SELECTION AND STORAGE OF PHYSICS EQUIPMENT IN OREGON HIGH SCHOOLS

by

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CHAPTER I

INTRODUCTION

Factors Influencing Equipment Requirements

There are a number of factors which influence the amount of laboratory equipment and materials necessary for teaching a high-school physics course. Among these are the textbook, the pupils, the community, the size of the class, the number of demonstrations and pupil experiments, and the degree of pupil participation in laboratory work. Though the use of a state-adopted textbook in Oregon tends toward standardization in course content from one school to another, the teacher's choice of laboratory manual may cause considerable variation. The needs, interests, and abilities of the pupils vary appreciably between schools as well as between different classes in the same school. The influence of the community varies because of social and economic differences between communities. The size of the class and the decision of the teacher as to what demonstrations to perform and what experiments to ask the pupils to do, and the number of pupils who work together on each experiment, are the most important factors in determining how much equipment is necessary for teaching the

course.

This decision is often difficult to make because economy of time and money favors the demonstration method, though the pupil-experimentation method has been much more successful in developing problem-solving and instrumental skills than has the demonstration method. According to the Forty-sixth Yearbook of the National Society for the Study of Education (7, p.53), "Each method possesses certain unique values. Hence both are necessary, each to supplement the other, in every science course at every level."

Individual laboratory work is to be preferred over cooperative work because the latter usually results in a lack of participation by some pupils. Lack of equipment may force some sort of group laboratory work. However, the number of pupils working on a given experiment should not exceed two, unless the manipulatory activity involved requires more. In order to reduce the amount of equipment needed, experiments may be arranged so that no two groups of pupils are performing the same experiment at the same time, but this method has the disadvantages of sacrificing the order of the laboratory sequence and being difficult to supervise.

The physics teacher not only has all of the routine duties of classroom instruction, but in addition has the duties of selecting, maintaining, and storing laboratory supplies and equipment. These additional duties are very

laborious and time-consuming because of the large amount of equipment necessary for teaching physics.

Much of the equipment used in teaching high-school physics may be constructed by the pupils and teacher as projects, providing that sufficient time and the necessary tools and supplies are available. Repair shops and junk yards may serve as sources of materials or equipment. A lack of funds to purchase needed equipment may often increase the load of extra duties imposed upon the physics teacher by forcing him to devote undue time to the construction of equipment for demonstrations or experiments which he feels are necessary for the course. Since funds are usually limited, it is very important that they be properly expended. Each proposed expenditure should be carefully considered to determine its potential educational value so that more valuable items may be purchased before less valuable ones.

Statement of the Problem

A study of the teaching conditions affecting the work of science teachers in the State of New York (2, p.7) disclosed that nearly one-half of a group of 331 teachers reported inadequacies in science room furnishings, experimental equipment, or textbooks. In addition, 140 of 313 teachers reported that they had no laboratory work at all. A recent study made by the United States Office of

Education (13, p.41) found that the most frequently mentioned problems reported by 715 high schools in all parts of the nation were those related to equipment and supplies. The Department of Science Education of Oregon State College has received numerous requests for information concerning the minimum essentials in equipment and materials for a course in high-school physics. An answer to this question is sought by school administrators, science supervisors, and classroom teachers.

There is little doubt that many high-school physics teachers are handicapped by a lack of equipment for use in conducting demonstrations and laboratory experiments. This lack of essential equipment reduces the role of the teacher to talking about science instead of being able to demonstrate science, and eliminates the pupil participation so necessary to any science course. This lack of equipment has led to a great diversity in the content of the high-school physics courses and in the training which the individual pupils receive.

Another serious problem which confronts many of the high schools is that of proper storage of equipment and supplies after they have become the property of the school. Improper storage of equipment often results in the damaging of delicate instruments or in excessive corrosion of polished metal surfaces. Such damage reduces the useful life of the equipment and necessitates early repairs or

replacement. Such high repair and replacement costs of essential items prevent the acquisition of much desirable equipment.

The recognition of the need by high-school teachers for assistance in the selection and storage of equipment and materials for teaching high-school physics prompted the writer to make this study.

Purpose of the Study

A search of the literature revealed that master lists of apparatus for teaching high-school physics are available (11) and that lists have been published as a part of certain laboratory manuals which include the equipment required for the performance of all of the laboratory experiments in those particular manuals. There are also lists of minimum equipment which have been compiled by supply companies. The lists of the latter type usually include the equipment required for both laboratory and demonstration work, but are generally based upon items which are sold by the company compiling the list, and are furnished primarily for the purpose of furthering the sale of the company's products. These lists place no dependence upon the use of local resources, nor are they fitted to the needs and interests of the pupils or the requirements of the community.

Many suggestions appear in such literature as to how

materials should be stored, but most of these apply to ideal situations rather than to the best utilization of existing facilities.

It is the purpose of this study to determine the opinions of teachers in the field as to the minimum essentials in materials and equipment for teaching a high-school physics course. In order to make this study as useful as possible to the teachers of Oregon, it is restricted to the State of Oregon, the Oregon state course of study in high-school physics (19, pp.113-150), the state adopted textbook (10), and the laboratory manual by the same author (9).

Procedures Used in This Study

The Oregon School Directory (16) was used in the preparation of a list of high schools in the State of Oregon in which physics was included in the curriculum.

Lists of equipment and supplies were compiled by careful analysis of the state-adopted textbook in high-school physics, the physics laboratory manual by the same author, the Oregon state course of study in high-school physics, and various demonstration experiments in high-school physics. A questionnaire was prepared using these lists as a basis. The physics teachers of the schools selected to participate in the study were requested to mark the number of items which they thought to be <u>essential</u> for teaching a class of twenty-four pupils, and to mark the

number of items which they thought to be desirable for teaching the same class. Those items which the teachers considered to be neither essential nor desirable were to be indicated as unnecessary. Blank spaces were left on the questionnaire for the addition of any other items which the teachers thought necessary or desirable.

Information concerning the storage of equipment and supplies was obtained from the literature and from teachers' responses to the questions, "Are storage facilities adequate?" and "What should adequate storage facilities include?"

The Oregon State Department of Education and the Department of Science Education of Oregon State College expressed interest in this study and examined the lists of equipment. The letter of transmittal which accompanied the questionnaire was signed by the State Director of Secondary Education, the Head of the Department of Science Education of Oregon State College, and by the writer.

The questionnaires were mailed to the selected schools during March, 1951. A follow-up in the form of a postal card was sent as a reminder to those schools from which no reply had been received after a four-week period.

Limitations of the Study

The fact that only about one hundred of the 224 standard secondary schools in the state included physics in the

curriculum limited this study to less than half of the high schools in Oregon. The length of the questionnaire was undoubtedly the most serious limitation placed upon the study. It was necessary for the questionnaire to be long in order that most of the equipment and materials which might be necessary in teaching high-school physics would be included. Some of the teachers indicated that they spent as much as three hours in completing their questionnaires. Teachers as a rule are required to put in long hours, and the science teacher must spend additional time in preparation of demonstrations and laboratory experiments; therefore, it was to be expected that many of the teachers would decide that they could not afford the time necessary for the completion of the questionnaires.

The tendency to ask for more than that which is necessary in the hopes of having a reserve supply on hand may also have influenced some of the teachers in their responses. This tendency on the part of a few teachers showed up in the range of the numbers or quantities which the teachers requested and it did not seriously affect the median and the mode. The median number of quantity requested by the teachers was used as a basis in developing the suggested list presented in Chapter IV.

CHAPTER II

THE HISTORY OF PHYSICS TEACHING IN OREGON HIGH SCHOOLS

The teaching of physics as a science in Oregon high schools developed from a subject known as "Natural Philosophy" which was taught in the early academies and high schools of the state.

According to Bain (1, p.89) the second annual catalog or bulletin which was published by the Umpqua Academy for the school year 1856-1857 listed natural philosophy as a part of the curriculum. This is the earliest date for which the writer was able to find any information regarding the teaching of the subject in Oregon.

The First Biennial Report of the Superintendent of Public Instruction of the State of Oregon (14, p.21), covering the period from 1872-1874, contains the following quotation by the State Superintendent:

> I have tried to ascertain the number of schools in the state in which branches are taught which are not required in a county certificate, but have been unable to obtain any correct information on that point. I am inclined to believe, however, from what I can gather from the (County) Superintendents' reports that there are at least one hundred public schools in the state in which one or more of the following branches are taught: University Arithmetic, Algebra, Geometry, Composition, Natural Philosophy, Chemistry, Bookkeeping, and Physiology.

There were 518 public schools of ordinary grade and

but 12 of advanced grade covered in this report. Many of the schools of ordinary grade must have included some of the above subjects in the curriculum. This same report (14, p.34) lists Steele's Fourteen Weeks as being the first state-adopted textbook for natural philosophy. At this time physics was not taught on the high-school level as a separate science, but remained a part of the course in natural philosophy. This was not true on the college level, since the Corvallis State Agricultural College, during the school year 1873-1874, had a "School of Physics" (14, p.106). B. L. Arnold was president of the college and professor of physics at this time.

Undoubtedly the early academies and high schools were lacking in equipment for teaching "natural philosophy". Cubberley (8, p.469) wrote that some lecture-table demonstration had become common by 1850 in the better academies and high schools of the United States, and, after 1870, laboratory instruction for students began to find a place for itself. There is little information in the literature concerning the equipment which was available in Oregon at this time, with the exception that Bishop Scott Grammar and Divinity School in Portland was reported (14, p.102) as "having philosophical and chemical apparatus unsurpassed in the state" during the school year 1873-1874.

"The Sixteenth Annual Report of the Public Schools of the City of Portland, Oregon" (22, p.93), for the school

year 1888-1889, lists physics as an elective for pupils preparing for a college course. This is the first instance in which the writer found physics to be included under that title in the high-school curriculum in Oregon. However, previous reports of the public schools of Portland were not available, and it is possible that the subject might have been included in the curriculum of the Portland High School at an earlier date.

The University of Oregon catalog, for the school year 1893-1894 (20, p.49), lists physics as a required course for entrance into the freshman class and the catalog for the school year 1895-1896 (21) gives a suggested course of study for secondary schools which lists physics as a course which will be accepted for credit towards admission to the university.

"The Twenty-Sixth Annual Report of the Public Schools of the City of Portland, Oregon" (23, p.76) gives the following description of the high-school physics course as given in 1898-1899:

> Avery's School Physics. One period, forty-five minutes per day; recitation and laboratory practice on alternate days. Subjects taught: properties of matter, metric system, and mechanics and its application to solids, liquids, and gasses.

According to this report (23, p.74), there were 992 children registered in the Portland High School during the school year 1898-1899 and 159, or sixteen per cent, of

those registered were enrolled in physics.

The "Rules Governing the Standardizing and Accrediting of Secondary Schools" (17, p.90), which were adopted by the Oregon State Board of Education on November 1, 1920, state:

> If general science, biology, or physiology and botany, physics, and chemistry are all offered, the school must have the apparatus as given for the different subjects in the lists of apparatus which will be found following these rules. Every high school must offer courses in at least two of these subjects.

The explanatory information accompanying the list for teaching physics stated that the list was prepared by F. P. Stauffer of Lincoln High School, Portland, Oregon, and the list was largely taken from a laboratory manual. This list was prepared for a class of four to eight pupils and the total cost of the apparatus was $258.98 based upon the prices quoted in a catalog published in 1919.

The Oregon State Course of Study in High-school Science, published in 1937 (18, pp.86-92), contains a list of minimum equipment required for teaching a class in high-school physics of from ten to twelve pupils. This list contains both demonstration and laboratory apparatus and supplies and is based upon the state-adopted textbook and the accompanying laboratory manual in use at the time of publication of the list.

The peak enrollment in high-school physics in the United States, based upon percentage of enrollment, was in 1895. Table I (26, pp.28-29) shows this peak and a

following steady decline in the percentage of pupils enrolled. Beginning with 1910 the percentage of pupils enrolled is based upon the number of pupils in schools which reported studies to the United State Office of Education. In previous years, the percentage was based upon the total number of pupils in all of the public high schools of the nation.

TABLE I

REGISTRATION IN HIGH-SCHOOL PHYSICS IN THE UNITED STATES

Year	Number of pupils in high school	Number of pupils enrolled in physics	Per cent enrolled
1890	202.965	46,184	22.21
1895	350,099	79,720	22.27
1900	519,251	98,846	19.04
1905	679,702	106,430	15.66
1910	739,143	107,988	14.61
1915	1,165,495	165,854	14.23
1922	2,155,460	192,380	8.93
1928	2,896,630	198,402	6.85
1934	4,496,514	281,928	6.27

The United States Office of Education reports similar studies made in 1947 and 1948. The 1947 study (13, p.8) reported that 9,036 pupils of a total enrollment of 164,551 pupils registered in the reporting schools were enrolled in physics. The per cent enrolled in high-school physics in this test sample was 5.49. The study made in 1948 (24) reported a further decline in percentage of pupils enrolled. Two hundred ninety-one thousand four hundred

seventy-three pupils of a total enrollment of 5,399,452 pupils, or 5.40%, were reported as being enrolled in the physics course.

It should be noted that the percentage of total enrollment is based upon the number of pupils registered in grades nine through twelve and that, although the percentage of pupils enrolled in physics is now only one-fourth of what it was in 1895, the total number of pupils enrolled has increased many times since then.

Similar data for the State of Oregon were not available for the period from 1890 to 1930, but it is likely that the percentage of pupils enrolled in high-school physics in Oregon declined in the same manner. Table II is a compilation of the reported enrollments in physics and in applied physical science from the biennial reports of the State Superintendent of Public Instruction of the State of Oregon (15) for the period from 1930 to 1950.

TABLE II

ENROLLMENTS IN PHYSICS AND PHYSICAL SCIENCE

IN OREGON HIGH SCHOOLS

School Year	Enrollment in Physics	Per cent of total	Enrollment in Physical Science	Per cent of total
1930-1931	1339	2.74	--	--
1931-1932	1665	3.29	--	--
1932-1933	1691	3.05	--	--
1933-1934	2913	5.26	--	--
1934-1935	2279	3.95	--	--
1935-1936	2726	4.67	--	--
1936-1937	2603	4.33	--	--
1937-1938	2770	4.46	--	--
1938-1939	2841	4.53	--	--
1939-1940	2793	4.45	--	--
1940-1941	2419	3.95	85	0.13
1941-1942	2151	3.56	959	1.59
1942-1943	2289	4.00	300	0.53
1943-1944	2687	4.91	157	0.29
1944-1945	2496	4.42	227	0.41
1945-1946	2636	4.21	248	0.39
1946-1947	2743	4.43	467	0.75
1947-1948	2513	3.92	738	1.15
1948-1949	2466	3.78	477	0.73
1949-1950	2406	3.61	655	0.98

It is apparent from Table II that the percentage enrollment in high-school physics from 1930 to 1950 fluctuated from year to year. This fluctuation was probably due to the small number of pupils enrolled or to the practice of some small schools of offering physics and chemistry on alternate years. The percentage enrolled in physics in Oregon is below the national average. During the school year 1950-1951 approximately 100 of the 224 standard high schools in the state offered the course as a

part of the curriculum.

During recent years there has appeared a combined course in physical science which includes subject matter from both physics and chemistry. This course is generally taught in the smaller high schools of the state which lack space and equipment required for a science laboratory and solve the problem by offering a combined course without laboratory experience on the part of the pupils. Since this subject was only recently introduced into the smaller high schools of the state which did not formerly include physics in the curriculum, it is most likely that its introduction has had little influence on the decline of the proportion of pupils studying physics.

Steelman (27, p.85) listed the following factors which might contribute to the low enrollment in chemistry and physics:

1. The present offering does not provide adequately either for the needs of the students who do not intend to study science further, or for the science-talented students who are capable of rigorous work and do intend to continue in science.

2. The crowded secondary school curriculum does not permit the displacement of other subject areas.

3. College entrance requirements commonly require only one unit in science.

4. Many schools lack adequate equipment, methods,

and teaching personnel.

No matter what has caused this decline in the percentage of pupils enrolled in physics and chemistry, it is apparent that the decline continues. Enrollment in combined courses of physical science, however, is expected to increase. The Forty-sixth Yearbook of the National Society for the Study of Education (7, p.191) lists as reasons for this expected increase "Recognition of the superior possibilities of a composite physical science course ..... in contributing to the aims of general education, and the disposition of colleges to recognize the physical science course as a bonafide college-entrance unit for the non-science major".

CHAPTER III

THE STUDY

Significance of the Study

The primary purpose of the study was to prepare a suggestive list of equipment and materials which could be used by high-school physics teachers in evaluating the stock of equipment which they now have on hand and in determining what items of equipment should be secured to make their physics course more complete. The study also gathered information concerning the storage of the equipment and materials used in teaching high-school physics. This information is presented as a guide for proper storage of equipment and materials.

Methods Used in Securing the Information

Since no one is more aware of the requirements for teaching a given course than the classroom instructor, it was decided to obtain the opinions of teachers in the field as to their requirements for teaching high-school physics. A questionnaire containing one page of general questions covering the teaching of physics and nine pages on which 443 specific items of equipment and materials were listed was prepared by the writer.

The lists of equipment and materials were derived from

a careful analysis of the state course of study in high-school physics (19, pp.113-150), the state-adopted textbook (10), the physics laboratory manual by the same author (9), and from various lists of demonstration experiments. The lists of equipment and materials included those items which were mentioned in these sources with the exception of certain expensive items which could be borrowed from local sources. The equipment and materials were divided into a number of categories or lists in order to facilitate filling out the questionnaire. These lists were as follows: (1) Equipment for laboratory experiments, (2) Equipment for lecture demonstrations, (3) Glassware, (4) Chemicals for pupil experiments, (5) Chemicals for lecture demonstrations, (6) Tools, (7) Miscellaneous supplies, (8) Wire, and (9) Materials which can be purchased locally.

The teachers of the participating high schools were requested to indicate the number or amount of each item which was considered to be the minimum essential requirements for teaching physics to a class of twenty-four pupils and to indicate the number or amount which was considered desirable for teaching the same class. Items for which the teachers had no use were to be marked as unnecessary. Blank spaces were left at the end of each list for the addition of items by the teachers.

The questionnaire and a letter explaining the purpose of the study were mailed to seventy-five selected high

schools in the State of Oregon during March, 1951. Copies of the letter and the questionnaire appear in Appendices A and B. A follow-up in the form of a postal card was sent as a reminder to those schools from which no reply had been received after a four-week period. Forty-two replies, or fifty-six per cent of the total number of questionnaires which had been sent out, were received. The first page, containing the general information about teaching physics, was usable in all of the returned questionnaires, although answers to certain specific questions had been omitted by a few of the teachers. Three teachers completed only the first page of the questionnaire and indicated that they did not have time to complete the remainder or considered themselves not qualified to voice an opinion as to what their requirements might be. Two of the returns were received at too late a date to be included in the tabulation of the equipment and materials section. One return was based upon a class of ten pupils instead of the requested twenty-four and, with the exception of the page of general information, was not used.

Treatment of the Data

The data obtained from the page of general information were tabulated as the number of replies received for which an average, a median, and a mode were determined. The lists of equipment and materials were tabulated to include

the number of responses per item, the range in the number of items requested, the median number of items requested, and the mode. In cases where the median was in terms of a fraction of a specific item, it was raised to the next whole number if the fraction was equal to one-half or more; otherwise the fraction was dropped.

The original intent of the study was to determine the differences in equipment and materials requested by teachers from different sizes of schools. It was proposed to place the schools into groups based upon the enrollment. After making the necessary adjustments in the three-year and five-year high schools to a four-year basis, an examination of the data indicated that there was no consistent difference between sizes of schools. It is very probable that basing the questionnaire on a class of twenty-four pupils tended to erase the differences in opinion which would have existed had it been based upon the number of pupils actually enrolled in the classes.

Tabulation of the Data

The group of forty-two high schools which returned questionnaires was composed of seven three-year, thirty-three four-year, and two five-year high schools. The length of class period varied from fifty to sixty minutes. The average length of class period was 54.95 minutes and the median and the mode were both fifty-five minutes.

Administrative requirements usually restrict the laboratory period to the same amount of time as other class periods. Double periods have occasionally been used for science laboratories, but have led to difficulty in scheduling them to fit in with other courses on the high-school level. Wise (28, p.13) found that high-school teachers preferred a ninety-minute laboratory period and high-school principals favored a sixty-minute period.

The teachers' responses to the questions on the page of general information are tabulated in Table III. It is apparent from this table that approximately twenty-five per cent of the reporting schools do not offer a course in physics every year. In all but one of the schools in which physics was not taught each year, it was reported as being alternated with chemistry. About fifteen per cent of the reporting schools indicated that a combined course in physical science was taught. Less than one-half (forty-five per cent) of the teachers reported that the storage facilities for equipment and materials used in teaching physics were adequate. The number would probably be somewhat smaller if the schools had the materials on hand which the teachers indicated as being necessary or desirable.

TABLE III

GENERAL INFORMATION CONCERNING THE TEACHING OF PHYSICS IN OREGON HIGH SCHOOLS

Question	Yes	No	Per cent yes
Is physics taught each year?	31	11	73.8
Is physics alternated each year with chemistry?	10	27	27.0
Is a combined course in physical science taught?	6	33	15.4
Do you use special laboratory periods?	12	23	34.3
Do you use a specified number of periods each week for laboratory?	8	22	26.7
Is the laboratory period provided when needed?	33	2	94.3
Do you use demonstrations during class periods?	38	0	100.0
Do you use teacher demonstrations?	40	0	100.0
Do you use pupil demonstrations?	29	8	78.4
Do you use pupil-teacher demonstrations?	26	7	78.8
Do you use a single text?	34	7	82.9
Do you use a laboratory manual?	26	15	63.4
Are storage facilities adequate?	19	23	45.2

Tables IV through XII show the teachers' responses for each item appearing on the lists of equipment and materials. The limitation placed upon this study by the length of the questionnaire is indicated by the decreasing number of teacher responses per item from the first to the last page of the lists. A number of teachers indicated the actual time which they spent in filling out the questionnaire. This time varied from one and one-quarter hours to three hours.

There were certain items on which the teachers were reluctant to indicate their opinions. It is likely that lack of familiarity with the item or failure to recognize the item under the name used in the questionnaire contributed to the relatively low response to some of the items.

The lists of equipment and materials were prepared in such a manner that items which were included in the list for laboratory experiments were not included in the lists for lecture demonstrations. An exception to this is the demonstration generator which appears in both lists. Since only one was requested in each section, the recommended list contains only one of this type of generator.

Tables IV and V contain items of equipment which are used in the laboratory and in lecture demonstrations. It was anticipated that the teachers might assume that because certain items were listed under demonstrations that the

TABLE IV

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Ammeter, A.C., 0-15 amperes	36	1-6	1	2	36	1-12	12	6
Ammeter, D.C., 0-10 amperes	35	1-12	1,6	3	34	1-12	6	6
Aspirator bottle, 500 cc.	31	0-6	1	1	31	0-24	0	1
Balance, compression spring, 250 gm.	32	0-12	0,6	4	33	0-24	12	6
Balance, sensitive to 0.01 gm.	34	0-12	1	1	32	0-12	1	2
Balance, spring, 250 gm.	33	0-24	6	4	35	0-36	12	7
Balance, spring, 2000 gm.	35	0-24	6	6	35	0-36	12	10
Balance, spring, 30 lb.	33	0-6	1	1	34	0-12	1	1
Balance, trip with agate bearings	30	0-12	1	2	30	0-12	6	4
Balance support and clamp for meter stick	35	1-12	6	4	34	1-24	12	11
Barometer, aneroid	36	0-1	1	1	32	1-6	1	1
Barometer, mercurial	34	0-2	1	1	33	0-5	1	1
Battery jar, 1 gallon	34	1-12	1	3	34	0-12	6	6
Battery jar, 1 quart	36	0-12	0,2,6	2	35	0-18	12	4
Battery, storage, 6 volt	32	0-15	1	1	35	0-25	1	1
Battery stand and clamp	30	0-4	0	0	30	0-6	0	0
B battery, 90 volt	31	0-5	0	1	34	0-12	0-	1
Bell, electric	36	1-12	6	4	32	0-24	12	6
Binding posts	28	0-100	24	12	29	0-200	48	24
Block, aluminum, rectangular	34	0-12	1	3	33	0-24	12	6
Block, lead, rectangular	34	0-12	0,1,2	2	33	0-24	12	6
Bunsen burner with rubber tubing and wingtop	36	2-24	6	6	34	2-24	12	12
Calorimeter, aluminum	35	0-12	6	4	33	0-15	12	6

TABLE IV (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Calorimeter, brass	35	0-12	0	1	36	0-24	0	1
Calorimeter, electric	33	0-12	0	0	33	0-6	1	1
Caliper, micrometer	35	1-15	1	2	33	1-12	6	6
Caliper, vernier	36	1-15	1	3	34	1-12	12	6
Catch bucket	32	0-12	6	4	33	0-15	12	6
Clamp, burette	33	1-24	6	6	31	2-36	12	12
Clamp, C type	29	0-12	6	6	29	0-15	12	12
Clamp, meter stick	34	0-24	6,12	6	32	0-24	12	12
Clamp, pendulum	31	0-12	1	1	30	0-24	6	6
Clamp, screw (for rubber tubing)	33	0-50	6	6	32	0-50	12	12
Clamp, test tube	34	0-24	12	8	34	0-24	12	12
Clay triangle	34	0-24	0	2	35	0-25	0	6
Coefficient of expansion apparatus	34	1-12	1	1	33	1-12	6	4
Compass, magnetic	34	0-24	6	6	32	0-48	12	10
Compass, pencil	30	0-24	0	1	29	0-24	0	2
Compass needle	32	0-12	1	2	29	0-24	2,12	4
Composition-of-forces board	31	0-24	1	1	34	0-12	6	5
Connectors, brass	25	0-48	0	6	26	0-48	0	11
Conversion chart, English and metric units	33	0-4	1	1	31	0-12	1	1
Cylinder, aluminum (density)	34	1-12	1,6	4	32	0-15	12	7
Cylinder, brass (density)	34	0-12	1,6	3	32	0-14	12	6
Crucible, porcelain	30	0-24	6	6	31	0-36	0,12	12
Daniell cell	32	0-6	1	1	33	0-6	1	1
Demonstration cell	32	0-12	1	1	33	0-12	1	1

TABLE IV (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Dividers, measuring	31	0-24	0	2	31	0-24	12	6
Dry cell, 1½ volt (flashlight)	32	0-12	0	0	34	0-24	0	1
Dry cell, 1½ volt (standard no. 6)	34	2-36	12	12	34	4-48	12	12
Electrolysis apparatus	33	0-4	1	1	31	1-6	1	1
Evaporating dish	32	0-24	6	6	30	0-36	12	12
Forceps	34	0-24	6	6	31	0-24	12	12
Fuses (various types)	31	0-24	6	6	32	0-36	12	12
Galvanometer, demonstration type	35	0-2	1	1	30	0-4	1	1
Galvanometer, student type	35	0-12	6	3	36	0-12	6	6
Galvanoscope	35	0-12	1	1	29	0-12	0,1,12	2
Generator, demonstration type	34	0-2	1	1	28	0-6	1	1
Glass bulb (specific gravity)	34	0-12	1	1	34	0-12	12	5
Hall's cars (inclined plane)	34	0-12	6	3	30	0-12	12	7
Hot water heater (model)	32	0-2	0	0	30	0-6	0,1	1
Hydrometer, battery jar	33	0-6	1	1	31	0-12	1	3
Hydrometer, for liquids heavier than water	35	0-12	1	1	30	0-12	6	4
Hydrometer, for liquids highter than water	36	0-12	1	1	29	0-12	6	4
Hygrodeik	31	0-1	0	0	29	0-2	0	0
Hygrometer	31	0-1	1	1	26	0-3	1	1
Inclined plane apparatus	34	0-12	1	2	30	0-12	12	6
Jolly balance	31	0-12	0	1	29	0-12	0	1
Key, contact	34	0-12	6	4	31	0-24	12	12
Lamp, carbon filament, 16 c.p.	32	0-12	1	1	29	0-12	12	4
Lamp, carbon filament, 32 c.p.	32	0-6	1	1	29	0-12	1,12	2

TABLE IV (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Lamp, fluorescent with socket	31	0-6	1	1	29	0-12	1	1
Lamp board with sockets	34	0-6	1	1	28	0-12	1,6	4
Lens, double convex, 5cm.focal length	34	0-18	1	2	29	0-36	6	6
Lens, double convex, 10cm.focal length	34	1-18	1	2	29	1-24	6	6
Lens, double convex, 30cm. focal length	34	0-12	1	2	30	0-24	6,12	6
Lens, magnifying with handle	34	0-12	1	1	31	0-12	6	4
Lens holder	34	0-24	1	4	29	0-24	12	12
Light box	32	0-12	1	1	29	0-12	1,6	2
Magnet, bar	35	1-24	6	6	29	4-24	12	12
Magnet, horseshoe	35	1-12	6	6	29	1-24	12	12
Measure, 1 quart	32	0-10	1	1	27	0-12	1	2
Metal cup (highly polished for determination of dew point)	31	0-6	1	1	27	0-12	1	1
Meter stick, English and metric units	35	1-24	6	6	29	1-36	12	12
Metronome	31	0-2	1	1	30	0-12	1	1
Mirror, plane	34	1-12	6	6	29	1-24	12	12
Mirror, concave-convex	34	1-12	1	3	29	1-24	12	6
Milliammeter	31	0-6	1	1	27	0-12	1	1
Motor, A.C., $\frac{1}{4}$ h.p.	28	0-3	1	1	31	0-6	1	1
Motor, D.C., 1/8 h.p.	30	0-2	1	1	32	0-6	1	1
Motor, demonstration type (St. Louis)	33	1-14	1	1	28	1-12	1	4
Optical bench	34	0-12	1	1	29	0-12	12	6
Overflow can	34	0-12	6	4	29	0-15	12	12
Pendulum, with metal and wooden bobs	34	0-12	1	2	31	0-12	12	4
Prony brake	30	0-3	1	1	30	0-6	1	1
Protractor	35	0-24	6	6	30	0-30	24	12
Pulley, single sheave	35	0-24	4,6,12	5	32	0-24	12,24	10

TABLE IV (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Pulley, double sheave	34	0-24	4,6	5	32	0-24	24	8
Pulley, triple sheave	34	0-24	6	4	31	0-24	12	8
Reflector, parabolic	30	0-2	1	1	30	0-12	1	1
Relay, telegraph	34	0-12	1	1	30	0-12	1	2
Resistance box	35	0-12	1	2	31	0-12	6,12	4
Rheostat, 5 amp. (10 ohms)	33	0-12	1	1	30	0-12	6	4
Ringstand, with 3 rings	33	1-24	6	6	29	1-24	12	12
Rods for torsional apparatus	28	0-12	0	1	28	0-24	0	1
Ruler, English and metric units	31	0-24	6,12	6	30	0-30	24	16
Scale pans	27	0-12	0	2	26	0-24	0	4
Screen, ground glass	31	0-12	1	2	29	0-12	1,12	2
Screen, holder	32	0-12	6	4	29	0-12	12	6
Slidewire	29	0-12	1	1	26	0-12	0	2
Sling psychrometer	32	0-2	0	1	31	0-6	1	1
Speed (revolution) counter	31	0-2	1	1	30	0-4	1	1
Starting rheostat	27	0-2	1	1	30	0-6	1	1
Steam boiler	34	0-12	1	2	31	0-12	1	4
Stop watch	31	0-4	1	1	30	0-10	1	2
Switch, knife	34	0-18	6	6	31	0-36	12	12
Switch, push button	34	0-12	6	6	31	0-24	12	12
Temperature resistance coil	29	0-6	1	1	30	0-12	0	1
Telegraph key	33	0-12	1	2	31	1-12	1	3
Telegraph sounder	34	0-12	1	2	31	1-12	1	3
Thermometer, -10° to 110° C.	35	1-24	6	6	30	1-25	12	12
Thermometer, -5° to 250° C.	33	0-10	1	1	33	0-15	2	2
Thermometer, 30° to 400° F.	33	0-10	0	1	33	0-20	0	1

TABLE IV (Concluded)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum Requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Thermos bottle	30	0-4	1	1	34	0-6	1	1
Torsional apparatus	29	0-6	0	0	33	0-12	0	1
Towels	21	0-24	0	0	23	0-24	0	0
Triode vacuum tube and receptacle	29	0-24	1	1	29	0-12	1	1
Tripod	29	0-24	6	6	28	0-24	12	11
Tuning fork, 256 C	35	1-12	1	2	31	1-12	2	4
Tuning fork, 320 E	35	1-12	1	2	31	1-12	2	4
Tuning fork, 384 G	35	1-12	1	2	31	1-12	2	4
Tuning fork, 512 C'	35	1-12	1	2	31	1-12	2	4
Vacuum pump	33	1-2	1	1	31	1-6	1	1
Vibrograph	30	0-4	1	1	27	0-6	1	1
Voltmeter, 0-150 volts A.C.	33	1-6	1	1	30	1-12	1,2	4
Voltmeter, 0-10 volts D.C.	34	1-12	1	2	30	1-12	12	6
Water pan	26	0-12	0	3	25	0-20	12	6
Water trap for steam boiler	32	0-24	1	1	31	0-24	12	4
Weights, avoirdupois, 1 to 5 lbs.	33	0-20	1	1	32	0-20	2,6	2
Weights, metric, 1 to 1000 gms.	35	1-13	1	3	30	2-12	12	6
Weights, precision, to 100 gms.	33	0-12	1	1	30	0-15	1	3
Weights, slotted with hanger (set)	32	0-12	2	2	29	0-24	12	6
Wheatstone bridge	33	0-12	1	1	32	0-12	1	4
Wheel and axle	34	1-12	1	1	31	1-12	12	4
Wire gauze, asbestos center	34	0-24	6	6	32	0-24	12	12

teachers would mark only one each of these items as necessary. Although it was found that the median number requested was usually one, the range in the number of items requested indicates that some of the teachers would use the items in laboratory experiments.

An attempt was made to eliminate all duplications of items from the lists. There are, however, certain items which can be included under other headings. For example, both the Hygrodeik and the sling psychrometer are forms of hygrometers. In this particular instance the Hygrodeik was listed as unnecessary by a majority of the teachers, but a sling psychrometer was listed as essential. The hygrometer listed as being recommended in Chapter IV is a sling psychrometer.

One flashlight was found to be essential. Most of the teachers assumed that the batteries were included as a part of the flashlight, while a few did not make such as assumption. This difference was used as a basis for listing the items as "flashlight with batteries" in the recommended list.

Since the torsional apparatus was determined as desirable but not essential, the rod for the torsional apparatus, although determined as essential, was dropped from the recommended list of minimum equipment.

The relatively few responses to the item "towels" may be explained in that many teachers indicated in the

TABLE V

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Airplane, toy	27	0-1	0	0	34	0-3	1	1
Baroscope (for demonstrating buoyancy of air)	27	0-3	0,1	1	32	0-6	1	1
Bicycle pump	27	0-1	1	1	30	0-2	1	1
Bimetallic bar	28	0-2	1	1	30	0-4	1	1
Bucket and cylinder (Archimedes)	30	0-3	1	1	27	0-8	1	1
Cartesian diver	29	0-6	1	1	31	0-6	1	1
Cathode ray oscilloscope	28	0-1	1	1	31	0-2	1	1
Circuit breaker, electromagnetic	27	0-1	1	1	29	0-6	1	1
Circuit breaker, thermostatic	25	0-1	1	1	28	0-6	1	1
Color disk	31	0-1	1	1	28	0-2	1	1
Condenser, automobile	30	0-2	1	1	31	0-6	1	1
Condenser, variable	32	0-2	1	1	27	0-12	1	1
Cryophorus (for demonstrating freezing by evaporation	30	0-1	1	1	29	0-1	1	1
Electroscope, metal leaf	35	1-6	1	1	27	1-6	1	1
Electroscope, pith ball	33	0-6	1	1	29	0-6	1	1
Electroscope, vacuum tube	28	0-1	0	0	31	0-2	1	1
Electrostatic machine (Wimshurst)	29	0-1	1	1	30	0-2	1	1
Electric fan	28	0-1	1	1	30	0-2	1	1
Extension cord	33	0-6	1	1	28	0-12	1	2
Filter, colored glass	31	0-6	1	1	29	0-24	1	1
Filter, ultraviolet	29	0-3	1	1	31	0-6	1	1
Filter, Wratten A (yellow)	28	0-3	1	1	30	0-6	1	1
Filter, Wratten B (green)	29	0-3	1	1	31	0-6	1	1

TABLE V (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Filter, Wratten C (blue)	28	0-3	1	1	30	0-6	1	1
Filter, Wratten G (red)	28	0-3	1	1	30	0-6	1	1
Flashlight	30	0-1	1	1	30	0-6	1	1
Funnel, metal, 6 inch	30	0-6	1	1	30	0-12	1	1
Generator, A.C.	25	0-1	1	1	31	0-3	1	1
Generator, automobile	24	0-1	0	0	31	0-3	1	1
Generator, demonstration	29	0-1	1	1	27	0-1	1	1
Generator, mechanical	28	0-1	1	1	29	0-3	1	1
Governor, steam engine (model)	25	0-3	1	1	32	0-6	1	1
Gyroscope	34	0-3	1	1	29	0-6	1	1
Hydraulic press (model)	30	0-1	1	1	30	0-3	1	1
Induction coil	34	1-3	1	1	30	1-6	1	1
Lamp, neon glow, 2 watt	25	0-6	1	1	29	0-12	1	1
Lamp, sodium vapor	24	0-6	1	1	31	0-12	1	1
Leyden jar	31	0-6	1	1	31	0-12	1	2
Magdeburg hemispheres	31	0-1	1	1	29	0-4	1	1
Magnet, alnico	29	0-12	1	1	27	0-6	1	2
Magnet, cylindrical bar	28	0-24	0,1	1	29	0-12	1	1
Microphone, carbon granule	28	0-2	1	1	30	0-4	1	1
Microphone, condenser	28	0-2	0	0	32	0-4	1	1
Microphone, crystal	29	0-2	1	1	30	0-4	1	1
Microphone, moving coil	28	0-2	0	0	30	0-4	0	1
Microscope	26	0-12	1	1	31	0-24	1	1
Mirror, flexible metal	27	0-6	1	1	33	0-12	1	1
Motor, water	23	0-2	1	1	32	0-6	1	1
Motor-generator demonstration unit	23	0-1	1	1	31	0-2	1	1
Newton's ring apparatus	26	0-3	1	1	31	0-6	1	1

TABLE V (Continued)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Organ pipe	28	0-2	1	1	31	0-8	1	1
Pendulum bob, Foucalt type w/suspension	30	0-1	0	0	34	0-4	1	1
Phonograph turntable	28	0-1	0	0	33	0-1	0	0
Photoelectric cell	25	0-2	1	1	32	0-4	1	1
Photometer, bunsen	31	0-6	1	1	31	0-12	1	1
Polaroid disk	30	0-6	1	1	30	0-12	1	1
Plumb bob	26	0-6	1	1	32	0-12	1	1
Pneumatic trough (glass)	31	0-6	1	1	34	0-12	1	1
Pressure gauge (Bourdon type)	29	0-3	1	1	30	0-6	1	1
Prism, hollow glass	30	0-4	1	1	32	0-12	1	1
Projector, lantern slide	27	0-1	1	1	30	0-1	1	1
Pyrometer, portable hand type	29	0-2	0	0	31	0-6	1	1
Pump, compression (glass model)	29	0-2	1	1	30	0-6	1	1
Pump, force type (glass model)	30	0-2	1	1	28	0-6	1	1
Pump, lift type (glass model)	30	0-2	1	1	28	0-6	1	1
Radiometer, Crookes	31	0-2	1	1	31	0-6	1	1
Rectifier, tungar	28	0-2	1	1	32	0-4	1	1
Reflector, automobile headlight	28	0-4	0	0	34	0-6	1	1
Rod, glass	30	0-12	1	2	28	0-24	1	3
Rod, hard rubber	31	0-12	1	1	28	0-24	1	3
Radio tube, type 27	25	0-6	1	1	28	0-12	1	1
Radio tube, type 30	25	0-6	1	1	28	0-12	1	1
Radio tube, type 37	25	0-6	1	1	28	0-12	1	1
Radio tube, type 76	25	0-6	1	1	28	0-12	1	1
Resistor, 10 watt, 200 ohm	25	0-5	1	1	24	0-10	1	1
Resistor, 10 watt, 1600 ohm	25	0-3	1	1	24	0-6	1	1
Rotator, hand operated	31	0-2	1	1	27	0-6	1	1

TABLE V (Concluded)

TEACHERS' OPINIONS ON THE AMOUNT OF EQUIPMENT REQUIRED FOR USE IN DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Savart's wheel	29	0-1	0	0	28	0-3	0	1
Siren disk	29	0-1	1	1	28	0-3	1	1
Sonometer	31	0-6	1	1	30	0-6	1	1
Specific gravity stick	29	0-12	1	1	32	0-12	1	1
Spectrometer	25	0-3	0	0	31	0-6	1	1
Speedometer, automobile	26	0-3	0	0	34	0-6	1	1
Stroboscope	26	0-3	0	0	32	0-6	1	1
Switch, single pole, double throw	32	0-6	1	1	30	0-16	2	2
Switch, double pole, double throw	30	0-6	1	1	30	0-16	1	2
Switch, double pole, single throw	32	0-6	1	1	29	0-16	1	2
Switch, rotary	29	0-6	0	1	31	0-16	0	1
Switch, toggle	28	0-6	0	1	29	0-16	0	1
Syringe bulb	25	0-10	1	1	29	0-12	1	1
Thermocouple	27	0-4	1	1	29	0-6	1	1
Thermometer, air	27	0-6	1	1	29	0-12	1	1
Thermometer, maximum-minimum	25	0-2	1	1	32	0-6	1	1
Transformer	30	0-6	1	1	27	0-12	1	1
Transformer core	25	0-4	1	1	31	0-6	1	1
Tuning forks, one pair mounted in resonance boxes	32	0-1	1	1	29	0-4	1	1
Telephone transmitter and receiver	28	0-1	1	1	29	0-3	1	1
Whistle, high frequency	28	0-3	1	1	30	0-6	1	1
Wattmeter	27	0-4	1	1	33	0-6	1	1

margins that the pupils were required to purchase their own or that paper towels were furnished through the janitorial services. This item, although necessary, has been omitted from the recommended list.

Table VI shows the teachers' responses to the items on the list of glassware. It is significant that there is only one item -- a bell jar -- that was considered necessary by all of the teachers. It would be extremely difficult to conduct a course in physics without the use of some of the other items of glassware. These items are often borrowed from the chemistry stockroom and it is possible that some of the teachers did not include as necessary those items which they were able to borrow from this source.

Tables VII and VIII show the responses to the amount of various chemicals. That teachers were somewhat reluctant to list their requirements of chemicals is shown by fewer responses per chemical item than for the remainder of the lists. A common reply was that chemicals were obtained through the chemistry stockroom whenever required and no record was made of the amounts involved. The procedure of purchasing supplies common to two or more courses on one order is good practice in that advantage may be taken of bulk prices, but a record should be made of the amounts used in each course.

One ounce of mercuric oxide was determined as being

TABLE VI

TEACHERS' OPINIONS ON THE AMOUNT OF GLASSWARE REQUIRED

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Beaker, 100 ml.	31	0-24	6,12	6	27	0-50	12	12
Beaker, 250 ml.	32	0-24	12	6	27	0-50	12	12
Beaker, 400 ml.	31	0-24	12	6	27	0-50	12	12
Beaker, 1000 ml.	30	0-24	6	6	26	0-50	12	10
Bell jar	31	1-12	1	1	25	1-12	1	2
Bottle, 2 liter	29	0-12	1	1	26	0-24	0	2
Burette, 100 ml.	28	0-15	0,2	2	30	0-24	12	3
Condenser, Liebig	29	0-12	1	1	30	0-24	1,6	4
Cylinder, graduated, 25 ml.	32	0-24	0	2	30	0-50	0	6
Cylinder, graduated, 100 ml.	30	0-24	6	4	30	0-50	12	7
Cylinder, graduated, 250 ml.	31	0-24	1	2	27	0-30	12	4
Cylinder, graduated, 1000 ml.	31	0-12	1	1	28	0-20	6	3
Cylinder, hydrometer jar, 12 inch	28	0-12	1	1	27	0-12	0,4	3
Eudiometer tube	29	0-5	0	0	30	0-12	0	1
Flask, distilling, 250 ml.	31	0-24	1	2	31	0-50	12	5
Flask, Erlenmeyer, 50 ml.	30	0-72	0,6	4	28	0-100	0,12	6
Flask, filtering	29	0-24	0	1	29	0-50	0	3
Flask, round bottomed, 250 ml.	30	0-24	6	5	28	0-50	12	6
Funnel, 4 inch diameter	33	0-24	1	3	29	0-50	12	7
J-tube	29	0-24	1	1	30	0-25	1,2,6	2
Manometer, open tube, 6-7 mm. diameter (for mercurial barometers)	32	0-24	1	1	27	0-25	0	3
Pycnometer, 25 ml. (specific gravity bottle)	31	0-15	1	1	31	0-15	1,2,12	3

TABLE VI (Concluded)

TEACHERS' OPINIONS ON THE AMOUNT OF GLASSWARE REQUIRED

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Resonance tube, glass	31	0-15	1	1	28	0-15	1	3
Rod, stirring (lbs.)	29	0-12	1	1	24	0-6	1	1
T-tube	29	0-24	0	2	25	0-50	0	4
Test tube, 6 inch (pyrex)	32	0-144	12,24	18	29	0-200	24	36
Test tube, 8 inch	32	0-144	24	12	30	0-200	12,24	24
Thistle tube	33	0-24	6	6	31	0-36	12	12
Tubing, glass, 5-7 mm. diameter (lbs.)	30	0-15	5	4	21	0-12	10	5

TABLE VII

TEACHERS' OPINIONS ON THE AMOUNT OF CHEMICALS REQUIRED FOR USE IN PUPIL EXPERIMENTS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Acetamide (¼ lb. btl.)	26	0-8	1	1	27	0-8	1	1
Acid, benzoic (¼ lb. btl.)	24	0-4	0	0	24	0-8	0	0
Acid, citric (¼ lb. btl.)	23	0-4	0	0	24	0-8	0	0
Acid, hydrochloric (lbs.)	27	0-20	1	5	24	0-25	1,6	5
Acid, nitric (lbs.)	25	0-10	1	2	22	0-21	1	2
Acid, salicylic (¼ lb. btl.)	24	0-20	0	0	25	0-28	0	0
Acid, stearic (lbs.)	25	0-5	0	0	25	0-10	0	0
Acid, sulfuric (lbs.)	29	1-28	1,5	5	22	1-45	4,10	7
Acid, tartaric (¼ lb. btl.)	23	0-5	0	0	25	0-10	0	0
Alcohol, denatured (gallons)	29	0-10	1	1	25	1-25	1	1
Alcohol, 95% (gallons)	24	0-5	0	1	22	0-10	0	1
Bismuth metal (ozs.)	25	0-30	0	2	25	0-35	4	4
Copper sulfate crystals	29	1-10	1	2	25	1-16	5	5
Gum camphor (ozs.)	24	0-8	0	0	23	0-24	0	1
Iron filings (lbs.)	30	½-5	1	1	25	1-15	2	3
Mercury metal (lbs.)	30	1-15	5	5	26	1-20	5	5
Nickel metal, shot (¼ lb. can)	26	0-4	0	1	25	0-8	0	1
Potassium alum (¼ lb. btl.)	24	0-4	0	0	26	0-8	0	1
Potassium dichromate (¼ lb. btl.)	28	0-4	1	1	25	0-12	0	1
Potassium permanganate (¼ lb. btl.)	26	0-4	0,1	1	26	0-12	0	1
Pyrogallol (ozs.)	24	0-32	0	0	24	0-32	0	0
Sodium dichromate (¼ lb. btl.)	26	0-4	0	0	25	0-8	0	0
Tin metal, shot (¼ lb. can)	27	0-4	1	1	25	0-8	0,1,2	2
Resorcin (ozs.)	25	0-16	0	0	26	0-16	0	0
Zinc metal, mossy (lbs.)	28	0-5	1	1	25	0-8	0	2
Zinc oxide, powder (¼ lb. btl.)	28	0-4	0	0	24	0-4	0	1

TABLE VIII

TEACHERS' OPINIONS ON THE AMOUNT OF CHEMICALS REQUIRED FOR DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Acetone, (lbs.)	26	0-10	1	1	25	0-15	1	1
Acid, acetic (lbs.)	24	0-5	0	1	25	0-7	0	1
Aluminum powder (¼ lb. can)	25	0-4	1	1	24	0-8	1	1
Ammonium hydroxide, 26-28% (lbs.)	25	0-8	0,1	1	20	0-21	0	1
Ammonium nitrate (¼ lb. btl.)	25	0-8	0	0	25	0-8	0	0
Ammonium oxalate (¼ lb. btl.)	26	0-4	0	0	25	0-4	0	0
Anthracene (¼ lb. btl.)	25	0-1	0	0	24	0-2	0	0
Antimony metal, powder (¼ lb. btl.)	24	0-4	0	1	25	0-4	0	1
Benzene (lbs.)	23	0-5	0	1	22	0-8	0	1
Benzine (lbs.)	24	0-2	0	0	21	0-2	0	0
Calcium chloride (lbs.)	26	0-5	1	1	24	0-8	0	1
Carbon disulfide (lbs.)	25	0-5	1	1	24	0-8	0	1
Carbon tetrachloride (lbs.)	26	0-10	1	1	24	0-8	1,2	2
Chlorobenzene (lbs.)	25	0-2	0	0	25	0-2	0	0
Ether, ethyl (lbs.)	27	0-3	1	1	22	0-5	1	1
Fluorescein (ozs.)	25	0-4	0	0	25	0-8	0	0
Glycerine (¼ lb. btl.)	26	0-8	1	1	24	0-12	0	1
Hydrogen peroxide (¼ lb. btl.)	26	0-4	0	0	24	0-6	0	0
Iodine (ozs.)	25	0-16	0	1	23	0-16	0	1
Lampblack (lbs.)	24	0-1	1	1	23	0-2	1	1
Lead acetate (¼ lb. btl.)	25	0-1	0	0	22	0-4	0	0
Magnesium metal, ribbon (ozs.)	25	1-16	0	1	22	0-16	0	2
Manganese dioxide (¼ lb. btl.)	27	0-4	1	1	23	0-8	0	1
Manganese metal, powder (ozs.)	25	0-8	0	0	24	0-8	0	0
Mercuric Chloride (ozs.)	26	0-8	0	0	24	0-8	0	0
Mercuric oxide (ozs.)	27	0-32	0	1	24	0-48	0	0

TABLE VIII (Concluded)

TEACHERS' OPINIONS ON THE AMOUNT OF CHEMICALS REQUIRED FOR DEMONSTRATIONS

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Phenolphthalein (ozs.)	26	0-16	0	1	22	0-16	0	1
Phosphorus, yellow (ozs.)	24	0-16	0	0	24	0-32	0	0
Potassium Iodide (ozs.)	26	0-16	0	0	23	0-32	0	0
Silver nitrate (ozs.)	26	0-32	1	1	24	0-32	0	1
Sodium acetate ($\frac{1}{4}$ lb. btl.)	26	0-1	0	0	23	0-2	0	0
Sodium bisulfite ($\frac{1}{4}$ lb. btl.)	25	0-2	0	0	24	0-4	0	0
Sodium hydroxide (lbs.)	27	0-5	1	1	24	0-7	0	1
Sodium thiosulfate ($\frac{1}{4}$ lb. btl.)	26	0-4	1	1	25	0-12	0	1
Sulfur (lbs.)	25	0-5	0	1	23	0-5	0	1

necessary from the responses of twenty-seven teachers, but no mercuric oxide was desirable based upon the responses of twenty-four teachers. This contradiction was eliminated by considering one ounce of the material as being both necessary and desirable on the recommended list of chemicals.

Table IX shows the responses to the amount of tools necessary. The amount of work done in building and repairing equipment is limited by the tools and supplies which are available for use. These tools may be the property of the physics laboratory, or they may be borrowed from some other agency within the school. A triangular file was the only tool which was considered necessary by all of the teachers. Since most common use for this item is in cutting glass tubing, it appears as if some of the teachers were doing little in the way of building new equipment or in repairing equipment on hand.

Table X contains the opinions on a list of miscellaneous materials. Rubber stoppers and one-fourth inch rubber tubing were the only items on this list which all of the teachers listed as necessary. It should be noted that the rubber tubing on this list is in addition to that required for use with the bunsen burners. Aluminum, tin, and zinc tubing were determined as being unnecessary. The specific use for which this tubing was proposed in a demonstration experiment was the construction of a compensated pendulum.

Table XI shows the teachers' opinions on the amount of

TABLE IX

TEACHERS' OPINIONS ON THE AMOUNT OF TOOLS REQUIRED

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Corkborers, set of 6	32	0-4	1	1	27	0-6	1	1
Drill, hand operated	29	0-2	1	1	28	0-4	1	1
Drill, set of 1/16 to 3/8 inch dias.	29	0-2	1	1	27	0-2	1	1
File, flat	28	0-5	1	1	29	0-12	1	2
File, triangular	33	1-12	6	3	28	1-24	2	6
Glass cutter	31	0-6	1	1	28	0-12	1	2
Hammer, claw	29	0-3	1	1	28	0-6	1	1
Hacksaw, with blades	30	0-3	1	1	28	0-6	1	1
Measuring tape, 50 ft.	26	0-1	1	1	30	0-3	1	1
Pliers, needle nosed	31	0-6	1	1	27	0-12	1	1
Pliers, side cutting	31	0-6	1	1	27	0-12	1	1
Saw, crosscut	27	0-2	1	1	29	0-4	1	1
Scissors	31	0-6	1	1	28	0-12	1	1
Screw driver, small	32	0-6	1	1	27	0-12	1	1
Screw driver, medium	31	0-4	1	1	26	0-12	1	1
Screw driver, large	29	0-4	1	1	27	0-6	1	1
Snips, metal	30	0-6	1	1	27	0-12	1	1
Soldering iron	32	0-2	1	1	27	0-12	1	1
Square, carpenter's	28	0-2	1	1	31	0-4	1	1
Wrench, adjustable, 8 inch	29	0-3	1	1	28	0-6	1	1

TABLE X

TEACHERS' OPINIONS ON THE REQUIREMENTS OF MISCELLANEOUS SUPPLIES

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Aluminum foil (sq. ft.)	28	0-12	1	1	24	0-12	1,2	1
Aluminum shot (lbs.)	29	0-2	1	1	27	0-6	0	1
Asbestos sheet (sq. ft.)	28	0-10	3	3	24	0-6	0,2,4	4
Blue print paper (sheet 8x10 inches)	29	0-100	0	6	25	0-100	0	12
Copper gauze, fine mesh (sq. ft.)	26	0-8	1	1	23	0-15	1	1
Copper sheet, 1/16 in. (sq. ft.)	28	0-8	1	1	25	0-12	1,3	2
Copper shot (lbs.)	30	0-5	1	1	27	0-6	2	2
Carbon rod, $\frac{1}{2}$ in. dia. (ft.)	30	0-12	1	2	24	0-15	2	2
Lead sheet, 1/16 in. (sq. ft.)	28	0-5	1	1	25	0-6	1	1
Lead shot (lbs.)	30	0-5	1	1	27	0-10	2	2
Mica sheet (4x6 in. sheets)	28	0-12	0	1	26	0-12	0	1
Phosphorescent paint (ozs.)	30	0-6	0	1	26	0-10	0	1
Rubber dam (sq. ft.)	29	0-4	1	1	24	0-6	0	3
Stopcock grease (tube)	29	0-2	1	1	26	0-6	1	1
Stoppers, cork, assorted (lbs.)	29	0-5	1	1	25	0-10	2	2
Stoppers, rubber, assorted (lbs.	30	1-10	5	5	25	1-15	2	5
Tinfoil (sq. ft.)	27	0-5	0,1	1	27	0-25	0	1
Tubing, aluminum, $\frac{1}{4}$ in. (ft.)	29	0-12	0	0	28	0-12	0	0
Tubing, copper, $\frac{1}{4}$ in. (ft.)	29	0-12	0	1	29	0-20	0	2
Tubing, rubber, $\frac{1}{4}$ in. (ft.)	29	2-100	10	12	25	4-100	50	24
Tubing, rubber, 3/8 in. (pressure)	29	0-25	10	10	24	0-50	10	10
Tubing, tin, 1/8 in. (ft.)	29	0-6	0	0	29	0-10	0	0
Tubing, zinc, 1/8 in. (ft.)	29	0-6	0	0	29	0-10	0	0
Vacuum wax (ozs.)	29	0-16	2	2	25	0-16	2	4
Wood's metal (ozs.)	28	0-16	1	2	25	0-32	4	4
Zinc sheet, 1/16 in. (sq. ft.)	30	0-5	1	1	25	0-10	1	3

TABLE XI

TEACHERS' OPINIONS ON THE AMOUNT OF WIRE REQUIRED

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Wire:								
copper bare, no. 8 (lbs.)	26	0-4	1	1	25	0-10	1	2
copper, bare, no. 10 (lbs.)	27	0-4	1	1	27	0-10	1	2
copper, double cotton covered, no.18(lbs.)	29	0-10	1	1	28	0-6	2	2
copper, double cotton covered, no.24(lbs.)	27	0-10	1	1	24	0-6	2	2
copper, double cotton covered, no.28(lbs.)	29	0-10	1	1	25	0-12	1	1
copper, double cotton covered, no.30(lbs.)	27	0-10	1	1	24	0-5	1	1
copper, double cotton covered, no.34(lbs.)	27	0-10	1	1	25	0-5	1	1
copper, enameled, no. 24 (lbs.)	28	0-3	1	1	23	0-12	0	2
Copper, enameled, no. 28 (lbs.)	27	0-3	0	1	25	0-12	0	1
copper, enameled, no. 32 (lbs.)	27	0-2	0	1	24	0-12	0	1
copper, enameled, no. 36 (lbs.)	29	0-2	0	1	24	0-12	0	1
copper, rubber insulated, no. 12 (lbs.)	27	0-6	0,1	1	24	0-12	0	2
copper, rubber insulated, no. 14 (lbs.)	28	0-10	1	1	25	0-12	0	2
chromel, no. 12 (4 oz. spool)	25	0-2	0	0	25	0-4	0	0
chromel, no. 16 (4 oz. spool)	24	0-2	0	0	24	0-4	0	0
chromel, no. 20 (4 oz. spool)	26	0-2	0	0	23	0-4	0	0
nichrome, no. 12 (1 oz. spool)	27	0-3	1	1	24	0-5	1	1
nichrome, no. 16 (1 oz. spool)	26	0-3	0	0	24	0-5	0	0
nichrome, no. 20 (1 oz. spool)	27	0-3	1	1	25	0-5	0	1
nichrome, no. 24 (1 oz. spool)	25	0-4	1	1	23	0-5	1	1
nichrome, no. 27 (1 oz. spool)	27	0-4	0,1	1	24	0-5	0	1
piano, no. 2 (spool)	28	0-2	1	1	22	0-4	1	1
piano, no. 5 (spool)	28	0-2	1	1	22	0-5	1	1
piano, no. 7 (spool)	27	0-2	1	1	22	0-4	1	1

wire necessary. Many sizes and types of wire are required in the performance of demonstrations and experiments, although a great amount of any specific size or type is not normally required. The results seem to show that a great variety of sizes and types is felt necessary by the teachers. It is possible that the listing of many sizes of a specific kind of wire on the questionnaire may have led to its omission from the recommended list because the teachers did not agree on the size of wire preferred. This appears to have been true in the case of the chromel wire.

Table XII contains the teachers' opinions of their needs for materials on the list of items which could be purchased locally. These materials were placed in this group because they could be obtained from local sources when needed and, therefore, did not have to be ordered through one of the scientific supply companies. The amounts requested of these items by most of the teachers appear to be reasonable with the exception of one request for twenty-four quarts of shellac as necessary and forty-eight quarts as desirable. Various weights of oil were included in this list with the supposition that some of the teachers would use them in demonstrations or experiments concerning the viscosity of liquids. In spite of the fact that most of the teachers listed oil as being unnecessary, it is the opinion of the writer that a certain amount of oil is necessary for use as a lubricant and as a

rust preventative.

Table XIII contains the items which were added to the lists by the teachers. The response for any one of these items was not sufficient to include that item in the recommended list. The vacuum plate was assumed by the writer (and probably by many of the teachers) to be furnished with the vacuum pump. Since this item is listed separately in the supply catalogs, a vacuum plate has been included in the recommended list of equipment.

TABLE XII

TEACHERS' OPINIONS ON THE AMOUNT OF MATERIALS WHICH MAY BE PURCHASED LOCALLY

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Art colors (set)	27	0-3	0	0	28	0-6	0	1
Brads (ozs.)	25	0-8	0	1	27	0-16	0	2
Candles (lbs.)	31	1-24	1	1	27	1-10	2	2
Carpet tacks (ozs.)	24	0-16	1	1	27	0-16	2	2
Dowels, wooden, $\frac{1}{4}$ inch (ft.)	24	0-12	0	0	27	0-20	0	1
Dry ice (lbs.)	30	0-5	0	1	27	0-10	0	2
Fishline, silk (spool)	28	0-2	1	1	25	0-4	1,2	1
Glass marbles, (dozen)	31	0-2	0	0	28	0-4	0	0
Kerosene (gallon)	28	0-2	1	1	25	0-2	1	1
Lamp, auto headlight, 6 volt	27	0-6	0	1	23	0-6	0	1
Lamp, clear glass, 40 watt	26	0-6	1	1	21	0-12	0,2	2
Lamp, colored, red, 40 watt	26	0-4	1	1	20	0-12	0	1
Lamp, colored, blue, 40 watt	26	0-4	1	1	20	0-12	0	1
Lamp, colored, green, 40 watt	26	0-4	1	1	20	0-12	0	1
Lamp, tungsten, frosted, 25 watt	29	0-12	1	1	25	0-12	0	2
Lamp, tungsten, frosted, 40 watt	28	0-6	1	1	24	0-12	0,2,6	2
Lamp, tungsten, frosted, 60 watt	28	0-6	1	1	23	0-12	0,2	2
Lamp, tungsten, frosted, 100 watt	28	0-12	1	1	24	0-12	2	2
Lamp, tungsten, frosted, 150 watt	30	0-6	1	1	23	0-12	0,2	2
Nails, assorted (lbs.)	29	0-10	1	2	24	0-10	1,5	3
Naphthalene flakes (lbs.)	28	0-6	1	1	23	0-4	1	1
Needles, darning	27	0-36	12	6	23	0-24	12	12
Oil, SAE no. 10 (quarts)	29	0-1	0	0	21	0-2	0	0
Oil, SAE no. 20 (quarts)	23	0-1	0	0	22	0-2	0	0
Oil, SAE no. 30 (quarts)	27	0-1	0	0	23	0-2	0	0

TABLE XII (Concluded)

TEACHERS' OPINIONS ON THE AMOUNT OF MATERIALS WHICH MAY BE PURCHASED LOCALLY

Item	Minimum requirements				Amount desirable			
	Replies	Range	Mode	Median	Replies	Range	Mode	Median
Oil, SAE no. 40 (quarts)	24	0-1	0	0	21	0-2	0	0
Oil, SAE no. 50 (quarts)	25	0-1	0	0	21	0-2	0	0
Paraffin, (lbs.)	30	1-5	1	1	24	1-6	1	2
Rubber balloons	28	0-24	12	9	24	0-50	12	12
Rubber bands (box)	27	1-3	1	1	23	0-6	1	1
Screw eyes	23	0-36	12	12	22	0-48	12,24	12
Screw hooks	23	0-36	12	12	22	0-48	12	12
Shellac (quarts)	23	0-24	1	1	23	0-48	1	1
Sodium chloride (lbs.)	28	0-10	1	2	23	0-10	5	4
Solder (lbs.)	28	0-5	1	1	24	0-7	1	1
Sugar (lbs.)	27	0-10	1	1	25	0-10	1	1
Tape, friction (roll)	30	1-12	1	1	25	1-12	2	2
Tape, rubber (roll)	29	0-4	1	1	26	0-8	1	1
Wax, sealing (ozs.)	28	0-16	1	2	22	0-16	1	4
Wax, floor (ozs.)	27	0-8	0	0	25	0-6	0	0

TABLE XIII

ITEMS WHICH WERE ADDED BY TEACHERS

TO THE LISTS OF EQUIPMENT AND MATERIALS

Item	Number of responses	Minimum required	Number desirable
Ammeter, A.C., 0.1 to 1.0 amperes	1	1	1
Ammeter, D.C., 1 to 5 amperes	1	1	1
Atomic chart and model	1	0	1
Beaker, 50 ml.	1	12	12
Capillary tubes	1	1 set	
Conductivity of solutions apparatus	1	1	
Flask, round bottomed 500 ml.	1	1	3
Funnel, glass, large	1	1	
Fuse wire	1	1	
Generator, magneto-electric, hand operated	1	1	
Linear expansion apparatus	1	1	
Measure, 1 liter	1	1	1
Nichrome wire #30	1	4 spools	
Cptical disk with lenses and mirrors	1	1	
pH ion indicator set	1	0	1
Photographic paper	1	25 sheets	
Platinum wire	1	5 feet	
Power supply, D.C.	1	1	1
Refractor plates, glass	1	6	
Spiral spring pointer	1	1	
Steam engine (model)	1	1	
Steam turbine (model)	1	1	
Surface tension apparatus	1	2	4
Vacuum plate	2	1	1
Vise, anvil	1	0	2
Zinc sulfate	1	¼ lb.	

CHAPTER IV

A RECOMMENDED LIST OF EQUIPMENT FOR USE IN TEACHING HIGH-SCHOOL PHYSICS IN OREGON

The National Society for the Study of Education (7, p.243) recommends that the science teacher be granted an annual budget for the purchase of supplies and equipment. It is also recommended that this budget be further broken down into a budget for annual supplies, such as breakable items and items which are consumed through use; and another budget consisting of items listed in order of preference, based upon a long-term plan for building up the science equipment of the school. Such a long-term plan should be developed by each science teacher and should be kept up-to-date as new equipment is purchased or obtained in other ways.

The list developed in this study should be helpful to the classroom teacher in the preparation of such a long-term plan for the purchase of physics equipment, but the list should not be followed blindly, since it may not include items of particular local interest and it may include some items which are not suited to a given high-school situation. Neither should the teacher consider only the scientific supply companies as sources of supply, because many of the items may be constructed by the pupils as projects or may be secured from local salvage and repair

agencies at little or no cost. Mail-order houses, local industries, drug stores and dime stores are also sources from which equipment and supplies may be purchased.

The final decision as to which items of equipment are to be purchased should be left up to the classroom teacher, providing that the proposed purchases fall within the budgetary allowances. A definite plan concerning the purchase of physics equipment and materials should be prepared by each teacher showing which items he considers most important and the order in which he believes the items should be purchased. Only by following such a plan can the teacher insure that those items which are most needed are the ones which are purchased as funds are made available.

The median amount of each item listed by the teachers in this study as being either necessary or desirable was used as the basis for the preparation of the list of recommended equipment and materials presented in this chapter. In addition to the equipment in the lists, at least two types of fire extinguishers should be available. The National Science Teachers' Association (6, Chapter IX, p.28) recommends the carbon tetrachloride type as the best general purpose extinguisher for use in the physics laboratory, but it should be remembered that this extinguisher produces poisonous fumes and is therefore dangerous when used upon fires in poorly ventilated spaces. The carbon dioxide type of extinguisher is effective for all types of

fires and has the added advantage of not harming the equipment upon which it is used. The foam or soda-acid type extinguisher is satisfactory for use on burning trash or liquids, but it is dangerous to use upon electrical equipment and, in addition, may harm the equipment. From a consideration of the above characteristics, it is recommended that one of the fire extinguishers available to the laboratory be of the carbon dioxide type.

The list of recommended equipment and materials is contained in Tables XIV to XX. These tables follow the same form as the questionnaire with the exception that no distinction is made between items for use in performing lecture demonstrations and those required in performing pupil experiments.

TABLE XIV

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Airplane, toy	0	1
Ammeter, A.C., 0-15 amperes	2	6
Ammeter, D.C., 0-10 amperes	3	6
Aspirator bottle, 500cc.	1	1
Balance, compression spring, 250gm.	4	6
Balance, sensitive to 0.01gm.	1	2
Balance, spring, 250gm.	4	7
Balance, spring, 2000gm.	6	10
Balance, spring, 30 lb.	1	1
Balance, trip with agate bearings	2	4
Balance, support and clamp for meter stick	4	11
Barometer, aneroid	1	1
Barometer, mercurial	1	1
Baroscope (for demonstrating buoyancy of air)	1	1
Battery jar, 1 gallon	3	6
Battery jar, 1 quart	2	4
Battery, storage, 6 volt	1	1
"B" Battery, 90 volt	1	1
Bell, electric	4	6
Bicycle pump	1	1
Bimetallic bar	1	1
Binding posts	12	24
Block, aluminum, rectangular	3	6
Block, lead, rectangular	2	6
Bucket and cylinder (Archimedes)	1	1
Bunsen burner with rubber tubing and wingtop	6	12
Calorimeter, aluminum	4	6
Calorimeter, brass	1	1
Calorimeter, electric	0	1
Caliper, micrometer	2	6
Caliper, vernier	3	6
Cartesian diver	1	1
Catch bucket	4	6
Cathode ray oscilloscope	1	1
Circuit breaker, electromagnetic	1	1
Circuit breaker, thermostatic	1	1
Clamp, burette	6	12

TABLE XIV (Continued)

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Clamp, "C" type	6	12
Clamp, meter stick	6	12
Clamp, pendulum	1	6
Clamp, screw (for rubber tubing)	6	12
Clamp, test tube	8	12
Clay triangle	2	6
Coefficient of expansion apparatus	1	4
Color disk	1	1
Compass, magnetic	6	10
Compass, pencil	1	2
Compass needle	2	4
Composition-of-forces board	1	5
Condenser, automobile	1	1
Condenser, variable	1	1
Connectors, brass	6	11
Conversion chart, English and metric units	1	1
Cryophorus (for demonstrating freezing by evaporation)	1	1
Cylinder, aluminum (density	4	7
Cylinder, brass (density)	3	6
Crucible, porcelain	6	12
Daniell cell	1	1
Demonstration cell	1	1
Dividers, measuring	2	6
Dry cell, 1½ volt (standard no. 6)	12	12
Electrolysis apparatus	1	1
Electroscope, metal leaf	1	1
Electroscope, pith ball	1	1
Electroscope, vacuum tube	0	1
Electrostatic machine (Wimshurst)	1	1
Electric fan	1	1
Evaporating dish	6	12
Extension cord	1	2
Filter, colored glass	1	1
Filter, ultraviolet	1	1
Filter, Wratten A (yellow)	1	1
Filter, Wratten B (green)	1	1
Filter, Wratten C (blue)	1	1
Filter, Wratten G (red)	1	1

TABLE XIV (Continued)

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Flashlight with batteries	1	1
Forceps	6	12
Funnel, metal, 6 inch	1	1
Fuses (various types)	6	12
Galvanometer, demonstration type	1	1
Galvanometer, student type	3	6
Galvanoscope	1	2
Generator, A.C.	1	1
Generator, automobile	0	1
Generator, demonstration	1	1
Generator, mechanical	1	1
Glass bulb (specific gravity)	1	5
Governor, steam engine (model)	1	1
Gyroscope	1	1
Hall's cars (inclined plane)	3	7
Hot water heater (model)	0	1
Hydraulic press (model)	1	1
Hydrometer, battery jar	1	3
Hydrometer, for liquids heavier than water	1	4
Hydrometer, for liquids lighter than water	1	4
Inclined plane apparatus	2	6
Induction coil	1	1
Jolly balance	1	1
Key, contact	4	12
Lamp, carbon filament, 16 c.p.	1	4
Lamp, carbon filament, 32 c.p.	1	2
Lamp, fluorescent with socket	1	1
Lamp, neon glow, 2 watt	1	1
Lamp, sodium vapor	1	1
Lamp board with sockets	1	4
Lens, double convex, 5cm. focal length	2	6
Lens, double convex, 10cm. focal length	2	6
Lens, double convex, 30cm. focal length	2	6
Lens, magnifying with handle	1	4
Lens holder	4	12
Leyden jar	1	2
Light box	1	2
Magdeburg hemispheres	1	1
Magnet, alnico	1	2

TABLE XIV (Continued)

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Magnet, cylindrical bar	1	1
Magnet, bar	6	12
Magnet, horseshoe	6	12
Measure, 1 quart	1	2
Meter stick, English and metric units	6	12
Metronome	1	1
Microphone, carbon granule	1	1
Microphone, condenser	0	1
Microphone, crystal	1	1
Microphone, moving coil	0	1
Microscope	1	1
Mirror, concave-convex	3	6
Mirror, plane	6	12
Mirror, flexible metal	1	1
Milliammeter	1	1
Metal cup (highly polished for determination of dew point)	1	1
Motor, A.C., ¼ h.p.	1	1
Motor, D.C., 1/8 h.p.	1	1
Motor, demonstration type (St. Louis)	1	4
Motor, water	1	1
Motor-generator demonstration unit	1	1
Newton's ring apparatus	1	1
Optical bench	1	6
Organ pipe	1	1
Overflow can	4	12
Pendulum, with metal and wooden bobs	2	4
Pendulum bob, Foucalt type with suspension	0	1
Photoelectric cell	1	1
Photometer, bunsen	1	1
Polaroid disk	1	1
Plumb bob	1	1
Pneumatic trough (glass)	1	1
Pressure gauge (Bourdon type)	1	1
Prism, hollow glass	1	1
Projector, lantern slide	1	1
Prony brake	1	1
Protractor	6	12
Pulley, single sheave	5	10
Pulley, double sheave	5	8
Pulley, triple sheave	4	8
Pump, compression (glass model)	1	1
Pump, force type (glass model)	1	1
Pump, lift type (glass model)	1	1

TABLE XIV (Continued)

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Pyrometer, portable hand type	0	1
Radio tube, type 27	1	1
Radio tube, type 30	1	1
Radio tube, type 37	1	1
Radio tube, type 76	1	1
Radiometer, Crookes	1	1
Rectifier, tungar	1	1
Reflector, automobile headlight	0	1
Reflector, parabolic	1	1
Relay, telegraph	1	2
Resistance box	2	4
Resistor, 10 watt, 200 ohm	1	1
Resistor, 10 watt, 1600 ohm	1	1
Rheostat, 5 amp. (10 ohms)	1	4
Ringstand, with 3 rings	6	12
Rods for torsional apparatus	0	1
Rod, glass	2	3
Rod, hard rubber	1	3
Rotator, hand operated	1	1
Ruler, English and metric units	6	16
Savart's wheel	0	1
Scale pans	2	4
Screen, ground glass	2	2
Screen, holder	4	6
Siren disk	1	1
Slidewire	1	2
Sling psychrometer	1	1
Sonometer	1	1
Specific gravity stick	1	1
Spectrometer	0	1
Speed (revolution) counter	1	1
Speedometer, automobile	0	1
Starting rheostat	1	1
Steam boiler	2	4
Stop watch	1	2
Stroboscope	0	1
Switch, knife	6	12
Switch, single pole, double throw	1	2
Switch, double pole, double throw	1	2
Switch, double pole, single throw	1	2
Switch, rotary	1	1

TABLE XIV (Concluded)

RECOMMENDED LIST OF EQUIPMENT

Item	Minimum Number	Number Desirable
Switch, toggle	1	1
Switch, push button	6	12
Syringe bulb	1	1
Temperature resistance coil	1	1
Telegraph key	2	3
Telegraph sounder	2	3
Telephone transmitter and receiver	1	1
Thermocouple	1	1
Thermometer, -10° to 110° C.	6	12
Thermometer, -5° to 250° C.	1	2
Thermometer, 30° to 400° F.	1	1
Thermometer, air	1	1
Thermometer, maximum-minimum	1	1
Thermos bottle	1	1
Torsional apparatus	0	1
Transformer	1	1
Transformer core	1	1
Triode vacuum tube and receptacle	1	1
Tripod	6	11
Tuning fork, 256 C	2	4
Tuning fork, 320 E	2	4
Tuning fork, 384 G	2	4
Tuning fork, 512 C'	2	4
Tuning forks, one pair mounted in resonance boxes	1	1
Vacuum plate	1	1
Vacuum pump	1	1
Vibrograph	1	1
Voltmeter, 0-150 volts A.C.	1	4
Voltmeter, 0-10 volts D.C.	2	6
Water pan	3	6
Water trap for steam boiler	1	4
Wattmeter	1	1
Weights, avoirdupois, 1 to 5 lbs.	1	2
Weights, metric, 1 to 1000 gms.	3	6
Weights, precision, 1 to 100 gms.	1	3
Weights, slotted with hanger (set)	2	6
Wheatstone bridge	1	4
Wheel and axle	1	4
Whistle, high frequency	1	1
Wire gauze, asbestos center	6	12

TABLE XV

RECOMMENDED LIST OF GLASSWARE

Item	Minimum Number	Number Desirable
Beaker, 100 ml.	6	12
Beaker, 250 ml.	6	12
Beaker, 400 ml.	6	12
Beaker, 1000 ml.	6	10
Bell jar	1	2
Bottle, 2 liter	1	2
Burette, 100 ml.	2	3
Condenser, Liebig	1	4
Cylinder, graduated, 25 ml.	2	6
Cylinder, graduated, 100 ml.	4	7
Cylinder, graduated, 250 ml.	2	4
Cylinder, graduated, 1000 ml.	1	3
Cylinder, hydrometer jar, 12 inch	1	3
Eudiometer tube	0	1
Flask, distilling, 250 ml.	2	5
Flask, Erlenmeyer, 50 ml.	4	6
Flask, filtering	1	3
Flask, round bottomed, 250 ml.	5	6
Funnel, 4 inch diameter	3	7
J-tube	1	2
Manometer, open tube, 6-7 mm. diameter (for mercurial barometers)	1	3
Pycnometer, 25 ml. (specific gravity bottle)	1	3
Rod, stirring (lbs.)	1	1
Resonance tube, glass	1	3
T-tube	2	4
Test tube, 6 inch (pyrex)	18	36
Test tube, 8 inch	12	24
Thistle tube	6	12
Tubing, glass, 5-7 mm. diameter (lbs)	4	5

TABLE XVI

RECOMMENDED LIST OF CHEMICALS

Item	Minimum Number	Number Desirable
Acetamide (¼ lb. btl.)	1	1
Acetone, (lbs.)	1	1
Acid, acetic (lbs.)	1	1
Acid, hydrochloric (lbs.)	5	5
Acid, nitric (lbs.)	2	2
Acid, sulfuric (lbs.)	5	7
Alcohol, denatured (gallons)	1	1
Alcohol, 95% (gallons)	1	1
Aluminum powder (½ lb. can)	1	1
Ammonium hydroxide, 26-28 % (lbs.)	1	1
Antimony metal, powder (¼ lb. btl.)	1	1
Benzene (lbs.)	1	1
Bismuth metal (ozs.)	2	4
Calcium chloride (lbs.)	1	1
Carbon disulfide (lbs.)	1	1
Carbon tetrachloride (lbs.)	1	2
Copper sulfate crystals	2	5
Ether, ethyl (lbs.)	1	1
Glycerine (¼ lb. btl.)	1	1
Gum camphor (ozs.)	0	1
Iodine (ozs.)	1	1
Iron filings (lbs.)	1	3
Lampblack (lbs.)	1	1
Magnesium metal, ribbon (ozs.)	1	2
Manganese dioxide (¼ lb. btl.)	1	1
Mercury metal (lbs.)	5	5
Mercuric oxide (ozs.)	1	1
Nickel metal, shot (½ lb. can)	1	1
Phenolphthalein (ozs.)	1	1
Potassium alum (¼ lb. btl.)	0	1
Potassium dichromate (½ lb. btl.)	1	1
Potassium permanganate (½ lb. btl.)	1	1
Silver nitrate (ozs.)	1	1
Sodium hydroxide (lbs.)	1	1
Sodium thiosulfate (¼ lb. btl.)	1	1
Sulfur (lbs.)	1	1
Tin metal, shot (¼ lb. can)	1	2
Zinc metal, mossy (lbs.)	1	2

TABLE XVII

RECOMMENDED LIST OF TOOLS

Item	Minimum Number	Number Desirable
Corkborers, set of 6	1	1
Drill, hand operated	1	1
Drill, set of 1/16 to 3/8 inch dias.	1	1
File, flat	1	2
File, triangular	3	6
Hammer, claw	1	1
Hacksaw, with blades	1	1
Glasscutter	1	2
Measuring tape, 50 ft.	1	1
Pliers, needle nosed	1	1
Pliers, side cutting	1	1
Saw, crosscut	1	1
Snips, metal	1	1
Scissors	1	1
Screw driver, small	1	1
Screw driver, medium	1	1
Screw driver, large	1	1
Soldering iron	1	1
Square, carpenters	1	1
Wrench, adjustable, 8 inch	1	1

TABLE XVIII

RECOMMENDED LIST OF MISCELLANEOUS SUPPLIES

Item	Minimum Number	Number Desirable
Aluminum foil (sq. ft.)	1	1
Aluminum shot (lbs.)	1	1
Asbestos sheet (sq. ft.)	3	4
Blue print paper (sheet 8x10 inches)	6	12
Copper gauze, fine mesh (sq. ft.)	1	1
Copper sheet, 1/16 in. (sq. ft.)	1	2
Copper shot, (lbs.)	1	2
Carbon rod, $\frac{1}{2}$ in. dia. (ft.)	2	2
Lead sheet, 1/16 in. (sq. ft.)	1	1
Lead shot (lbs.)	1	2
Mica sheet (4x6 in. sheets)	1	1
Phosphorescent paint (ozs.)	1	1
Rubber dam (sq. ft.)	1	3
Stoppers, rubber, assorted (lbs.)	5	5
Stoppers, cork, assorted (lbs.)	1	2
Stopcock grease (tube)	1	1
Tinfoil (sq. ft.)	1	1
Tubing, copper, $\frac{1}{4}$ in. (ft.)	1	2
Tubing, rubber, $\frac{1}{4}$ in. (ft.)	12	24
Tubing, rubber, 3/8 in. (pressure)	10	10
Vacuum wax (ozs.)	2	4
Wood's metal (ozs.)	2	4
Zinc sheet, 1/16 in. (sq. ft.)	1	3

TABLE XIX

RECOMMENDED LIST OF WIRE

Item	Minimum Number	Number Desirable
Wire:		
copper, bare, no. 8 (lbs.)	1	2
copper, bare, no. 10 (lbs.)	1	2
copper, double cotton covered, no. 18 (lbs.)	1	2
copper, double cotton covered, no. 24 (lbs.)	1	2
copper, double cotton covered, no. 28 (lbs.)	1	1
copper, double cotton covered, no. 30 (lbs.)	1	1
copper, double cotton covered, no. 34 (lbs.)	1	1
copper, enameled, no. 24 (lbs.)	1	2
copper, enameled, no. 28 (lbs.)	1	1
copper, enameled, no. 32 (lbs.)	1	1
copper, enameled, no. 36 (lbs.)	1	1
copper, rubber insulated, no. 12 (lbs.)	1	2
copper, rubber insulated, no. 14 (lbs.)	1	2
nichrome, no. 12 (1 oz. spool)	1	1
nichrome, no. 20 (1 oz. spool)	1	1
nichrome, no. 24 (1 oz. spool)	1	1
nichrome, no. 27 (1 oz. spool)	1	1
piano, no. 2 (spool)	1	1
piano, no. 5 (spool)	1	1
piano, no. 7 (spool)	1	1

TABLE XX

RECOMMENDED LIST OF MATERIALS FOR LOCAL PURCHASE

Item	Minimum Number	Number Desirable
Art colors (set)	0	1
Brads (ozs.)	1	2
Candles (lbs.)	1	2
Carpet tacks (ozs.)	1	2
Dowels, wooden, ¼ inch (ft.)	0	1
Dry ice (lbs.)	1	2
Fishline, silk (spool)	1	1
Kerosene (gallon)	1	1
Lamp, auto headlight, 6 volt	1	1
Lamp, clear glass, 40 watt	1	2
Lamp, colored, red, 40 watt	1	1
Lamp, colored, blue, 40 watt	1	1
Lamp, colored, green, 40 watt	1	1
Lamp, tungsten, frosted, 25 watt	1	2
Lamp, tungsten, frosted, 40 watt	1	2
Lamp, tungsten, frosted, 60 watt	1	2
Lamp, tungsten, frosted, 100 watt	1	2
Lamp, tungsten, frosted, 150 watt	1	2
Nails, assorted (lbs.)	2	3
Naphthalene flakes (lbs.)	1	1
Needles, darning	6	12
Paraffin, (lbs.)	1	2
Rubber balloons	9	12
Rubber bands (box)	1	1
Screw eyes	12	12
Screw hooks	12	12
Shellac (quarts)	1	1
Sodium chloride (lbs.)	2	4
Solder (lbs.)	1	1
Sugar (lbs.)	1	1
Tape, friction (roll)	1	2
Tape, rubber (roll)	1	1
Wax, sealing (ozs.)	2	4

CHAPTER V

STORAGE OF LABORATORY EQUIPMENT

Functions of Storage Facilities

The storage of equipment and materials used in teaching high-school physics presents many problems because of the wide variety of items which must be stored separately. The most important factors in the storage of physics equipment are flexibility, accessibility, and supervision. Flexibility of storage facilities is necessary in order to give pupils an opportunity to plan for organizing materials to be stored, and in order to take care of the many sizes and odd shapes of laboratory equipment. Well-planned storage should be a concrete example of the neatness and orderliness expected in the study of physics, and yet the equipment must be readily available in order to avoid confusion and its consequent loss of time. Supervision of the storage facilities is necessary not only to see that equipment and materials are properly cared for, but also to insure that the pupils are protected from dangerous substances.

The Committee of School Facilities for Science Instruction of the National Science Teachers' Association (6, Chapter IX, pp.19-20) lists the following functions about which the storage problem centers:

1. Segregation and protection of chemicals. This includes protection of students from acids and other injurious substances.

2. Storage of delicate and costly as well as less expensive equipment.

3. Storage of supplies needed in current physics experiences

4. Storage of audio-visual materials of instruction.

5. Storage of books and notebooks.

6. Storage lockers built into equipment for student use.

The Separate Storeroom

The National Science Teachers' Association (6, Chapter IX, p.20) recommends a separate storeroom for all except the very small schools. This storeroom should not only be of sufficient size to provide adequate space for storage of the equipment, but in addition it should provide space and facilities for repair and construction of equipment. This storeroom should be adjacent to the classroom which it serves and should approximate twenty per cent of the classroom area. It should have both natural and artificial lighting and should have a means of forced ventilation.

Only forty-five per cent of the teachers in this study reported that storage facilities were adequate for the equipment which was on hand at the time of the study.

It is not feasible to tabulate the many different

replies which were received in answer to the question concerning what adequate storage facilities should include. Many types of storage facilities were reported in use. These included open shelves in the classroom, pupil desks, movable cabinets, built-in cabinets, combined storerooms with other sciences, and separate storerooms for physics equipment.

One teacher reported having only a small closet and a demonstration table in which to store the physics equipment. The other teachers listed varying amounts of storage facilities with few having a separate storeroom for physics equipment. The majority of the teachers expressed a desire for storage facilities that are readily available and yet capable of being locked.

Built-in Cabinets

Built-in cabinets are recommended by the National Science Teachers' Association (6, Chapter IX, p.21) as substitutes when a separate storeroom is not available or when the separate storeroom is not of sufficient size. Doors are necessary to protect the apparatus from dust, moisture, theft, and damage by unauthorized use. Sliding doors are the most satisfactory type for wall cabinets because they are easily locked and do not project into the room as do doors which are mounted on hinges. Glass panels may be placed in the doors so that the contents are visible

without opening the cabinet. This provides a means of interesting pupils in the equipment and at the same time provides an incentive for the person in charge to keep the material neat and orderly, since it is always under observation. Cabinets of this type may be used for equipment which is frequently used and yet is not assigned to any pupil or group of pupils. The flexibility of storage space in cabinets is accomplished by means of movable shelves. This flexibility of storage space is necessary to accommodate pieces of equipment of varying sizes and shapes.

Storage in Classroom and Laboratory Furniture

The term furniture includes such units as pupil desks and chairs, tables, teacher desks, demonstration desks, and movable cabinets. Important factors in the selection of classroom and laboratory furniture are: (1) utility, (2) flexibility, (3) visual comfort, (4) physical comfort, (5) durability, and (6) safety.

The instructor should have a demonstration desk in addition to the ordinary teacher's desk required for routine classroom matters. The demonstration desk should have drawers for storage of equipment and supplies to be used in the performance of demonstrations. Since the demonstration desk becomes a center of pupil interest, it is necessary that it be of sufficient height to be clearly seen by all the pupils and that the top be large enough to

accommodate the usual demonstration equipment without overcrowding. Outlets for gas, water, and electricity, and a chemical-resistant sink, should be available. Items of equipment which are used frequently by the instructor should be stored permanently in the demonstration desk, and other items should be stored here only during periods of greatest use.

There are many standard demonstration desks available for purchase. Typical specifications are (6, Chapter IX, p.17) as follows:

Specifications	Length	Width	Height	Depth
Overall	8'-0"	30"	37"	--
Knee space	-	22 7/8"	32 3/8"	25 1/8"
1 Cupboard	-	33 1/2"	27 3/4"	24 5/8"
2 Drawers	-	14 3/4"	5 5/8"	21"
3 Drawers	-	32"	5 5/8"	21"
1 Soapstone Sink .	18"	14"	--	10 1/2"

Equipment

1 single cold water pantry cock; 1 single hot water pantry cock; 1 double gas cock; 1 duplex AC receptacle in rail; 1 soapstone sink; 1 set of lead drain fittings; 1 tumbler lock on one drawer; 2 flush plates and 19 mm. upright rods with clamps and wood cross bar.

A filing cabinet is recommended for the use of the teacher in order to keep proper records concerning materials and equipment. Space should be provided either in a filing cabinet or in some other suitable place for storage of leaflets and educational booklets which are available at no cost from many commercial sources throughout the

country. These pamphlets and booklets should be stored according to the units to which they apply.

A corner or section of the room should be used as a library or reference corner where pupils may look up physical data without frequent trips to the library. Necessary shelves should be available for holding these reference books as well as appropriate selections from the pamphlets and booklets mentioned above.

There has been considerable argumentation over the advantages and disadvantages of fixed desks compared to movable tables for use by the pupils. Twenty of the teachers in this study indicated that they preferred laboratory desks which were equipped for gas, water, and electricity, and which contained storage compartments and drawers. Five of the teachers indicated that they preferred laboratory tables which could be moved about, but they made no mention of the utilities mentioned above. The movable type of table necessitates additional work space on the sides and back of the room, provided with storage cabinets, shelves, sinks, and water, gas, and electrical outlets.

In the event that fixed desks are used, the items of equipment which are most frequently used in the performance of experiments should be stored in the desks. If movable tables are used, then these items of equipment should be stored in wall cabinets where they are readily available

to the pupils and yet may be locked if the room is used for other purposes.

Materials Requiring Special Conditions of Storage

Chemicals should be stored away from other equipment to prevent unnecessary corrosion of equipment and to reduce danger from careless handling by the pupils. Linear storage in alphabetical order is usually the most acceptable means of storing chemicals with the exception of those items which should be stored separately. This method has the advantages of presenting all items so that they are visible and of eliminating the necessity for reaching over other items, but it has the disadvantage of using a large amount of wall space. One teacher in the study recommended that a special lead-bottomed compartment be used for the storage of liquid acids and bases. This suggestion appears to be a very satisfactory means of segregating the potentially dangerous items on the recommended list.

Segregation of equipment according to teaching units will save considerable time in finding equipment for the performance of experiments and demonstrations, but it may not be as conservative of space as other methods of storage. The instructor should adopt a plan of storage which best fits the equipment and facilities which are available, and he should also maintain a stock record of the materials and equipment which are on hand so that

many unnecessary trips to the storage facilities to check items of equipment are eliminated.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

A recommended list of materials and equipment for use in teaching high-school physics in the State of Oregon was prepared from a tabulation of the responses of forty-two physics teachers to a questionnaire. The teachers were asked to specify the amount of each item of materials and equipment which they considered necessary and the amount which they considered desirable for teaching an adequate course in high-school physics to a class of 24 pupils.

A number of general questions concerning the teaching of high-school physics were also asked in the questionnaire in order to gather some information as to how physics is taught in different schools. From a tabulation of these answers it was determined that less than half of the teachers felt that their present storage facilities were adequate for the stock of equipment and materials on hand. A majority indicated a preference for some type of storage room or cabinet which could be locked. All types of storage from separate rooms to open shelves were reported as being in use.

Various combinations of storage facilities are often used in the same school, so no conclusion can be drawn

from this study as to which type is the most used.

Conclusions

The following conclusions about the teaching of physics in the schools of this study are made from the tabulation of the results of the general questions and from statistics of The United States Office of Education and the Office of the Superintendent of Public Instruction of the State of Oregon.

1. The average annual enrollment in high-school physics in the United States is declining each year.

2. A course in physical science, which includes material from chemistry and physics, is being successfully taught in many schools. This course is increasing in popularity, especially in the smaller schools.

3. Physics is taught each year in about three-fourths of the schools of this sample and is alternated annually with chemistry in most of the remaining schools of the sample.

4. Most of the teachers provide a laboratory period as needed instead of setting aside certain days of the week for this purpose.

5. Demonstrations are conducted by all teachers during class periods.

6. Pupil demonstrations and pupil-teacher demonstrations are conducted in about three-fourths of the schools.

7. Over three-fourths (82.9%) of the teachers depend upon a single textbook for pupil use.

8. Over half (63.4%) of the schools use a laboratory manual.

9. Less than half (45.2%) of the schools have storage facilities which are adequate for the equipment now on hand.

Recommendations

The following recommendations are made, based upon this study:

1. Each physics teacher should evaluate his present stock of materials and equipment and prepare a list of items which are not on hand but are needed. The list prepared in this study may be used as a guide, but it should not be followed blindly.

2. This list of equipment should be arranged in the order of greatest need by the teacher so that the most needed items are purchased before other items as funds are made available.

3. Teachers should plan laboratory work in such a way as to eliminate unnecessary duplication of expensive items of equipment.

4. Similar studies should be made for other high-school laboratory sciences, such as chemistry and biology, which require relatively large amounts of materials and

equipment.

5. Further study should be made concerning the space requirements of storing physics equipment so that information of this type might be made available to schools which are planning new construction or remodeling of existing facilities.

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22. Portland, Oregon. Public schools. Sixteenth annual report of the public schools of the city of Portland, Oregon, 1888-1889. David Steel, successor to Himes the printer, Portland, 1889. 112p.

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APPENDICES

APPENDIX A

COPY OF THE LETTER OF TRANSMITTAL

OREGON STATE COLLEGE
School of Science
Corvallis, Oregon

Department of Science Education

Dear Fellow Teacher:

For some time the State Department of Education, the Department of Science Education at Oregon State College, and many science teachers have expressed a desire for information concerning what should be considered the minimum essentials in materials, equipment, and storage facilities for a high-school physics program. It is with this in mind that this study is being undertaken and that you have been selected as a participant.

This study will attempt to define the minimum essentials for an adequate program in physics. It should serve as a valuable guide to the State Department of Education, school districts, school administrators, and physics teachers in selecting materials and equipment for use in teaching the subject. The list was compiled from: Dull, C. E., Metcalfe, H. C., and Brooks, W. O., Modern Physics; Dull, C. E., Laboratory Experiments in Physics; Dull, C. E. and Smith, A. B., Physics Workbook; other laboratory experiment books; and various demonstration experiments in physics.

It is with some apology that we ask you to complete the enclosed questionnaire and return to us at your earliest convenience. We realize that it is long, but if we are to solve some of the major problems in science education, it is necessary that we work cooperatively in seeking their solution. Sufficient postage is enclosed to cover the cost of mailing.

We believe that you will be interested in the results and assure you that they will be made available sometime during the summer. Your cooperation in filling out the questionnaire will be appreciated.

Sincerely yours,

Ernie L. Cummins
Graduate Student
Oregon State College

Cliff Robinson
State Director of
Secondary Education

Stanley E. Williamson
Head of Department of
Science Education
Oregon State College

APPENDIX B

COPY OF THE QUESTIONNAIRE

GENERAL INFORMATION

Name of Physics instructor _____

Name of school _____

Is it a ___3, ___4, ___5 year school?

Number of pupils in school _____

Length of class period _____ minutes.

Is physics taught each year in your school? ___yes, ___no.

Is it alternated each year with chemistry? ___yes, ___no.

Is a combined course in physical science taught? ___yes, ___no.

How are experiments performed?

1. Special laboratory periods ___yes, ___no.
   a. Specified number of periods each week ___yes, ___no.
   b. Laboratory period provided as needed ___yes, ___no.
   c. Pupils work: ___individually, ___in pairs, ___other.
2. Demonstrations during class period ___yes, ___no.
   a. Teacher demonstrations ___yes, ___no.
   b. Pupil demonstrations ___yes, ___no.
   c. Teacher-pupil demonstrations ___yes, ___no.

Do you use a single text? ___yes, ___no.

Do you use multiple texts? ___yes, ___no.

Do you use a laboratory manual? ___yes, ___no. If yes, give author, title, and publisher _____

What type of laboratory desks are in use? _____

What type of laboratory desk would you recommend? _____

_____

Are storage facilities adequate? ___yes, ___no.

What would adequate storage facilities include? (explain)

_____

_____

_____

LIST OF EQUIPMENT FOR LABORATORY EXPERIMENTS

Directions: On the following pages please list in the appropriate blank at the right of each item (a) column I, the minimum number of each item required for a class of twenty-four pupils; (b) column II, the number that would be desirable for the same class; and (c) column III, place an "x" if you believe the item unnecessary.

ITEM	I MINIMUM NUMBER REQUIRED	II NUMBER DESIRABLE	III UNNECESSARY
Ammeter, A.C., 0-15 amperes	____	____	____
Ammeter, D.C., 0-10 amperes	____	____	____
Aspirator bottle, 500 cc.	____	____	____
Balance, compression spring, 250 gm.	____	____	____
Balance, sensitive to 0.01 gm.	____	____	____
Balance, spring, 250 gm.	____	____	____
Balance, spring, 2000 gm.	____	____	____
Balance, spring, 30 lb.	____	____	____
Balance, trip with agate bearings	____	____	____
Balance support and clamp for meter stick	____	____	____
Barometer, aneroid	____	____	____
Barometer, mercurial	____	____	____
Battery jar, 1 gallon	____	____	____
Battery jar, 1 quart	____	____	____
B battery, 90 volt	____	____	____
Battery, storage, 6 volt	____	____	____
Battery stand and clamp	____	____	____
Bell, electric	____	____	____
Binding posts	____	____	____
Block, aluminum rectangular	____	____	____
Block, lead, rectangular	____	____	____

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Bunsen burner with rubber tubing and wingtop			
Calorimeter, aluminum			
Calorimeter, brass			
Calorimeter, electric			
Caliper, micrometer			
Caliper, vernier			
Catch bucket			
Clamp, burette			
Clamp, "C" type			
Clamp, meter stick			
Clamp, pendulum			
Clamp, screw (for rubber tubing)			
Clamp, test tube			
Clay triangle			
Coefficient of expansion apparatus			
Compass, magnetic			
Compass, pencil			
Compass, needle			
Composition-of-forces board			
Connectors, brass			
Conversion chart, English and metric units			
Cylinder, aluminum (density)			
Cylinder, brass (density)			
Crucible, porcelain			
Daniell cell			
Demonstration cell			
Dividers, measuring			
Dry cell, 1½ volt (flashlight)			
Dry cell, 1½ volt (standard #6)			
Electrolysis apparatus			
Evaporating dish			
Forceps			
Fuses (various types)			
Glass bulb (specific gravity)			
Galvanometer, demonstration type			
Galvanometer, student type			
Galvanoscope			
Generator, demonstration type			
Hall's cars (inclined plane)			
Hot water heater (model)			
Hydrometer, battery jar			
Hydrometer, for liquids heavier than water			
Hydrometer, for liquids lighter than water			
Hygrodeik			

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Hygrometer	———	———	———
Inclined plane apparatus	———	———	———
Jolly balance	———	———	———
Key, contact	———	———	———
Lamp, carbon filament, 16 c.p.	———	———	———
Lamp, carbon filament, 32 c.p.	———	———	———
Lamp, fluorescent with socket	———	———	———
Lamp board with sockets	———	———	———
Lens, double convex, 5 cm. focal length	———	———	———
Lens, double convex, 10 cm. focal length	———	———	———
Lens, double convex, 30 cm. focal length	———	———	———
Lens, magnifying with handle	———	———	———
Lens holder	———	———	———
Light box	———	———	———
Meter stick, English and metric units	———	———	———
Measure, 1 quart	———	———	———
Magnet, bar	———	———	———
Magnet, horseshoe	———	———	———
Metronome	———	———	———
Mirror, plane	———	———	———
Mirror, concave-convex	———	———	———
Milliammeter	———	———	———
Metal cup (highly polished for determination of dew point)	———	———	———
Motor, A.C., ¼ h.p.	———	———	———
Motor, D.C., 1/8 h.p.	———	———	———
Motor, demonstration type (St. Louis)	———	———	———
Optical bench	———	———	———
Overflow can	———	———	———
Pendulum, with metal and wooden bobs	———	———	———
Prony brake	———	———	———
Protractor	———	———	———
Pulley, single sheave	———	———	———
Pulley, double sheave	———	———	———
Pulley, triple sheave	———	———	———
Reflector, parabolic	———	———	———
Resistance box	———	———	———
Relay, telegraph	———	———	———
Rheostat, 5 amp. (10 ohms)	———	———	———
Ringstand, with 3 rings	———	———	———
Rods for torsional apparatus	———	———	———
Ruler, English and metric units	———	———	———

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Scale pans	____	____	____
Screen, ground glass	____	____	____
Screen holder	____	____	____
Slidewire	____	____	____
Sling psychrometer	____	____	____
Speed (revolution) counter	____	____	____
Starting rheostat	____	____	____
Steam boiler	____	____	____
Stop watch	____	____	____
Switch, knife	____	____	____
Switch, push button	____	____	____
Telegraph key	____	____	____
Telegraph sounder	____	____	____
Temperature resistance coil	____	____	____
Thermometer, -10° to 110° C.	____	____	____
Thermometer, -5° to 250° C.	____	____	____
Thermometer, 30° to 400° F.	____	____	____
Thermos bottle	____	____	____
Torsional apparatus	____	____	____
Towel	____	____	____
Triode vacuum tube and receptacle	____	____	____
Tripod	____	____	____
Tuning fork, 256 C	____	____	____
Tuning fork, 320 E	____	____	____
Tuning fork, 384 G	____	____	____
Tuning fork, 512 C'	____	____	____
Vacuum pump	____	____	____
Vibrograph	____	____	____
Voltmeter, 0-150 volts A.C.	____	____	____
Voltmeter, 0-10 volts D.C.	____	____	____
Water pan	____	____	____
Water trap for steam boiler	____	____	____
Weights, avoirdupois, 1 to 5 lbs.	____	____	____
Weights, metric, 1 to 1000 gms.	____	____	____
Weights, precision, to 100 gms.	____	____	____
Weights, slotted with hanger (set)	____	____	____
Wheatstone bridge	____	____	____
Wheel and axle	____	____	____
Wire gauze, asbestos center	____	____	____
Other: _____	____	____	____
_____	____	____	____
_____	____	____	____

LIST OF EQUIPMENT FOR LECTURE DEMONSTRATIONS

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Airplane, toy	____	____	____
Baroscope (for demonstrating buoyancy of air)	____	____	____
Bicycle pump	____	____	____
Bimetallic bar	____	____	____
Bucket and cylinder (Archimedes)	____	____	____
Cartesian diver	____	____	____
Cathode ray oscilloscope	____	____	____
Circuit breaker, electromagnetic	____	____	____
Circuit breaker, thermostatic	____	____	____
Color disk	____	____	____
Condenser, automobile	____	____	____
Condenser, variable	____	____	____
Cryophorus (for demonstrating freezing by evaporation)	____	____	____
Electric fan	____	____	____
Electroscope, metal leaf	____	____	____
Electroscope, pith ball	____	____	____
Electroscope, vacuum tube	____	____	____
Electrostatic machine (Wimshurst)	____	____	____
Extension cord	____	____	____
Filter, colored glass	____	____	____
Filter, ultraviolet	____	____	____
Filter, Wratten A (yellow)	____	____	____
Filter, Wratten B (green)	____	____	____
Filter, Wratten C (blue)	____	____	____
Filter, Wratten G (red)	____	____	____
Flashlight	____	____	____
Funnel, metal, 6 inch	____	____	____
Generator, A.C.	____	____	____
Generator, automobile	____	____	____
Generator, demonstration	____	____	____
Generator, mechanical	____	____	____
Governor, steam engine (model)	____	____	____
Gyroscope	____	____	____
Hydraulic press (model)	____	____	____
Induction coil	____	____	____
Lamp, neon glow, 2 watt	____	____	____
Lamp, sodium vapor	____	____	____
Leyden jar	____	____	____
Magdeburg hemispheres	____	____	____
Magnet, alnico	____	____	____
Magnet, cylindrical bar	____	____	____
Microphone, carbon granule	____	____	____

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Microphone, condenser	———	———	———
Microphone, crystal	———	———	———
Microphone, moving coil	———	———	———
Microscope	———	———	———
Mirror, flexible metal	———	———	———
Motor, water	———	———	———
Motor-generator demonstration unit	———	———	———
Newton's ring apparatus	———	———	———
Organ pipe	———	———	———
Pendulum bob, Foucalt type with suspension, 75 lb. bob	———	———	———
Phonograph turntable	———	———	———
Photoelectric cell	———	———	———
Photometer, bunsen	———	———	———
Polaroid disk	———	———	———
Plumb bob	———	———	———
Pneumatic trough (glass)	———	———	———
Pressure gauge (Bourdon type)	———	———	———
Prism, hollow glass	———	———	———
Projector, lantern slide	———	———	———
Pyrometer, portable hand type	———	———	———
Pump, compression (glass model)	———	———	———
Pump, force type (glass model)	———	———	———
Pump, lift type (glass model)	———	———	———
Radiometer, Crookes	———	———	———
Rectifier, tungar	———	———	———
Reflector, automobile headlight	———	———	———
Rod, glass	———	———	———
Rod, hard rubber	———	———	———
Radio tube, type 27	———	———	———
Radio tube, type 30	———	———	———
Radio tube, type 37	———	———	———
Radio tube, type 76	———	———	———
Resistor, 10 watt, 200 ohm	———	———	———
Resistor, 10 watt, 1600 ohm	———	———	———
Rotator, hand operated	———	———	———
Savart's wheel	———	———	———
Siren disk	———	———	———
Sonometer	———	———	———
Specific gravity stick	———	———	———
Spectrometer	———	———	———
Speedometer, automobile	———	———	———
Stroboscope	———	———	———
Switch, single pole, double throw	———	———	———
Switch, double pole, double throw	———	———	———
Switch, double pole, single throw	———	———	———
Switch, rotary	———	———	———
	———	———	———

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Switch, toggle	____	____	____
Syringe bulb	____	____	____
Thermocouple	____	____	____
Thermometer, air	____	____	____
Thermometer, maximum-minimum	____	____	____
Transformer	____	____	____
Transformer core	____	____	____
Tuning forks, 1 pair mounted in resonance boxes	____	____	____
Telephone transmitter and receiver	____	____	____
Whistle, high frequency	____	____	____
Wattmeter	____	____	____
Other: _____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____

LIST OF GLASSWARE

Beaker, 100 ml.	____	____	____
Beaker, 250 ml.	____	____	____
Beaker, 400 ml.	____	____	____
Beaker, 1000 ml.	____	____	____
Bell jar	____	____	____
Bottle, 2 liter	____	____	____
Burette, 100 ml.	____	____	____
Condenser, Liebig	____	____	____
Cylinder, graduated, 25 ml.	____	____	____
Cylinder, graduated, 100 ml.	____	____	____
Cylinder, graduated, 250 ml.	____	____	____
Cylinder, graduated, 1000 ml.	____	____	____
Cylinder, Hydrometer jar, 12 inch	____	____	____
Eudiometer tube	____	____	____
Flask, distilling, 250 ml.	____	____	____
Flask, Erlenmeyer, 50 ml.	____	____	____
Flask, filtering	____	____	____
Flask, round bottomed, 250 ml.	____	____	____
Funnel, 4 inch dia.	____	____	____
J-tube	____	____	____
Manometer, open tube, 6-7 mm. dia. (for mercurial barometers)	____	____	____

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Pycnometer, 25 ml. (specific gravity bottle)	____	____	____
Resonance tube, glass	____	____	____
Rod, stirring (lbs.)	____	____	____
T-tube	____	____	____
Test tube, 6 inch (pyrex)	____	____	____
Test tube, 8 inch	____	____	____
Thistle tube	____	____	____
Tubing, glass, 5-7 mm. dia. (lbs.)	____	____	____
Other: _____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____
_____	____	____	____

LIST OF CHEMICALS FOR PUPIL EXPERIMENTS

Acetamide (¼ lb. btl.)	____	____	____
Acid, benzoic (¼ lb. btl.)	____	____	____
Acid, citric (¼ lb. btl.)	____	____	____
Acid, hydrochloric (lbs.)	____	____	____
Acid, nitric (lbs.	____	____	____
Acid, salicylic (¼ lb. btl.)	____	____	____
Acid, stearic (lbs.)	____	____	____
Acid, sulfuric (lbs.)	____	____	____
Acid, tartaric (¼ lb. btl.)	____	____	____
Alcohol, denatured (gallons)	____	____	____
Alcohol, 95% (gallons)	____	____	____
Bismuth metal (ozs.)	____	____	____
Copper sulfate crystals (lbs.)	____	____	____
Gum camphor (ozs.)	____	____	____
Iron filings (lbs.)	____	____	____
Mercury metal (lbs.)	____	____	____
Nickel metal, shot (¼ lb. can)	____	____	____
Potassium alum (¼ lb. btl.)	____	____	____
Potassium dichromate (¼ lb. btl.)	____	____	____
Potassium permanganate (¼ lb. btl.)	____	____	____
Pyrogallol (ozs.)	____	____	____
Sodium dichromate (¼ lb. btl.)	____	____	____
Tin metal, shot (¼ lb. can)	____	____	____

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Resorcin(ozs.)	____	____	____
Zinc metal, mossy (lbs.)	____	____	____
Zinc oxide, powder (¼ lb. btl.)	____	____	____

LIST OF CHEMICALS FOR LECTURE DEMONSTRATIONS

Acetone, (lbs.)	____	____	____
Acid, acetic (lbs.)	____	____	____
Aluminum powder (¼ lb. can)	____	____	____
Ammonium hydroxide, 26-28% (lbs.)	____	____	____
Ammonium nitrate (¼ lb. btl.)	____	____	____
Ammonium oxalate (½ lb. btl.)	____	____	____
Anthracene (¼ lb. btl.)	____	____	____
Antimony metal, powder (¼ lb. btl.)	____	____	____
Benzene (lbs.)	____	____	____
Benzine (lbs.)	____	____	____
Calcium chloride (lbs.)	____	____	____
Carbon disulfide (lbs.)	____	____	____
Carbon tetrachloride (lbs.)	____	____	____
Chlorobenzene (lbs.)	____	____	____
Ether, ethyl (lbs.)	____	____	____
Fluorescein (ozs.)	____	____	____
Glycerine (¼ lb. btl.)	____	____	____
Hydrogen peroxide (¼ lb. btl.)	____	____	____
Iodine (ozs.)	____	____	____
Lampblack (lbs.)	____	____	____
Lead acetate (¼ lb. btl.)	____	____	____
Magnesium metal, ribbon (ozs.)	____	____	____
Manganese dioxide (¼ lb. btl.)	____	____	____
Manganese metal, powder (ozs.)	____	____	____
Mercuric chloride (ozs.)	____	____	____
Mercuric oxide (ozs.)	____	____	____
Phenolphthalein (ozs.)	____	____	____
Phosphorus, yellow (ozs.)	____	____	____
Potassium iodide (ozs.)	____	____	____
Silver nitrate (ozs.)	____	____	____
Sodium acetate (¼ lb. btl.)	____	____	____
Sodium bisulfite (¼ lb. btl.)	____	____	____
Sodium hydroxide (lbs.)	____	____	____
Sodium thiosulfate (¼ lb. btl.)	____	____	____
Sulfur (lbs.)	____	____	____
	____	____	____
Other: _____	____	____	____
_____	____	____	____

LIST OF TOOLS

	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Corkborers, set of 6	____	____	____
Drill, hand operated	____	____	____
Drill, set of 1/16 to 3/8 inch	____	____	____
File, flat	____	____	____
File, triangular	____	____	____
Glasscutter	____	____	____
Hacksaw, with blades	____	____	____
Hammer, claw	____	____	____
Measuring tape, 50 ft.	____	____	____
Pliers, needle nosed	____	____	____
Pliers, side cutting	____	____	____
Saw, crosscut	____	____	____
Scissors	____	____	____
Screw driver, small	____	____	____
Screw driver, medium	____	____	____
Screw driver, large	____	____	____
Snips, metal	____	____	____
Soldering iron	____	____	____
Square, carpenter's	____	____	____
Wrench, adjustable, 8 inch	____	____	____
Other: _____	____	____	____
_____	____	____	____

LIST OF MISCELLANEOUS SUPPLIES

Aluminum foil (sq. ft.)	____	____	____
Aluminum shot (lbs.)	____	____	____
Asbestos sheet (sq. ft.)	____	____	____
Blue print paper (sheet 8x10 in.)	____	____	____
Carbon rod, ½ in. dia. (ft.)	____	____	____
Copper gauze, fine mesh (sq. ft.)	____	____	____
Copper sheet, 1/16 in. (sq. ft.)	____	____	____
Copper shot (lbs.)	____	____	____
Lead sheet, 1/16 in. (sq. ft.)	____	____	____
Lead shot (lbs.)	____	____	____
Mica sheet (4x6 in. sheets)	____	____	____
Phosphorescent paint (ozs.)	____	____	____
Rubber dam (sq. ft.)	____	____	____
Stopcock grease (tube)	____	____	____
Stoppers, cork, assorted (lbs.)	____	____	____
Stoppers, rubber, assorted (lbs.)	____	____	____

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Tinfoil (sq. ft.)	____	____	____
Tubing, aluminum, ¼ in. (ft.)	____	____	____
Tubing, copper, ¼ in. (ft.)	____	____	____
Tubing, rubber, ¼ in. (ft.)	____	____	____
Tubing, rubber, 3/8 in.(ft.) (pressure)	____	____	____
Tubing, tin, 1/8 in. (ft.)	____	____	____
Tubing, zinc, 1/8 in. (ft.)	____	____	____
Vacuum wax (ozs.)	____	____	____
Wood's metal (ozs.)	____	____	____
Zinc sheet, 1/16 in. (sq. ft.)	____	____	____
Other: _____	____	____	____
_____	____	____	____

LIST OF WIRE

Copper, bare, no. 8 (lbs.)	____	____	____
Copper, bare, no. 10 (lbs.)	____	____	____
Copper, double cotton covered			
no. 18 (lbs.)	____	____	____
no. 24 (lbs.)	____	____	____
no. 28 (lbs.)	____	____	____
no. 30 (lbs.)	____	____	____
no. 34 (lbs.)	____	____	____
Copper, enameled			
no. 24 (lbs.)	____	____	____
no. 28 (lbs.)	____	____	____
no. 32 (lbs.)	____	____	____
no. 36 (lbs.)	____	____	____
Copper, rubber insulated			
no. 12 (lbs.)	____	____	____
no. 14 (lbs.)	____	____	____
Chromel, no. 12 (4 oz. spool)	____	____	____
no. 16 (4 oz. spool)	____	____	____
no. 20 (4 oz. spool)	____	____	____
Nichrome, no. 12 (1 oz. spool)	____	____	____
no. 16 (1 oz. spool)	____	____	____
no. 20 (1 oz. spool)	____	____	____
no. 24 (1 oz. spool)	____	____	____
no. 27 (1 oz. spool)	____	____	____
Piano, no. 2 (spool)	____	____	____
no. 5 (spool)	____	____	____
no. 7 (spool)	____	____	____
Other: _____	____	____	____

LIST OF MATERIALS WHICH MAY BE PURCHASED LOCALLY

ITEM	MINIMUM NUMBER REQUIRED	NUMBER DESIRABLE	UNNECESSARY
Art colors (set)	____	____	____
Brads (ozs.)	____	____	____
Candles (lbs.)	____	____	____
Carpet tacks (ozs.)	____	____	____
Dowels, wooden, ¼ in. (ft.)	____	____	____
Dry ice (lbs.)	____	____	____
Fishline, silk (spool)	____	____	____
Glass marbles (dozen)	____	____	____
Kerosene (gallon)	____	____	____
Lamp, auto headlight, 6 volt	____	____	____
Lamp, clear glass, 40 watt	____	____	____
Lamp, colored, red, 40 watt	____	____	____
Lamp, colored, blue, 40 watt	____	____	____
Lamp, colored, green, 40 watt	____	____	____
Lamp, tungsten, frosted, 25 watt	____	____	____
40 watt	____	____	____
60 watt	____	____	____
100 watt	____	____	____
150 watt	____	____	____
Nails, assorted (lbs.)	____	____	____
Naphthalene flakes (lbs.)	____	____	____
Needles, darning	____	____	____
Oil, SAE no. 10 (quarts)	____	____	____
Oil, SAE no. 20 (quarts)	____	____	____
Oil, SAE no. 30 (quarts)	____	____	____
Oil, SAE no. 40 (quarts)	____	____	____
Oil, SAE no. 50 (quarts)	____	____	____
Paraffin (lbs.)	____	____	____
Rubber balloons	____	____	____
Rubber bands (box)	____	____	____
Screw eyes	____	____	____
Screw hooks	____	____	____
Shellac (quarts)	____	____	____
Sodium chloride (lbs.)	____	____	____
Solder (lbs.)	____	____	____
Sugar (lbs.)	____	____	____
Tape, friction (roll)	____	____	____
Tape, rubber (roll)	____	____	____
Wax, sealing (ozs.)	____	____	____
Wax, floor (ozs.)	____	____	____
	____	____	____
Other: _____	____	____	____
_____	____	____	____

APPENDIX C

LIST OF PHYSICS TEACHERS WHO RETURNED QUESTIONNAIRES

	Name of Teacher	Name of School and Location
1.	Allen H. McCullough	Baker High School, Baker, Oregon
2.	Perry N. Spelbrink	Corvallis High School, Corvallis, Oregon
3.	C. Tallman	Canby High School, Canby, Oregon
4.	Gladys Chandler	Milwaukie High School, Milwaukie, Oregon
5.	Gilbert Shearer	West Linn High School, West Linn, Oregon
6.	Stanley Glick	Astoria High School, Astoria, Oregon
7.	Duane Johnson	Seaside High School, Seaside, Oregon
8.	Sam Flint	Scappoose High School, Scappoose, Oregon
9.	James Dallemand	Bandon High School, Bandon, Ore.
10.	John Queen	Marshfield High School, Coos Bay, Oregon
11.	Orlando Furno	North Bend High School, North Bend, Oregon
12.	Henry Aiken	Crook County High School, Prineville, Oregon
13.	Charles Keith	Bend High School, Bend, Oregon
14.	Dave Carroll	Grant Union High School, John Day, Oregon
15.	Beach Patton	Hood River High School, Hood River, Oregon
16.	Leland Johnson	Ashland High School, Ashland, Oregon
17.	Kenneth Evans	Central Point High School, Central Point, Oregon
18.	James Johnston	Medford High School, Medford, Oregon
19.	Frederick Shepard	Phoenix High School, Phoenix, Oregon
20.	Ronald W. Zahler	Cottage Grove High School, Cottage Grove, Oregon
21.	Clarence E. Diebel	Eugene High School, Eugene, Ore.
22.	John D. Hale	University High School, Eugene, Oregon
23.	Leo Herrala	McKenzie River High School, Finn Rock, Oregon
24.	Edward S. Murray	Waldport High School, Waldport, Oregon

	Name of Teacher	Name of School and Location
25.	James Lunn	Albany High School, Albany, Ore.
26.	Arthur M. Mason	Harrisburg High School, Harrisburg, Oregon
27.	Charles Steffens	Nyssa High School, Nyssa, Ore.
28.	June Philpott	Salem High School, Salem, Ore.
29.	Bertha McDaniel	Stayton High School, Stayton, Oregon
30.	Alf Nelson	Woodburn High School, Woodburn, Oregon
31.	Robert Poucher	Gresham High School, Gresham, Oregon
32.	Kingeman Bajema	Benson Polytechnic High School, Portland, Oregon
33.	Carlton E. Richter	Franklin High School, Portland, Oregon
34.	Leonard Richardson	Lincoln High School, Portland, Oregon
35.	Frank Richards	Dallas High School, Dallas, Ore.
36.	Jack Sowards	Cove High School, Cove, Oregon
37.	Ralph E. Stoffer	Beaverton High School, Beaverton, Oregon
38.	Arthur Brachmann	Forest Grove High School, Forest Grove, Oregon
39.	Archie Strong	Sherwood High School, Sherwood, Oregon
40.	Lucien E. Broyles	Tigard High School, Tigard, Ore.
41.	Ernest Heimbach	Newberg High School, Newberg, Oregon
42.	Charles B. Flynn	Willamina High School, Willamina, Oregon