLS

By W. C. Kelly

THE enrollment in physics in public high schools of the United States has decreased steadily during the past six decades. In 1895, about 23% of all high school pupils were enrolled in physics.[1] Over 95% of those graduating in that year had taken a course in physics. In 1952, about 4.3% of high school pupils were enrolled in physics [2] and approximately 21% of the graduates of that year had studied physics. Thus, high school physics has declined in the same period that saw physics rise to new importance in our national life.

The incongruity of this situation needs no underlining for readers of *Physics Today*. In less critical times, we could look upon this as an educational curiosity to be corrected at leisure. Today, it represents a national problem. This article contains information about enrollment trends in physics and other sciences and a brief discussion of their significance.

What are the facts? Figure 1 shows changes in both the total enrollment in high schools of the nation and the physics enrollment. Although about a quarter of a million pupils study physics these days, a steady interest in physics has clearly not accompanied the upward surge of enrollment. Remember, however, that this was a period of profound change in the social structure and the curriculum of the schools. In 1890, about 203 000 pupils attended high school. This number was 3.8% of all young people of high school age. Physics was one of nine subjects. In 1952, 5.7 million pupils attended public high schools, and this was 65% of the eligible. Physics was one of 274 subjects.

Table 1 shows percentage enrollments in physics for 1949 according to states. Note that these percentage enrollments are based on the annual total enrollments and must be multiplied roughly by five, allowing for the drop-out, to give the percentage of graduates of that year who have studied physics.

Some distinctive features of high school physics emerged from a study [3] of 733 representative schools (3% of the public high schools of the United States) in 1947–48. Physics was offered in about 48% of the schools having grades in which physics is usually studied. Not much variation appeared among schools of various sizes in the percentage of pupils enrolled in physics. Thus, schools with populations of over 2500 pupils had 7.9% of the total twelfth-grade enrollment of the sample and 7.2% of the total physics enrollment. Schools with populations between 1000 and 2499 had 32% of the total enrollment and 38% of the total physics enrollment, and so on down to the smallest schools. The ratio of the number of boys to the number of girls in these physics classes was about three. In chemistry, this ratio was about 1.3. The average number in a physics section was 19; in a chemistry section, 23. About 75% of the schools offering physics included laboratory work. Most commonly, the recitation time per week was five periods of either 45-minute or 60-minute length. Laboratory time was usually two 45-minute periods per week. Very few schools apparently offered one-semester courses in physics.

TABLE 1: *Percentage physics enrollments in high schools, 1949*

Alabama	5.9	Nebraska	6.4
Arizona	4.5	Nevada	4.0
Arkansas	1.4	New Hampshire	8.2
California	4.0	New Jersey	7.6
Colorado	5.6	New Mexico	3.7
Connecticut	6.8	New York	5.9
Delaware	6.0	North Carolina	5.1
Florida	4.2	North Dakota	5.2
Georgia	3.8	Ohio	5.9
Idaho	6.0	Oklahoma	1.8
Illinois	6.3	Oregon	4.1
Indiana	5.6	Pennsylvania	8.5
Iowa	8.4	Rhode Island	8.8
Kansas	5.3	South Carolina	3.6
Kentucky	3.0	South Dakota	6.5
Louisiana	2.6	Tennessee	3.3
Maine	5.9	Texas	3.1
Maryland	7.1	Utah	3.7
Massachusetts	7.8	Vermont	6.1
Michigan	5.8	Virginia	2.2
Minnesota	6.6	Washington	4.9
Mississippi	3.2	West Virginia	3.0
Missouri	3.2	Wisconsin	8.1
Montana	5.4	Wyoming	5.7

How do physics enrollments compare with those in high school biology, general science, and chemistry? Figure 2 shows changes in the percentage national enrollments in these subjects. Biology, usually studied in the tenth grade, leads, having risen from about 7% to 20% in less than forty years. General science, a ninth-grade subject, is a close second. Judged by enrollments, biology and general science are the high school science studies. Chemistry has held its place relatively well at about 7.6% of the total enrollment. Physics struggles along with present enrollments somewhat larger than sociology (3.4%), for example, but decidedly less than agriculture (6.7%).

1 *Offerings and Enrollments in High School Subjects*, Chapter 5, Biennial Survey of Education, 1948–50, Federal Security Agency, Washington, 1951.

2 *A Report on School and Science Enrollments in Identical Schools during the Fall of 1947 and the Fall of 1952*, P. G. Johnson, Office of Education, mimeographed report, 1952.

3 *The Teaching of Science in Public High Schools*. Bulletin 1950, No. 9. Office of Education, Federal Security Agency, Washington, 1950.

W. C. Kelly, associate professor of physics at the University of Pittsburgh, has been on a year's leave of absence from Pittsburgh during the tenure of a Ford Faculty Fellowship which extends through May of this year.

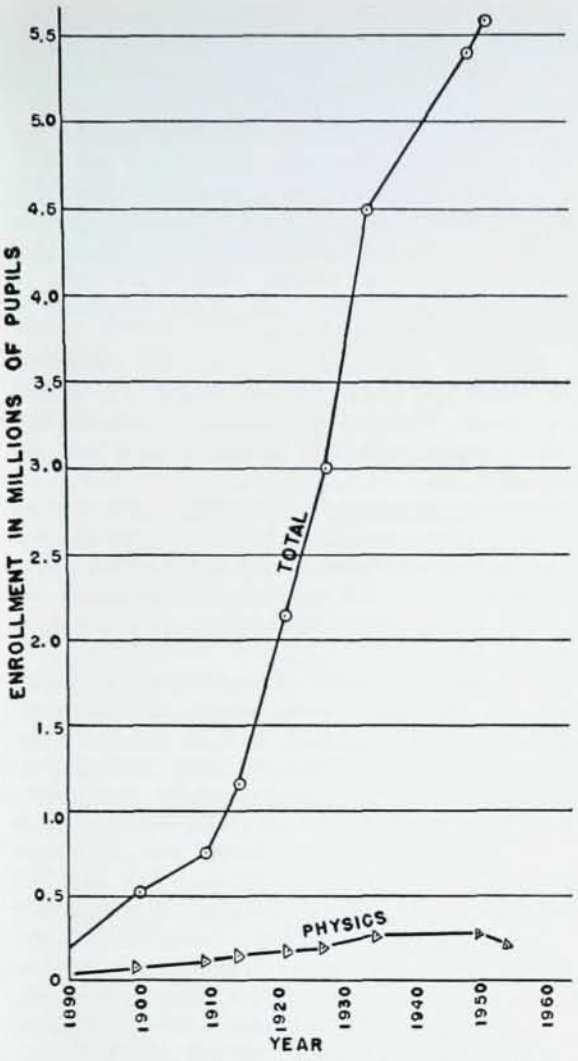

Fig. 1. Total enrollment and physics enrollment in the public high schools of the United States, 1890–1952.

Traditional high school mathematics has come upon hard times, too, as Figure 3 indicates. Algebra and geometry have declined in enrollment to about half of their enrollment in 1890. Trigonometry has come up slightly after a decrease in enrollment during the period 1910 to 1940. None of these studies, however, has undergone the decrease in enrollment by a factor of four that physics has experienced.

The evidence, then, is that physics has not only failed to please, but is not even looked upon as an educational K-ration. Unless its position in the schools is reinforced, high school physics will probably be transformed eventually into some other course—physical science, for example—which may or may not resemble systematic physics. A number of schools have experimented with a one-year course in physical science containing elements of physics, chemistry, astronomy, geology, and meteorology. A definitive description has not yet appeared. Here are two statements about such a course, representing somewhat different viewpoints.

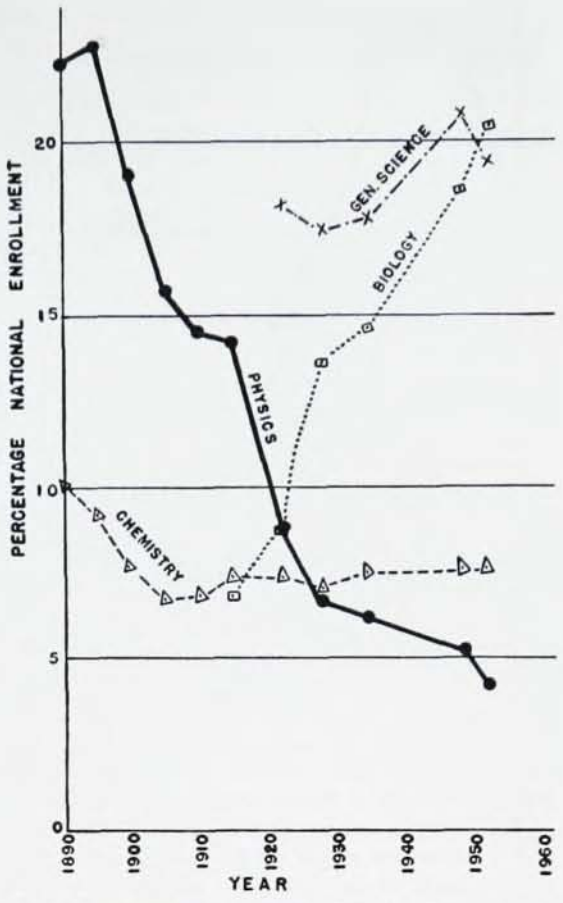

Fig. 2. Percentage national enrollments in four science courses, 1890–1952.

"The committee believes that it is reasonable that every high school student should be required to take a course in general biology, preferably at the ninth-grade level, and a course in general physical science, preferably at the tenth-grade level. Present trends in the teaching of science seem to indicate that the allocation of general science to grades one through eight with general biology and general physical science placed in the ninth and tenth grades offers a splendid base program of value to all students and from which the specialized courses such as chemistry and physics may well be logical outgrowths." [4]

"A review of the data seems to indicate that physics with its traditional objectives, organization, and content has lost its place as a high school subject. It does not fit into either the high school or the college pattern of modern education. Over fifty years of emphasis upon the need to make high school physics more functional in terms of the everyday life of the learner has been largely ignored by those responsible for elementary physics courses. The educational thinking which foreshadowed the decline of physics has at the same time defined the science course to replace it. Although the content of this new course is somewhat vague, its point of view and objectives are clear." [5]

[4] Final Report to the Central Association of Science and Mathematics Teachers, *School Sci. and Math.* **54**, 119 (1954).
[5] P. D. Hurd, *School Sci. and Math.*, **53**, 439 (1953).

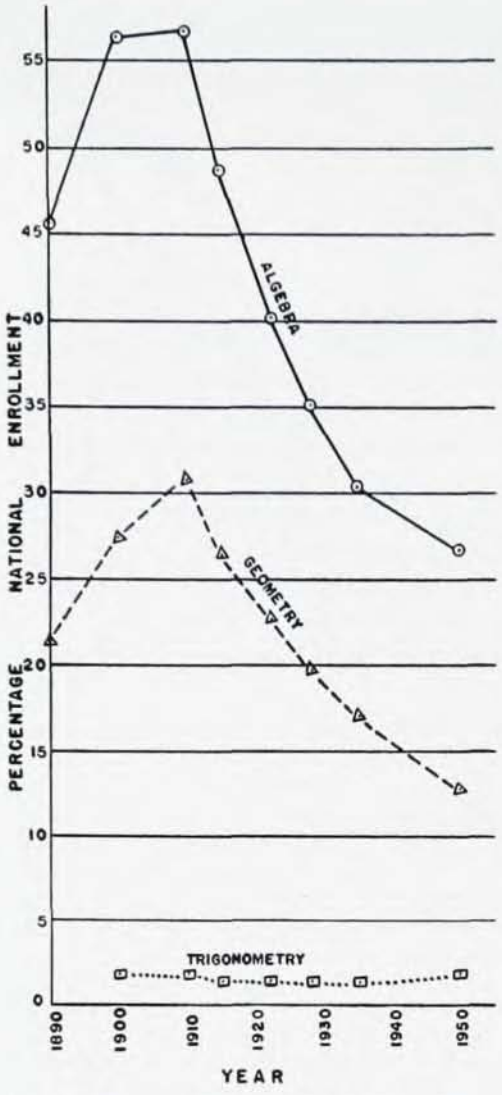

Fig. 3. Percentage national enrollments in mathematics, 1890–1949. "Algebra"—elementary and advanced algebra. "Geometry"—plane and solid geometry.

In 1952, the percentage national enrollment in physical science was about 3.8%. The pressure on public school administrators to replace physics and chemistry by a course in physical science will probably increase as the great rise in high school enrollment comes along late in this decade.

What attitude must physics as a profession take toward the decline of high school physics? Must we write off a subject which offers such splendid possibilities as a seed-bed of science talent and as a liberal study for our citizens in a scientific age? Are the needs of industry and the armed services for trainees with some knowledge of physics being met by the public high schools? These questions are directed to all who know the importance of physics in our national life.

Why has physics not realized its possibilities in the public schools? Many of the conditions which contribute have been identified by those who have studied this problem. Here are a few of the elements of the problem.

(1) *The preparation and the enthusiasm of the teacher* are of first importance. An excellent study[6] has recently outlined what must be done to train and keep effective science teachers.

(2) *The content of the course* needs critical scrutiny and revision. The subject matter has grown by accretion through the years and should be reduced. A more discriminating selection of subject matter can help to establish physics as a liberal study which contributes to the general education of the pupil.

(3) *Adequate equipment and time* for classroom demonstrations and laboratory experiments are lacking in many schools. Physics loses much of its meaning and most of its appeal when it is presented apart from its experimental basis.

(4) *Differential treatment of pupils according to their ability and interest* should be made a general practice. For teachers who have the will and the time, there are ways[7] of giving both the future scientist and his nonscientific classmate a satisfactory experience with physics.

(5) *The "public relations" of physics* need increased attention. Many pupils avoid physics because they know little about what it deals with or how it can be useful to them. Their parents and guidance counselors often know little more. Employers usually give no indication that physics would be a useful study. Physics has the reputation of being impossibly "tough" for all except a few unusually gifted persons. Any effective device for explaining physics to nonphysicists should be brought to bear on this problem—talks by physicists, leaflets, conferences with school administrators, and so on. In the long run, of course, the best influence on the community is a well-run course in high school physics taught by a competent, enthusiastic, and sympathetic teacher.

(6) *The graduation requirements of high schools and the admissions policies of colleges* might well be reexamined to see whether they reflect the needs of a civilization based increasingly on the physical sciences.

High school physics, as most practicing physicists have known it, is in a crucial situation. Its future will probably be decided within this decade. The decision will be a wiser one if physicists participate than if they remain aloof. A few physicists have given exemplary service in the past in their concern about high school physics. The problem is such a large one, however, that much more help is needed. Direction and inspiration can come from national organizations. But many more physicists and friends of physics, working as individuals or in local groups, with sympathy for the complex problems of the schools, must bring their talents and their enthusiasm to this problem.

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6 *Critical Years Ahead in Science Teaching*, Report of the Conference on Nation-wide Problems of Science Teaching in the Secondary Schools, Harvard University Printing Office, 1953. Copies may be obtained without charge from Mr. Elbert C. Weaver, Phillips Academy, Andover, Mass.

7 P. G. Johnson, *Am. J. Phys.* **15**, 480 (1947).