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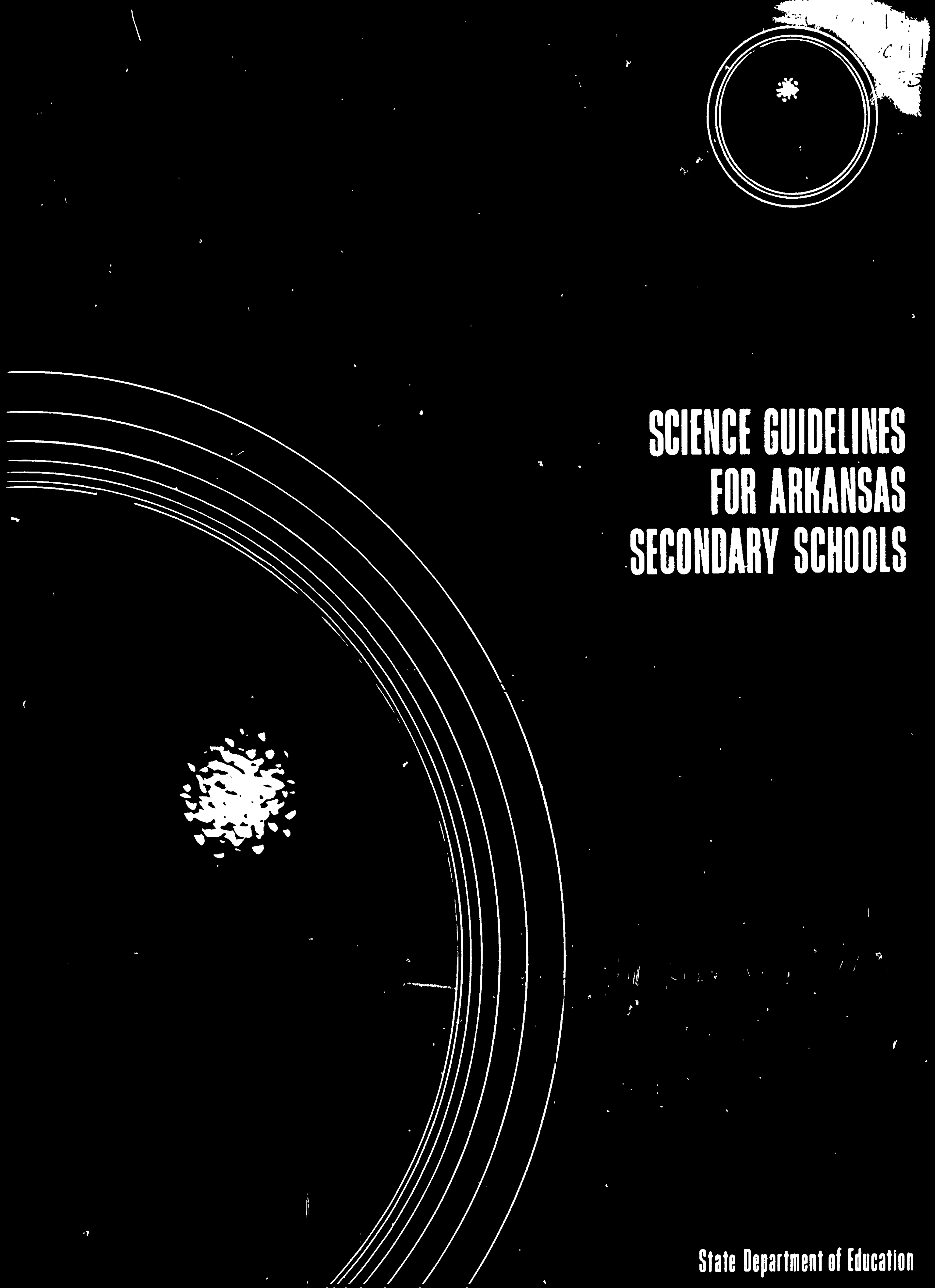
Guidelines for the development of secondary school science programs and facilities which will aid in the review of existing and proposed programs and in adapting classroom instruction to the needs of individual pupils. Science facilities are emphasized including space requirements, classrooms, laboratories, utilities, furniture, and audiovisual materials. Basic lists of necessary equipment are given for general science, biology, chemistry, physics and earth science, as well as supplementary lists for enriched programs in those fields. The appendix includes a bibliography of books and periodicals dealing with science teaching plus suggested classroom, laboratory, and combined classroom-laboratory floor plans. (NI)



SCIENCE GUIDELINES FOR ARKANSAS SECONDARY SCHOOLS

State Department of Education

Science Guidelines
For the
Secondary Schools
of
Arkansas

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FOREWORD

The successful launching of Sputnik and the rapid advance of technology has changed the public posture towards the role of the federal government in supporting public instruction. This has resulted in a revolution in American education.

This revolution has brought about major changes in many fields of teaching, but nowhere more than in science. This includes increased knowledge, improved facilities, added materials, and new offerings in the instructional program which creates new opportunities and challenges at the local level.

This publication is intended to offer guidelines which will help local schools in reviewing existing and proposed programs and in adapting classroom instruction to the needs of individual pupils in meeting the challenge of the Space Age.

A. W. Ford
Commissioner of Education

CONTENTS

COURSES OF STUDY

Numerous courses of study in the sciences have been developed by state agencies, curriculum study committees and various organizations, but none have been quite as successful as those built by the individual school to meet local needs and conditions. A well planned science curriculum is essential to an effective science program and the planning should be a cooperative effort of administrators, teachers and supervisors at all levels in the local school.

Areas of Science

Secondary science programs include the areas of junior high school science, biology, chemistry, botany, zoology, physics, geology, physiology, aero science, physical science, consumer science, and earth science. At the junior high level the program is rapidly moving toward one of physical science, life science and earth science instead of the traditional three years of general science. No school should attempt to offer all of these specific courses but every school should select those disciplines which will fit their needs. Whatever the offerings may be, the major thing to remember is that quality science programs are much more important than quantity programs. A few science courses well taught are much better than many courses poorly taught. Unless a qualified teacher is available, it would be better not to offer a specialized science or even a general science course. Mastery of a few basic concepts in a given course is preferable to a partial understanding of many concepts. In order to use the best qualified teachers, most effectively, the responsibility for teaching science and the building of a science program should be concentrated in a minimum number of well qualified teachers.

Goals of Science

In building a course of study in science the goals one hopes to reach must be considered. The selection of these goals may best be made by studying the needs of youth in relation to the culture in which they are being educated. Youth's needs for living in a democratic society are common skills, attitudes, behaviors and understandings all of which should be reflected in the goals of the total school program. As part of that program, the general goals of science teaching should relate to these needs. Actually the science program should have a threefold purpose. Each student should gain the necessary background of scientific principles and skills to live effectively in a democratic society. The program should also be directed towards the vocational needs of those who will play important roles in the community immediately upon their graduation from high school. Finally, special arrangements should be made for those who are academically talented and will continue their studies in institutions of higher learning. Teachers must also recognize that some of youth's needs change as changes occur in their culture. They must recognize that they will have to evaluate carefully the relationship of their program's goals to cultural changes taking place. Changes in goals of science teaching, if they are to be effective, necessitate changes in science programs. Neither goals nor programs can remain static.

Content

Reliance to an undue extent upon graded textbooks for the content and activities of science tend to make classroom activities an assembly-line type of procedure. Assembly-line procedures—with all students striving for limited goals, equal achievements, and a passing grade mark—tend to set limited goals which result in temporary factual learning. On the other hand—the more varied the instruction, the more adequately it is adjusted to the different needs, abilities, and interests of the students. Diversity of content and procedures in the classroom is necessary if students are to develop their abilities to the greatest extent. A high school chemistry course, for example, should be designed to fulfill the needs of two different groups of students—those who will go on into further study in the field and those who will not. For the latter students, the chemistry course should assist them to function more intelligently in a technological age and understand more fully the impact of science on our culture; for the first group, chemistry courses should, in addition, provide the background information and experiences necessary for college chemistry. All students need not do the same experiments, but when the same experiments are done they need not be done at the time or period.

Once a decision has been made as to what specific science courses are to be offered, the next logical step will be the selection of units for each course offering. The suggested format which follows indicates some items that should be included in any course of study.

Course Outline

Name of Course ______________________________

Title of Unit ______________________________

Overview of Subject Matter	Suggested Activities	Suggested Experiments	Suggested Audio-Visual Materials	Concepts to Be Derived

Suggested References	Other Text References

SCIENCE FACILITIES

The planning of science facilities should be a joint responsibility of teachers, administrators, school plant specialists, consultants, architects, and the Board of Education. Few schools can afford to provide all desirable science facilities, but every school should be able to plan for all science experiences included in its program. One of the major concerns, after the selection of a plant site, should be the amount of space devoted to science instruction.

Space Requirements

The teaching of science in the schools of today requires far more space per student than was provided in earlier facilities, primarily because of greater emphasis on laboratory activities. In addition to more individual laboratory work there is also more emphasis on group work and a greater need for space for the storage of the vast amount of learning materials. Assuming that the arrangement of the rooms makes for complete utilization of the space, effective science teaching requires thirty-five to forty square feet per student. This estimate does not include storage preparation areas, construction areas and darkrooms. If such areas are to be included, the space per student should be approximately fifty square feet.

The trend for science facilities is away from the old concept that class work and laboratory work had to be done in separate rooms. Combined facilities for all activities call for a somewhat greater space per pupil; however, the total space requirement is smaller than was necessary for the separate rooms. The new trend prevents one room being vacant when the other is in use, as well as preventing problems usually encountered in laboratory scheduling.

Experience indicates multiple use should be made of science rooms when the enrollment is less than five hundred students. A minimum of one classroom-laboratory space for general science and biology, and another for chemistry, physics, and other related courses should be adequate for schools with an enrollment of two hundred and fifty to five hundred. In smaller high schools consideration should be given to providing a single multi-purpose classroom-laboratory for all science teaching. The multi-purpose arrangement provides for flexibility and makes possible the ready transition from one kind of activity to another. It also relieves the inconveniences involved when a classroom is shared by a science teacher and a teacher from another field.

Specific floor plans of classroom laboratories for general science, biology, chemistry and physics are shown in the appendix.

Number of Classrooms

The number of classrooms laboratories or combined classroom-laboratories needed may be determined by the following formula:

$$\text{Number of Rooms} = \frac{\text{Student-periods}}{\text{average class size} \times \text{number of periods per week}}$$

For example, 300 students in biology meeting five times per week would require two rooms, assuming a school day of six periods and an average class of twenty-five.

$$\text{Number of rooms} = \frac{300 \times 5}{25 \times 30} = 2$$

Location

Science classrooms should not be located on the north side of the building. A southern exposure is preferred since growing plants need direct sunlight. Even in windowless buildings, a southern or eastern exposure would be more accessible to a needed greenhouse.

If the building consists of two stories, there are many advantages in locating the science facilities on the first floor. Chief among these advantages are the cost of plumbing, the ease of bringing laboratory materials into the area, the simplicity of leaving the building for field trips, and the accessibility to outside growing areas.

Specialized Spaces

In addition to classrooms, laboratories, and multi-purpose rooms, other space facilities needed for a total science program are: storage rooms, darkrooms, preparation areas, construction areas, and conference rooms. The amount of space devoted to storage should be approximately twenty per cent of the total science area. This figure is approximate since it is dependent upon whether or not provision has been made for storage within the classroom-laboratory itself. If the latter condition exists, a relatively smaller space may be adequate. It is desirable to have the storage area divided into two separate spaces. In one space, all chemicals should be stored. The other space should be given over to the storage of materials other than chemicals. The corrosive effects of vapors from certain chemicals make the separation of storage spaces necessary. Gravity ventilation is usually adequate for the general storge areas, but forced ventilation is highly recommended for the storage areas housing chemicals.

Where possible the storage area should have an outside entrance which would provide more freedom of the movement of materials coming into the building. By all means an opening to a plant alcove should be provided.

Each storage room should have adequate shelving. The length and depth of the shelving will depend upon the purpose for which it is to be used. Normally, a ten or twelve inch shelf will suffice for most materials and equipment. In no case should the depth be great enough to permit the storage of one item behind another. A definite place for every item should go a long way in determining the size of shelving, thus giving some order to arrangement and providing for good housekeeping. The most desirable shelving is the adjustable type; well braced and without sag. A portion of the shelving in the chemical storage area must be acid-resistant.

If a special preparation room is not provided, the chemical storage area should have a preparation table equipped with sink, water, gas and electrical outlets. The work surface of this table should be acid-resistant. The dimensions of the preparation table should be approximately 6′ x 2′ x 36″. The sink should be approximately 14″ x 10″ x 5½″.

A workbench, 6′ x 2′ x 36″ should be placed in the physical storage area if there is no special space for construction work. The bench should be made of sturdy material and equipped with a vise and electrical outlets. The top need not be acid-resistant. A drawer or storage space should be provided in the bench for such items as a hammer, screwdriver, pliers, tin snips, hacksaw, wrenches, brace and bit, etc.

If the classroom-laboratory can be well darkened, many fundamental experiments can be performed without a separate darkroom. Where one is provided, attention should be given to the access door if it is to serve the entire school as well as the science laboratories. The space needed for a darkroom will vary from one school to another. The minimum area should be approximately one hundred square feet. Equipment normally found in a darkroom consists of a developing table, a printing table, utility table and a cabinet.

The developing table should be equipped with sink, gas, drain, running water and 110-V a. c. outlet. A printing table with drawers (light tight for printing paper) should be placed adjacent to the developing table. The utility table will be needed for such equipment as enlargers, and the cabinet will be needed for storing developing materials. It is desirable that the walls of the darkroom be painted with non-reflecting black paint.

Utilities

In planning and equipping a modern science room, careful choice and proper location of adequate service facilities will provide for greater efficiency. Running water, waste service, gas service and electric service are the major utilities needed in all science rooms.

An adequate number of water outlets should be available in each classroom, darkroom, preparation room, laboratory and at all demonstration desks and work stations. All faucets should be of the slow-compression type, with working parts made of corrosion and abrasion resistant material. A cut-off valve should be placed in each major water line.

Waste lines and traps should be selected with care since they will be carrying materials that are highly corrosive. Glass, duriron, and durcon have proven to be most satisfactory for sewer lines. These materials may seem to be rather expensive; but in the long run the amount saved on plumbing bills will justify their use. The waste line should not be connected to the regular septic tank. An independent sewer system will have to be provided if the laboratory line is not connected to a city unit. Some city systems require that the sewage be treated before it goes into the city plant. Always check the plumbing codes of your community before connecting to a municipal system.

Sinks and troughs should be made of acid-resistant materials. Duriron, durcon, ceramic, soapstone, molded or welded plastic, stainless steel and glass are materials most commonly used for such facilities. The size of the sink depends largely upon its use. If it is to be mounted at the end or between tables, it should be approximately 20" x 15" x 10". A five foot demonstration desk should have one that is approximately 14" x 10" x 6". An eight foot demonstration desk needs one that is approximately 18" x 14" x 6". For perimeter mountings the sink should be approximately 12" x 10" x 6". Strainers should be provided for each sink since many items which fall into the waste line are not soluble in water. Proper care of the waste line can prevent a lot of inconvenience and save on plumbing bills.

Gaseous fuels liquefied under pressure (propane, butane, etc.) alcohol burners, electric hot plates and natural gas are the usual sources of heat for experimental work. Duplex gas outlets should be provided on demonstration tables, preparation tables, and all work stations. Cut-off valves should be provided in each supply line, and a master cut-off should be provided for each classroom and laboratory.

Adequate electric service for both present and future needs should be considered in planning science facilities. The nature of the equipment to be used will determine the type of circuits needed. Both a.c. and d.c. outlets should be provided at all anticipated work areas. General purpose outlets of not more than twenty amperes, 110-V should be provided for lighting and other common uses. Circuits of thirty amperes, 110-V are needed for electric heaters, motors and power tools. Some devices will require a 220-V circuit. With radio and television becoming a part of the instructional program, special antennae should be provided outside the building. The use of these instruments will require special conduits to bring the coaxial cable and antenna wire into the classroom. To control the distribution of current to the several work stations and appliances, a switchboard should be provided.

Electrical devices which must be kept in continuous operation such as incubators, drying ovens, and aquarium heaters should be equipped with automatic circuit-breakers so that the current will be shut off if the temperature approaches the danger point.

SCIENCE FURNITURE

Furniture for science classrooms and laboratories may be either fixed or movable. It is the machinery of the science program with apparatus and materials serving as the tools. Such furniture includes demonstration desks, fume hoods, student work stations, animal cages, display cabinets, storage cabinets, aquaria, germinating beds, incubators, refrigerators, tote tray cases and many other pieces of equipment designed to have a usable life approximately that of the building. The selection of science room furniture should be based upon the general nature of the work to be done.

Furniture Tops

Particular attention should be given to the tops of such items as demonstration desks, fume hoods, preparation areas, dark room equipment and student work stations. The tops of such furniture receive more mechanical and chemical abuse than any other type of laboratory equipment. Some of the more common types of tops are listed in Table 1. Regardless of the top selected, its life expectancy can be extended by proper treatment.

Table 1

Top Material	Chemical Resistance	Heat Resistance	Moisture Resistance	Stain Resistance	Recommended
Soapstone	Very good	High	Excellent	Stains Readily	High
Resin-Coated Asbestos Composition	Excellent	Excellent	Very good	Excellent	High
Resin-Coated Welded Fibre	Good	Limited	Good	Excellent	Good
Resin-Coated Maple	Excellent	Limited	Adequate	Very good	Fair
Natural Finish Maple	Fair	Limited	Fair	Fair	Fair
Stainless Steel	Good	Very good	Excellent	Good	Good
Formica	Poor	Good	Good	Good	Poor

Demonstration Desk

Successful demonstrations require a good demonstration desk with adequate facilities such as electrical outlets running water and gas. It should have as a part of its cabinet work sufficient storage for commonly used materials. The size may vary, however an 8' x 30" x 37" is most commonly used. One of this size provides adequate area for most demonstrations and is high enough for students to see the demonstration materials from their seats. Portable demonstration tables may be all right for elementary science rooms, but they are not satisfactory for secondary classrooms. Sinks for the demonstration desk should meet specifications suggested in the discussion of utilities, page 8.

Fume Hoods

There are several factors which should be considered before installing a fume hood in a high school science room. Does the state or local code requirements demand that one be provided? Will it be used enough to justify the expense? Can semi-micro techniques eliminate the need? Can special ventilation of the room be substituted for a hood? Can it be located so that it may be used for ordinary laboratory activities as well as for special experiments where gases are involved?

Where fume hoods are used, they should be specified with safety in mind. They should be constructed of noncombustible and corrosion resistant material with all glass being of the safety type. Services should be remote controlled, with electrical outlets located outside the hood. Plumbing fixtures within the hood should be protected with chemical-resistant coatings.

Sashes, where used, should be counter-balanced and so designed to provide for easy replacement of the safety glass. Both top and bottom baffles are needed so as to take care of light or heavy gases. The hood should be provided with an exhaust fan with a pilot light connected in the circuit so as to indicate when the fan is operating.

Fume hoods should be located so that they are out of the direct path of traffic and are not exposed to drafts of air caused by open windows or doors.

Portable fume hoods are now available and may be attached wherever an exhaust outlet is installed. The movable hood is much more economical to install and is proving to be adequate for most high school chemistry programs.

Student Work Stations

There is no substitute for experimentation and observation in developing appreciation for the methods of science. To gain a better understanding of these methods, individual students must be given an opportunity to do experimental work. Actual work with materials and forces requires that adequate student work stations be provided. Many patterns and types have been designed by various manufacturers. The more common classes are the perimeter or wall type and the island type. Figures 1 and 2 show examples of the wall type with Figure 3 being an example of the island pattern.

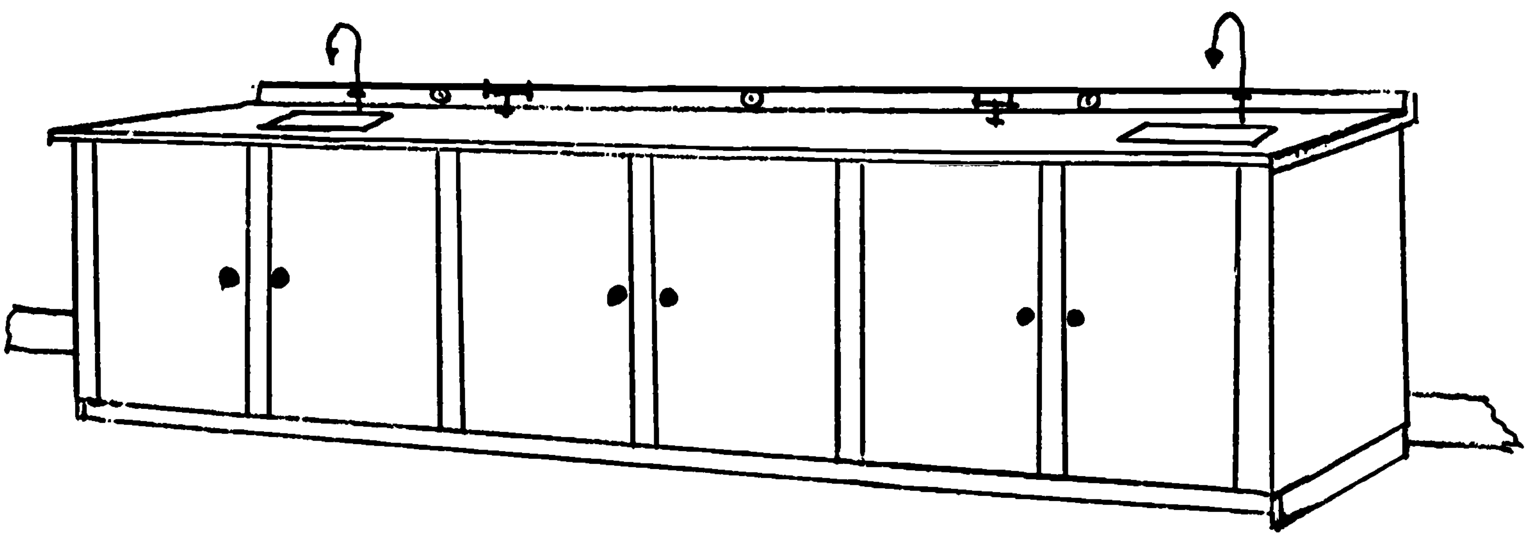


Figure 1

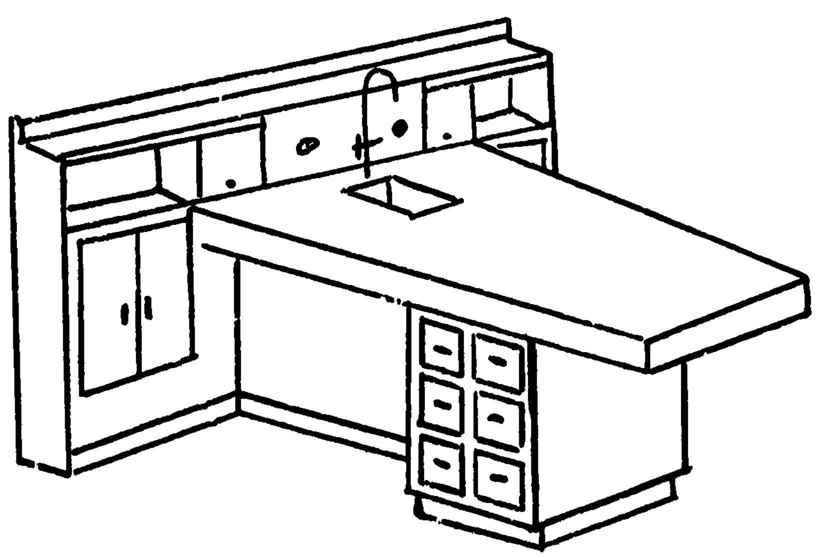


Figure 2

The unit in Figure 1 is only a part of a wall assembly whose length will be determined by the need and the size of the room. In this type, the sinks should be eight feet apart—center to center in order to have ample space between the tables when they are moved to the wall assembly. The top of this unit must be acid-resistant and its width should be approximately two feet. The heighth should be 37 inches. For multi-purpose use this type of work station is recommended. The greatest disadvantage is that it lacks individual storage space. Where more than one chemistry class makes use of the facilities, Figure 2 is probably more suitable in this respect. Tote trays are commonly used with work stations patterned on the style of Figure 1.

In Figure 2, four students have adequate space and storage for individual equipment and materials. This unit should be 37 inches high, 44 inches wide, and the top should be acid-resistant.

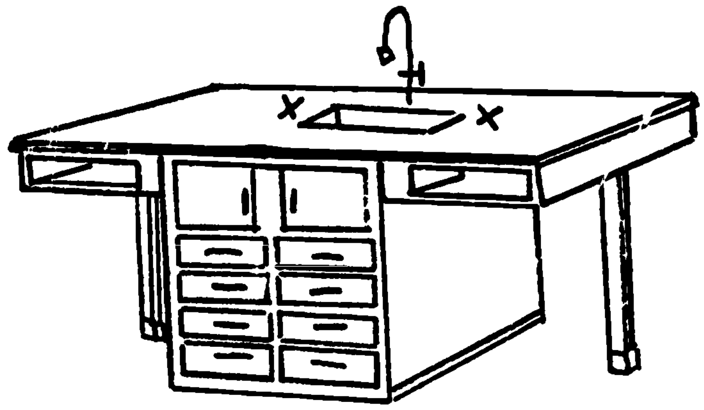


Figure 3

The over-all size of the island units may vary from a 4-student complex to one of 16-students. These units must be stationary, therefore there will be a lack of flexibility in the use of rooms equipped with this type of work stations.

Much of the laboratory work done in the sciences, other than chemistry, does not require service or utility connections. In such cases, a table of the 2-student type may serve as a work station. These tables should be approximately five feet in length, two feet wide and thirty inches high. The tops of these tables should be about one and one-half inches in thickness and made of acid-resistant material.

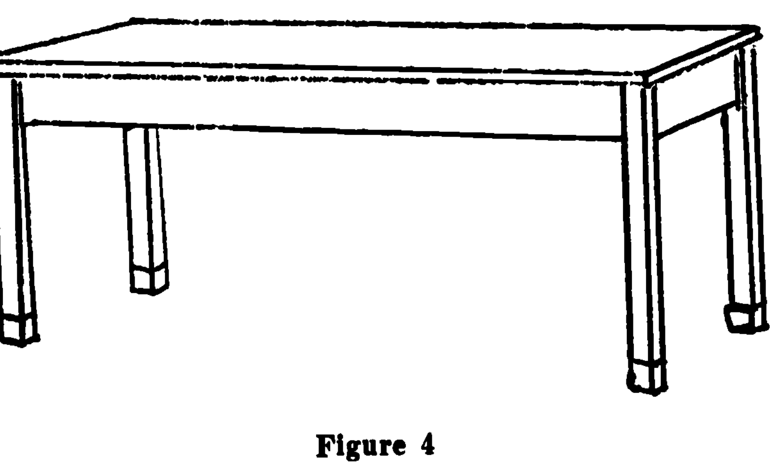


Figure 4

Demonstration desks, fume hoods and student work stations are the major furniture items in a science room, with accessory items including such things as cabinets, aquaria, germinating beds, refrigerators, incubators, animal cages, etc.

Cabinets: Cabinet needs will depend upon the extent to which the science program has been developed. Extensive programs demand more equipment and materials which in turn require more storage and display facilities. Table 2 gives the names of some of the common types of cabinets and lists the desirable sizes:

Table 2

Name	Width	Depth	Height
Microscope (15 cubicles)	22"	22"	82"
Skeleton	27"	16"	84"
Torso	22"	22"	82"
Notebook	27"	16"	84"
Tote Tray (24 Trays)	32"	22"	84"
Tote Tray (18 Trays)	47"	23"	36"
Display	62"	16"	84"
Reagent	35"	7"	30"
Key (160 Keys)	24"	3"	14"

The doors for all cabinets, except display cases, may be either glass or wood. Display cabinets must have transparent doors. In all cases where glass is used, it should be shatter-proof. The doors may be hinged or sliding. All cabinets should be well braced, of sturdy material, and fitted with adjustable shelves.

Open display shelving may be used instead of display cabinets. If such shelving is to be constructed locally, it should be made of solid hardwood or hardwood surface plywood. Where open shelving is to be used for reagents, it should be constructed of acid and alkali resisting carbonized hardwood. The shelves should be approximately 1¼" thick and spaced nine inches apart for one pound reagent bottles and eleven inches apart for five pound bottles.

Aquaria: The number and size of aquaria needed depend upon the science program and the use to be made of the units. More and more biology teachers are collecting and growing aquatic plants and animals from the local level for use in their classes. The most economical way to do this is by use of a large aquarium.

An aquarium used for this purpose should have a capacity of 30 to 50 gallons. The bottom and ends of an aquarium of this size should be made of soapstone. The sides should be of plate glass with polished bulb-edges or metal edges at the top. Nonrusting tie rods should be used to brace the sides. The sides and bottom should be set in non-hardening, waterproof cement. All drain fittings should be noncorrosive.

A selection of small movable aquaria with capacities of not more than five gallons should be provided for student use in growing aquatic animals and plants. Large pickle jars, cookie jars or carboys make excellent containers for the smaller aquaria. A glass tank set in a frame of stainless steel is the type most commonly used. The bottoms of such aquaria are usually made of heavy slate and the glass sides are set in non-hardening cement.

Terrarium: A terrarium is a basic need for each biology and each general science classroom. This piece of equipment provides a humid environment such as that found in lowlands and woodlands so that certain semi-aquatic animals and plants may grow. The terrarium should have a welded steel frame, a heavy slate bottom, and plate glass sides and top. The top and upper portion of the front side should be removable in order to provide for adequate ventilation. Other portions should be cemented to the frame. The interior part of this unit should be resistant to rot, rust, and corrosion.

Germinating Bed: Biology classrooms and general science rooms are usually equipped with some type of apparatus for observing the germination of seeds. Here the effects of depth, moisture, kind of seed, etc., can be studied. The commercial type of germinating bed will cost more than $200. Economical substitutes may be provided by using any open top metal, plastic or wooden box with a vertical glass front. In some cases milk cartons, plastic containers, glass jars, and plastic lined boxes have been used satisfactorily. If the schools prefer to build one locally, the following suggestions may be of some value. The over-all length should be about six feet; the inside width two feet; the depth, six inches; and the height from the floor three feet. The box should be made of sturdy lumber and lined with zinc or lead with a strainer and dripcock at the center. The front of the box should be made of plate glass and the frame or table on which it is mounted should have rubber-tired casters.

Refrigerator: Refrigerators in a science room are more of a convenience than a necessity. There are a few items which need refrigeration and ice cubes are needed occasionally. In no case, however, should one be purchased if it is to be used for food or beverages for teachers and pupils.

If a refrigerator is purchased, it should be bought locally so as to insure proper servicing when needed. The size will be determined largely by the activities which will demand cold storage items, such as ox-eyes, beef hearts, etc.

Incubator: Incubators needed in biology and general science are of two types, one for use in bacteriological studies and the other for egg incubation. Each type should be sturdily built.

The bacteriological incubator may be of double-walled compressed asbestos with stainless steel framework. It should be equipped with an air agitator mounted below the lower shelf. The inside door should be of pyrex glass, in order to view the contents without appreciable change in temperature. Thermostat control is needed and the temperature should range from variable room to about 60° C. The incubator should operate on 115 V or 220 Volt, 60 cycle, a.c. The size will be determined by the number of specimen to be incubated.

The egg incubator should consist of a high-quality heating unit and automatic temperature control enclosed in a durable non-corrosive, double-walled case. The case should have a light and an inspection window. A suitable water bath or vaporizer should be provided for the maintenance of optimum humidity. The incubator should operate on 115 volt 60 cycle a.c.

Animal Cages: At least two animal cages for housing small animals should be available for each biology room. Insect cages are also desirable for the breeding and study of insects. Either of these can be built in the school shop or in the science laboratory.

If factory made cages are desired, they should meet the following specifications: They should consist of heavy wire screen mounted on a sturdy metal frame. A hinged door with a good latch is needed. A pan or drawer should be provided to catch droppings. This pan should slide beneath a wire walk floor. Sizes may vary with the most common one being 13 inches high 18 inches wide, and 18 inches deep.

Laboratory Cart: A laboratory cart with acid-resistant top and shelves is needed to facilitate movement of apparatus and supplies. It can also be used for distribution of materials for student use thus decreasing the congestion around the demonstration desk or reagent shelves. The cart should be made of steel framing and coated with a protective lacquer. It should be equipped with ball bearing casters with rubber tires and must roll freely in all directions. The two shelves should have guard rails as safeguards against dropping. Over-all dimensions should be 36 inches high, 19 inches wide, and 36 inches long.

AUDIO-VISUAL MATERIALS AND EQUIPMENT

Audio-visual materials and equipment may be grouped under two general classifications, namely; non-projected and projected. Each type has its particular values and advantages, and no science program will be complete without a generous supply of each.

Non-projected Facilities

Under the heading of non-projected facilities, are such items as specimen, models, mock-ups, and wall displays. If such material is to serve the instructional purpose that it should, adequate storage and display areas must be provided. Such factors as to whether the specimen are alive or preserved must be taken into consideration. Size may also be a factor and the quality certainly must be considered. For many years, most biological models were made of plaster-of-paris or a chalky material which crumbled or was easily broken. Various types of plastics are proving to be more satisfactory for making all kinds of models.

A display cabinet recessed in the wall can be attractive and useful in science teaching. Such cabinets can be built in the school or purchased. In general, the exhibit case should have adjustable shelves. The back of the cabinet should be made of tackboard so that explanatory material can be readily attached. Minimum dimensions should be a width of four feet, a height of three feet and a depth of 18 inches. The position of this display unit should be such that the principal object of display will be approximately at eye level.

Open shelving and ample tackboard space are also desirable for the display of audio-visual materials that are to be examined and studied. The shelving should be adjustable and may vary in depth. The tackboard should be made of cork or some type of vegetable - fiber board and the dimensions should approximate those of the chalkboards.

Charts, maps, and globe as well as other printed audio-visual materials must be up-to-date if they are to be of value for instructional purposes. The size of such items must be large enough for classroom group use rather than for individual use.

Projected Facilities

Audio-visual materials coming under the classification of projected includes such items as microscopes, microprojectors, filmstrips, opaque, overhead, slide and motion picture projectors, phonographs, radios, tape recorders, and television receivers.

With changing designs and new models coming on the market each year it is impossible to set up more than suggested guidelines for the acquisition of audio-visual equipment. In every case where these materials are to be purchased, it is essential that specifications be supplied and checked, and that the quality and performance levels be determined to see that they meet the purposes intended. The availability of replacement parts and the ease of getting repair work done are factors of major importance. Other factors to be considered in evaluation audio-visual equipment are:

1. Controls clearly marked
2. Ease of threading film or tape
3. Shockproof design
4. Total light on the projection screen
5. Ease of cleaning optical parts
6. Ease of focusing
7. Absence of objectionable flicker
8. Uniformity of light distribution on screen
9. Minimum noise and vibration
10. Sturdy construction
11. Ease of access for servicing and maintenance
12. Audio reproduction adequate for room where service is used.

In general, is the machine or equipment the proper model for the intended use? Purchasing the right kind of equipment, however, does not mean that all problems are solved. The use of projection materials means that proper consideration must be given to darkening facilities, ventilation, screens, acoustics and electrical circuits. The Audio-Visual Equipment Directory published by the National Audio-Visual Association, Fairfax, Virginia, is perhaps the best source for information regarding audio-visual problems. Although this is a rapidly moving field, their annual publication is fairly complete in regard to designs, specifications, reproductions, and all types of audio-visual materials.

EQUIPMENT AND MATERIALS

Every room in which science is taught should have a demonstration desk equipped with sink, water, gas and electricity. Student work stations are also needed where adequate programs are provided. Apparatus and materials needed for the various science disciplines may be selected from the following lists. The type of experiments to be done and the number of students involved will determine the kind, size and quantity of each item needed for specific courses.

Where the laboratory is used for more than one science, many named items in more than one science list need not be additionally provided.

The type and kind of chemicals will vary so much according to needs, that none have been included in these lists. All general supply houses will furnish adequate chemical lists.

Ample storage space should be provided for proper protection and preservation of expensive equipment.

Basic General Science List

1. Anemometer
2. Balance, spring 250 c.c.
3. Balance, spring 1000 c.c.
4. Balance, triple beam
5. Balance, weights metric
6. Balance, weights English
7. Ball and ring
8. Barometer, aneroid
9. Battery jars
10. Beakers 250 c.c.
11. Beakers 500 c.c.
12. Beakers 1000 c.c.
13. Bell, electric
14. Bioscope

15. Bottles, labeled reagent
16. Bottles, wide mouth 8 oz.
17. Bottles, stopper extractor
18. Burner, alcohol
19. Burner, Bunsen
20. Buzzer, electric
21. Calorimeter, double wall
22. Candles
23. Camera, pinhole
24. Capillary tubes
25. Chart, Botanical
26. Chart, eye
27. Chart, nutrition
28. Chart, physiology
29. Chart, zoology
30. Clamp, burette
31. Clamp, meter stick
32. Clamp, test tube
33. Coils, resistance
34. Compass magnetic
35. Compound bar
36. Condenser, Liebig
37. Convection apparatus
38. Copper wire
39. Corks, assorted
40. Cork borers
41. Cylinder, graduated
42. Cylinder, density
43. Dew point appapratus
44. Dish, culture
45. Dish, evaporating
46. Dry cells
47. Dropping bottle
48. Droppers, medicine
49. Electromagnet horseshoe type
50. Electroscope
51. Filter paper
52. Flask, Erlenmeyer 250 c.c.
53. Flask Florence 250 c.c.
54. Funnel, short stem
55. Funnel, thistle top
56. Glass plates 5 in. x 5 in.
57. Globe, celesti[illegible]
58. Globe, Hall T[illegible]rian
59. Globe, Terrestial
60. Hall's carriage
61. Hand lens
62. Hot plate
63. Hygrometer wet and dry bulb
64. Hydrometer jar
65. Inclined plane
66. Lamp chimney
67. Litmus paper, blue
68. Litmus paper, red
69. Magnet, bar
70. Magnet, horseshoe
71. Magnet, U-shaped
72. Meter stick
73. Mirror, convex-concave
74. Mirror, plane
75. Model, force pump
76. Model, gasoline motor
77. Model, lift pump
78. Needle, knitting
79. Needle, magnetic dipping
80. Prism, equilatural glass
81. Pulleys, double
82. Pulleys, single
83. Pulley cord
84. Psychrometer. sling
85. Ringstand and rings
86. Rod glass
87. Sealing wax
88. Simple machine demonstration
89. Slides, cover glass
90. Slides. microscope plain
91. Star chart
92. Stoppers, rubber assorted
93. Switches, knife
94. Switches, push button
95. Test tubes
96. Test tubes brush
97. Test tubes rack
98. Thermometer C - scale
99. Thermometer F - scale
100. Thermometer, max.-min.
101. Top, color
102. Tools
103. Tote trays
104. Trough, pneumatic
105. Tubing, glass
106. Tubing, rubber
107. Tuning fork
108. Watch glass
109. Wing top
110. Wire gauze

For an enriched general science program the additional materials are recommended.

1. Aerator, aquarium
2. Aquarium heater
3. Aquarium thermostat
4. Ammeter, D. C. low scale
5. Ammeter, A. C. low scale
6. Archimedes principle apparatus
7. Aspirator (filter pump)
8. Barometer, mercurial
9. Baroscope
10. Battery lead storage
11. Battery, charger
12. Bell in vacuo
13. Bell jar
14. Binocular 4 X field glass
15. Board, spreading
16. Brownian movement apparatus
17. Cell student demonstration
18. Center of gravity apparatus
19. Chart, periodic system
20. Chart, spectrum visible
21. Cloud apparatus
22. Coil, helix solenoid

23. Coil, high frequency
24. Collection, rock and mineral
25. Color disk with motor
26. Electrical circuit, basic kit
27. Electrostatic demonstration kit
28. Electrolysis apparatus
29. Flower pots
30. Flower press
31. Flourescent liquid set
32. Flourescent mineral kit
33. Galvanometer
34. Generator, dynamo
35. Gyroscope, simple form
36. Hydraulic ram, working model
37. Hydrometer, heavy liquids
38. Hydrometer, light liquids
39. Incubator
40. Inverse squares apparatus
41. Lenses, demonstration set
42. Liter block, dissectible
43. Magdelburg hemispheres
44. Magnet electro-lifting
45. Model, eye (human)
46. Model, ear (human)
47. Model, heart (human)
48. Model, lungs (human)
49. Model, torso (human)
50. Model, flower
51. Model, leaf
52. Model, root
53. Model, stem
54. Motor, St. Louis
55. Mounts, Botanical
56. Mounts, Riker
57. Optical bench elem. form
58. Optical bench kit
59. Organ pipes
60. Osmosis apparatus
61. Pascals vases with gauge
62. Photoelectric cell and relay
63. Power supply, low voltage
64. Pump, air motor driven
65. Radiometer
66. Rain gauge
67. Rectifier, Tungar
68. Rotator, hand driven
69. Siphon, intermittent
70. Soil-test kit
71. Spoon, deflagration
72. Stroboscope, hand driven
73. Stethoscope
74. Telescope, reflecting 3 in.
75. Timer, stop watch
76. Vasculum
77. Voltmeter
78. Voltmeter-ammeter tester
79. Wheel and axle
80. Wheel, geared

Basic List for Biology

1. Balance, triple beam
2. Battery jars
3. Beaker, 250 c.c.
4. Beaker, 500 c.c.
5. Board, animal dissecting
6. Board, insect spreading
7. Boiler, double
8. Bottle, dropping
9. Bottle, insect killing
10. Bottle, stopper extractor
11. Bottle, wide mouth
12. Bottle, specimen
13. Brush, test tube
14. Burette, straight stop cock
15. Burner, Bunsen
16. Cage, animal
17. Cage, insect
18. Candles
19. Capillery apparatus
20. Centrifuge, hand driven
21. Chart, anatomy
22. Chart, Botany
23. Chart, Biology
24. Chart, Eye
25. Chart, Nutrition
26. Chart, Zoology
27. Clamp, test tube
28. Clamp, meter stick
29. Corks (assorted)
30. Cork borers
31. Cover glasses
32. Dish, crystallizing
33. Dish, evaporating
34. Dish, petri
35. Dissecting pans
36. Dissecting sets
37. Flask, Erlenmeyer
38. Flask, Florence
39. Filter paper
40. Flower pots
41. Flower press
42. Forceps, straight
43. Forceps, bone cutting
44. Funnels, short stem
45. Funnels, thistle
46. Gauze, wire
47. Germinating bed
48. Graduated cylinder
49. Glass tubing
50. Hot plate
51. Incubator
52. Insect net
53. Kit, microscope slide
54. Lamp, microscope sub-stage
55. Labels
56. Lancets, blood
57. Magnifiers, tripod
58. Mat, asbestos
59. Meter stick
60. Microscope, standard

61. Microscope, cover
62. Microscope, slide box
63. Model, ear (human)
64. Model, eye (human)
65. Model, heart (human)
66. Model, lungs (human)
67. Model, torso (human)
68. Model, flower
69. Model, root
70. Model, stem
71. Model, leaf
72. Mortar and pestle
73. Needle, inoculating
74. Pins, insect
75. Refrigerator
76. Rod, glass
77. Ringstand and rings
78. Rubber stoppers assorted
79. Rubber tubing
80. Scalpel, general
81. Slides, microscope plain
82. Spatula
83. Sterilizer, steam pressure
84. Stone, sharpener
85. Terrarium
86. Test tubes
87. Thermometers
88. Tools
89. Trays
90. Tubes, culture
91. Vials assorted
92. Vivarium
93. Watch glass
94. Weights

For an enriched biology program the additional materials are recommended.

1. Alidade
2. Animal kingdom set
3. Ant nest, observation
4. Autoclave
5. Auxanometer
6. Bacteria colony counter
7. Basket, test tube
8. Basket, wire
9. Beehive, observation
10. Binocular 4 X
11. Blender - mixer
12. Block, pinning
13. Bottle, Balsam
14. Bottle. reagent labeled
15. Box Rh blood typing
16. Cabinet, microscope
17. Cabinet, slide
18. Cabinet, tote tray
19. Cabinet, torso
20. Cabinet, skeleton
21. Camera
22. Case, insect specimen
23. Chart, periodic
24. Chart, spectrum
25. Chart. life history habitat
26. Collection, fossil
27. Crucible
28. Crucible cover
29. Culture glass. hydroponics
30. Desiccator with plate
31. Embedding table
32. Geiger counter radiological
33. Grafting tools
34. Hemocytometer set
35. Hemoglobinometer
36. Hooks and chains
37. Hydroponics equipment
38. Jar, staining
39. Kit, plastic embedding
40. Lactometer
41. Light source
42. Microprojector
43. Microscope, stereoschope
44. Microtome, hand
45. Mounts, Botanical
46. Mounts, Riker
47. Net, dip
48. Oven, drying
49. Photometer
50. Photosynthesis light screen
51. Press, dry mount
52. Probe
53. Rock test tube
54. Scalpel, cartliage
55. Scissors blunt point
56. Scissors fine point
57. Skeleton, human
58. Slides, prepared botany
59. Slides, prepared zoology
60. Slides, depression plain
61. Soil auger
62. Soil test set
63. Sphygmomanometer
64. Syringe, injection
65. Stethoscope
66. Tester, soil nitrate
67. Tester, soil phosphorus
68. Tester, soil potash
69. Thermometer, soil
70. Timer, stop watch
71. Tools
72. Vasculum
73. Vials, serum

Unless the general science and biology equipment has been adequately provided for it is best not to attempt to equip for chemistry or physics, but rather to enrich the earlier courses.

Individual laboratory work (or groups of two students) is almost a necessity in chemistry and physics courses. The demonstration method alone is not a satisfactory way of offering instruction in these courses. This will mean that the quantity of most items in the lists which follow will have to be numerically adequate to take care of individual or group needs.

Basic Chemistry List

1. Absorbent cotton
2. Atom models kit
3. Aspirator
4. Balance, Harvard
5. Balance weights
6. Barometer, Mercurial
7. Battery, lead storage
8. Battery, charger
9. Battery, tester
10. Beakers 250 c.c.
11. Beakers 400 c.c.
12. Beakers 600 c.c.
13. Blowpipe
14. Bottle, reagent labeled 8 oz.
15. Bottle, reagent labeled 4 oz.
16. Bottle, wide mouth 8 oz.
17. Bottle, glass stoppered
18. Bottle, dropping
19. Bottle, washing
20. Bottle, gas generating
21. Burette, glass stopcock
22. Burette, clamp
23. Burner, Bunsen
24. Burner, Fisher
25. Burner, Blast
26. Charcoal block
27. Chart, electromotive series
28. Chart, periodic
29. Chart, metric
30. Chart, spectrum
31. Centrifuge
32. Condenser, Liebig
33. Corks, assorted
34. Cork borers
35. Cork press
36. Crucibles
37. Crucible covers
38. Candles
39. Clamp holders
40. Condenser clamp
41. Copper sheet
42. Cylinder, graduated
43. Cylinder, hydrometer
44. Dish, crystallizing
45. Dish, evaporating
46. Desiccator and plate
47. Drying tube
48. Electrolysis apparatus
49. Eudiometer
50. File, rat-tail
51. File, triangular
52. Fire blanket
53. Fire extinguisher CO_2
54. Fire extinguisher dry chemicals
55. Fire extinguisher soda-acid
56. First aid cabinet
57. First aid chart
58. Flask, distilling
59. Flask, Erlenmeyer
60. Flask, Florence
61. Flask, filtering
62. Forceps, iron
63. Filter paper
64. Funnel, short stem
65. Funnel, long stem
66. Funnel, thistle tube
67. Gas diffusion apparatus
68. Generator, Gas Kipp
69. Generator, steam
70. Glass, cobalt
71. Glass rod
72. Glass tubing
73. Goggles
74. Graph paper
75. Hot plate
76. Hygrometer wet and dry bulb
77. Jar, battery
78. Labels, gummed
79. Laboratory cart
80. Litmus paper
81. Mat, asbestos
82. Magnifier, tripod
83. Meter stick
84. Microscope
85. Mortar and pestle
86. Nichrome wire
87. Platinum wire
88. Pump, motor driven
89. Oven, drying
90. Retort
91. Shower, safety
92. Spatula
93. Spoon, deflagrating
94. Sponge
95. Test tubes
96. Test tube brush
97. Test tube holder
98. Test tube support
99. Test tube rack
100. Tubing, rubber
101. Thermometer Cent. scale
102. Thermometer Fahr. scale
103. Tongs, crucible
104. Trough, pneumatic
105. Watch glass
106. Wire gauze squares

The following items are recommended if basic list is already acquired.

1. Acid pump
2. Bath, sand
3. Bath, water
4. Carboy caddy
5. Basket, test tube
6. Battery, nickel-cadmium
7. Bottle stopper extractor
8. Boyle's Law apparatus
9. Calorimeter, double wall
10. Cell, student demonstration
11. Chart, electron energy level
12. Chart, relative strength of acids and bases
13. Cloud chamber
14. Dew point apparatus
15. Distilled water storage
16. Flask, volumetric
17. Furnace, muffle
18. Glass blowing equipment
19. Glass cutter, hot wire
20. Gooch crucible
21. Milk testing apparatus
22. PH meter
23. Refrigerator
24. Shield, safety glass
25. Spectroscope
26. Vapor pressure apparatus
27. Viscosity tube
28. Water condenser

Basic List for Physics

1. Archimedes' Principle Apparatus
2. Aspirator, filter pump
3. Balance, single beam, avoirdupois and metric
4. Balance, spring
5. Balance, triple beam, high form
6. Balance, triple beam, low form, heavy duty
7. Ball, inertia
8. Balls, assorted
9. Bar, compound
10. Barometer, aneroid
11. Barometer, mercury
12. Battery cell, Gotham, demonstration
13. Battery charger
14. Battery, storage, lead-acid
15. Battery, storage, nickel-cadmium
16. Battery tester, hydrometer
17. Beaker, griffin, low form
18. Boyle's Law apparatus, flexible tube form
19. Brownian movement apparatus
20. Burner, Bunsen
21. Caliper, micrometer, metric
22. Caliper, Vernier
23. Calorimeter, double wall
24. Car, ballistic
25. Cartesian diver
26. Catskin
27. Cell, student demonstration
28. Center of gravity apparatus
29. Chart, periodic system, Hubbard
30. Chart, spectrum
31. Clamp, lever, knife edge
32. Clamp, meter stick
33. Clamps and tongs
34. Cloth, silk
35. Coil, helix, solenoid
36. Coil, induction, box form
37. Collision balls, apparatus with balls and scale
38. Compass, magnetic, 1.5 C.M.
39. Compass, magnetic, 4.5 C.M.
40. Conductivity of solid apparatus
41. Copper plating apparatus
42. Counter, revolution, hand-held
43. Crooke's tube
44. Cylinder, graduated
45. Density cylinder
46. Dish, evaporating, porcelain
47. Earphones
48. Electrical circuit, basic kit
49. Electrical circuit, basic, series, parallel, kit
50. Electrophorus, demonstration form
51. Electroscope, Braun form
52. Electrostatic kit
53. Expansion, linear rods
54. Filters, light, set
55. Fire extinguisher, carbon dioxide
56. Fire extinguisher, dry chemical
57. Flannel, wool cloth
58. Friction rod, ebonite
59. Friction rod, glass
60. First-aid cabinet with supplies
61. Flasks, Erlenmeyer
62. Flask, Florence, flat bottom
63. Fluorescent minerals kit
64. Funnel, short or long stem, fluted
65. Funnel tube, thistle top
66. Galvanometer, portable
67. Gas diffusion apparatus
68. Geissler tube
69. Generator, dynamo
70. Generator, steam
71. Goggles, student
72. Hoops, rotor accessory
73. Hot plate, single unit
74. Illuminator, incandescent projection bulb
75. Inclined plane with Hall's carriage and scale pan
76. Index of refraction plate
77. Induction study outfit
78. Interference plates
79. Inverse squares apparatus
80. Jack screw model
81. Jar, battery, cylindrical

82. Lamp, sodium vapor
83. Lamp, ultraviolet, demonstration
84. Lampboard, resistance
85. Lenses, demonstration set
86. Leyden jar
87. Leyden jar with discharger
88. Linear expansion apparatus, micrometer screw form
89. Liter block, dissectible
90. Magdeburg, hemispheres
91. Magnet, alnico, magnetron
92. Magnet, bar
93. Magnet, bar alnico
94. Magnet, bar, cylindrical, alnico
95. Magnet bar, support
96. Magnet disk, alnico
97. Magnet, horseshoe, alnico
98. Magnet, U-shaped
99. Magnetic effects of currents apparatus
100. Magnetic needle, dipping
101. Magnetizer
102. Mat, asbestos
103. Meter, a.c.
104. Meter, d.c.
105. Meter, Multimeter: Volt-Ohm-Milli-Ammeter
106. Meter sticks
107. Mirror, cylindrical
108. Mirror, plane
109. Mirror, spherical
110. Motor, electric, St. Louis
111. Needle, Magnetic, mounted
112. Oersted's Law apparatus, simple form
113. Optical bench, elementary form
114. Optical disk, diffraction grating and refraction tank
115. Overflow can
116. Photometer, bunsen form
117. Pile driver
118. Plumb bob
119. Power supply, electric, low voltage
120. Prism, equilateral, pin sighting
121. Prism, right angle
122. Pulley
123. Pump, motor driven, mounted, with pump plate
124. Rectifier, tungar type
125. Reflectors, parabolic
126. Resonance apparatus, sound
127. Rheostat, tubular, sliding contact
128. Rod, glass
129. Rod, permalloy
130. Rods and supports
131. Rotator, accessory set
132. Rotator, hand driven
133. Savart's toothed wheels
134. Sonometer, simple type, unassembled
135. Specimens, specific gravity and density
136. Specimens, specific heat
137. Spectroscope, direct vision
138. Spinthariscope
139. Spring, coiled, wave demonstrator
140. String vibrator
141. Support stand, metal, ring stand
142. Test tubes, borosilicate
143. Thermometer, centigrade, —10° to +110°
144. Timer, stop watch
145. Tools
146. Trajectory apparatus, pistol
147. Transformer, output 6V, 18 Amp.
148. Tube, barometer
149. Tube, cathode ray, deflecting
150. Tube, vacuum, kit
151. Tubing, glass
152. Tubing, rubber and plastic
153. Tuning forks, set
154. Weight hanger
155. Weights, metric
156. Weights, slotted, metric, large
157. Whistle, Galton's
158. Wheatstone bridge
159. Wheels, geared

Recommended List for Enriched Course in Physics

1. Acceleration apparatus
2. Airspeed indicator and pressure head
3. Amplifier, audio frequency
4. Balance, jolly
5. Barlow's wheel motor
6. Caliper, inside
7. Caliper, outside
8. Camera, Polaroid
9. Capacitance box, high range
10. Capacitance box, low range
11. Cell, solar
12. Cell, standard
13. Centripetal force apparatus
14. Chart, electromotive series
15. Cohesion figures, surface tension
16. Coil, Tesla high frequency
17. Coil, induction
18. Color, apparatus additive
19. Color, apparatus subtractive
20. Color disk with motor
21. Crane-boom set
22. Dosimeter, packet
23. Dosimeter, charger
24. Electricity basic demonstration kit
25. Force table
26. Galvanometer, mirror and scale form
27. Generator, Van De Graff
28. Governor, Watt's
29. Gyroscope wheel with handles and rotating platform
30. Hook's low apparatus
31. Inertial balance
32. Interferometer
33. Kundt's apparatus
34. Magnetic effects of currents apparatus
35. Mechanical equivalent of heat apparatus

36. Metronome
37. Microphone
38. Motor, Induction
39. Oscilloscope, cathode ray
40. Pendulum, Foucault
41. Photoelectric cell and relay
42. Polarizer, experimental kit
43. Polarizer, specimen kit
44. Potentiometer
45. Press, hydraulic
46. Pulley, differential
47. Receiver, superheterodyne demonstration
48. Refraction apparatus
49. Resistance board
50. Resistance box three-dial
51. Sextant, demonstration
52. Slide rule, demonstration
53. Stroboscope
54. Stroboscope, light source
55. Torsion apparatus
56. Transmitter, radio demonstration
57. Triode demonstrator
58. Tube free fall in vacuum
59. Tube tester
60. Tube venturi
61. Tuning forks, sympathetic
62. Vibrograph

Basic List Earth Science

1. Aspirator
2. Balance, triple beam
3. Barograph
4. Barometer, aneroid
5. Beaker
6. Bunsen burner
7. Charts, geology
8. Charts, astronomy
9. Clamps and tongs
10. Convection apparatus
11. Evaporating dish
12. Erlenmeyer flask
13. Florence flask
14. Forceps
15. Flourescent mineral kit
16. Globe, celestial
17. Globe, terrestial
18. Hammer, geological
19. Hot plate
20. Hygrometer wet and dry bulb
21. Magnifiers
22. Meter stick
23. Mineral collection
24. Psychrometer, sling
25. Rock collection
26. Ringstand and rings
27. Thermometer
28. Test tubes
29. Test tubes brush
30. Tools
31. Tray, carrying

Recommend for Advance Work in Earth Science

1. Anemometer
2. Collecting bag
3. Dewpoint apparatus
4. Geiger counter
5. Hoops, rotor accessory
6. Map, raised relief
7. Map, topographical
8. Map, weather
9. Microscope
10. Model, galaxy, milky way
11. Planetarium
12. Rain gauge
13. Star charts
14. Star finder
15. Sundial
16. Thermograph and charts

SAFETY

Safety is a matter of concern throughout the school. This is particularly true in science classrooms and science laboratories. Experiences in these areas involve the use of many pieces of apparatus, working with materials, and using energy. In many instances the activities are potential hazards to safety. Provisions that promote safety should be developed in planning facilities and in the purchasing of equipment. Such provisions should include the following:

(1) Approved fire extinguishers and fire blankets.

(2) First aid kits with adequate supplies.

(3) Flooring that is not slippery when wet.

(4) Emergency shower head.

(5) Wide aisles and exit passage.

(6) Cabinets and hood fitted with safety glass.

(7) Master switches for electrical circuits.

(8) Furniture with rounded corners and edges.

(9) Prominently placed shut-off valves for gas and water lines.

(10) Safety chart placed in prominent view of students.

(11) Electrical circuits with a potential of more than 25-V, a.c. should be grounded.

(12) Color codes should be used wherever safety hazards exist: (a) Red: for exits and fire equipment. (b) Yellow: for caution and around power tools.

Since many of the experiences in science involves motion either of the student or the equipment, space is highly important. The following should be observed:

(1) Students should be able to work individually or in groups at their work stations without moving into the aisles or involving themselves in inconvenient situations.

(2) Every student at the work station should have room behind to take a quick backward step without colliding with another student.

(3) Every student should have a clear view of all other students at his table or shared work station.

(4) Every student should be free to move quickly to the fume hood, to safety showers, and other safety facilities.

(5) The instructor should be able to help an individual student at his station without interferring with other students at the station.

Carefully planned storage space may contribute to good safety. Such qualities as the following should be considered:

(1) Adequate amount of storage so that damage and danger do not result because of crowding.

(2) Adequate depth of shelves so that articles cannot be readily dislodged.

(3) Avoid high storage.

(4) Use of racks and partitions.

(5) Special storage for chemicals that are toxic, inflammable, or that must be kept covered with liquid.

Auxiliary work stations are requirements of most science rooms. Balance stations, dispensing stations, centrifuge stations, and test equipment fall in this category. From the standpoint of safety, convenience and supervision these stations should be located as close to the point of use as possible, so that they are easily accessible to all students. In no case however, should they be located so as to complicate student traffic.

Appendix

PROFESSIONAL LITERATURE IN SECONDARY SCIENCE

This bibliography is only a partial list of the many professional books and periodicals which should be available for science supervisors and teachers.

I. Books

Brandwein, P. F. and others. "Teaching High School Science: A Book of Methods". Harcourt, Brace and Company, New York, New York 10017. 1958. $7.50.

Burnett, W. R. "Teaching Science in the Secondary School". Holt, Rinehart & Winston. New York 10017. 1957. $5.25.

Joseph, Alexander, and others. "Teaching High School Science: A Source Book for the Physical Sciences". Harcourt, Brace and Company, New York, N. Y. 10017. 1961. $7.95.

National Science Teachers Association. "New Developments in High School Science Teaching". National Education Association, Washington, D. C. 20036. 1960. $15.50.

National Science Teachers Association. "Quality Science for Secondary Schools". National Education Association. Washington D. C. 20036. 1960. $3.00.

Schwab, J. J. and Brandwein, P. F. "The Teaching of Science". Harvard University Press, Cambridge, Mass. 1962. $3.25.

Barthelemy, Richard; Dawson, J. R.; Lee, A. E. "Innovations in Equipment and Techniques for the Biology Teaching Laboratory". D. C. Heath & Co., Boston, Mass. 02116. 1964. $1.95.

Henry, Nelson B. "Rethinking Science Education". University of Chicago Press. Chicago, Ill. 1960.

Brandwein, P. F. and others. "BSCS Bulletin No. 2 Teaching High School Biology: A Guide to Working with Potential Biologists". Biological Sciences Curriculum Study, University of Colorado, Boulder, Col. 80301. 1962. $3.50.

Miller, D. F. and Blaydes, Glenn. "Methods and Materials for Teaching Biological Sciences". 2nd ed., McGraw-Hill, New York, N. Y. 10036. $7.95.

Morholt, Evelyn, and others. "Teaching High School Science: A Sourcebook for the Biological Sciences". Harcourt, Brace and Co. New York, N. Y. 10017. 1958. $7.50.

National Academy of Sciences. "Source Book". Holt, Rinehart & Winston, New York, N. Y. 10017. 1960. $3.20.

Alyea, H. N. and Dutton, F. B. "Tested Demonstrations in Chemistry". 5th ed. Journal of Chemical Education, Easton, Pa. 1963. $3.50.

Fitzgerel, R. K. and Kieffer, W. F. "Supplementary Readings for Chemical Bond Approach". Journal of Chemical Education. Easton, Pa. 1960. $3.00.

Fowler, G. "Lecture Experiments in Chemistry". Basic Books, Inc. New York, N. Y. 10016. 1959. $6.00.

Manufacturing Chemist's Association, Inc. "Guide for Safety in the Chemical Laboratory". D. Van Nostrand Co., 120 Alexander St., Princeton, N. J. 1954. $5.50.

Manufacturing Chemist's Association, Inc. "Scientific Experiments in Chemistry". Holt, Rinehart and Winston. New York, N. Y. 10017. 1962. $1.24.

Sanderson, R. T. "Teaching Chemistry with Models". D. Van Nostrand Co., 120 Alexander St., Princeton, N. J. 1962. $5.75.

American Geological Institute. "Selected References for Earth Science Courses". Prentice-Hall, Inc. Englewood Cliffs, New Jersey. 1964. $1.00.

Heller, R. L. "Geology and Earth Science Source Book". Holt, Rinehart & Winston, New York, N. Y. 10017. 1962. $2.96.

National Science Teachers Association. "Ideas for Teaching Science in the Junior High School". 1201 16th Street N.W., Washington, D. C. 20036. 1963. $4.00.

Gray, E. "American Institute of Physics Handbook". 2nd ed., McGraw-Hill Book Co., 330 W. 42nd Street, New York, N. Y. 1963. $29.75.

Bohr, Nils. "Atomic Physics and Human Knowledge". John Wiley & Sons, Inc. 605 Third Avenue, New York, N. Y. 10016. $3.95

Born, Max. "Einstein's Theory of Relativity". Rev. Ed. Dover Publications, Inc., 180 Varick Street, New York, N. Y. 10014. 1962. $2.00.

II. Periodicals

"Bio Science". American Institute of Biological Science, 2000 P Street, N.W., Washington, D. C. 20036. $12.00.

"Science Education". University of Tampa, Tampa, Florida. Quarterly. $5.00.

"Science News Letter". Science Service, Inc., 1719 N Street N.W., Washington, D. C. 20036. Weekly. $5.50.

"The Science Teacher". National Science Teachers Association, 1201 16th St. N.W., Washington, D. C. 20036. $10.00.

"Scientific America". 2 W. 45 Street, New York, N. Y. 10017. Monthly. $6.00.

"School Science and Mathematics". Central Association of Science and Mathematics Teachers, Box 108, Bluffton, Ohio. Oct.-June. $6.00.

"American Journal of Physics". American Institute of Physics, 335 E. 45th Street, New York, N. Y. Monthly. $10.00.

"The Physics Teacher". 1201 16th Street, N.W., Washington, D. C. 20036. $7.50.

"Space Science". 4211 Colie Drive, Silver Spring, Md. Sept.-June. $1.00.

"Journal of Chemical Education". American Chemical Society. Easton, Pa. Monthly. $4.00.

"Chemistry". American Chemical Society, 1155 Sixteenth St., N.W., Washington, D. C. 20036. Monthly. $3.00.

"The American Biology Teacher". National Association of Biology Teachers. Jordan Hall, Indiana University, Bloomington, Ind. Oct.-May. $8.00.

SOURCES OF FREE AND INEXPENSIVE MATERIALS

Aluminum Company of America, Pittsburg, Pa.

American Chemical Society, 1155 16th St., N.W., Washington 6, D. C.

American Dental Association, 222 E. Superior Street, Chicago 11, Illinois.

American Geological Institute, 2101 Constitution Avenue, N.W., Washington 25, D. C.

American Institute of Physics, 57 E. 55th Street, New York 22, New York

American Meterological Society, 3 Joy St., Boston 8, Mass.

American Museum of Atomic Energy, Box 117, Oak Ridge, Tenn.

American Nature Association, 1214 16th St., N.W., Washington 6, D. C.

American Paper and Pulp Association, 122 E. 42nd St., New York 17, N. Y.

American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

Dow Chemical Company, Midland, Mich.

E. I. DuPont de Nemours & Company, Wilmington 98, Delaware.

Eastman Kodak Company, Rochester 4, N. Y.

Ford Motor Company, 3000 Schaefer Rd., Dearborn, Mich.

General Electric Company, Education Relations Dept., 2-119, Schenectady 5, N. Y.

General Motors Corp., Educational Relations Section, P. O. Box 177, Detroit 2, Michigan.

Gulf Oil Company, Gulf Building, Pittsburg 30, Pa.

Metropolitan Life Insurance Company, School Health Bureau, New York, New York.

National Cancer Institute, Bethesda 14, Md.

New York Life Insurance Company, 51 Madison Avenue, New York 10, N. Y.

Radio Corporation of America, Dept. of Information, R.C.A. Bldg., 30 Rockefeller Plaza, New York 20, N. Y.

Remington Rand Inc., Dept. El-352M, 315 46th Avenue, New York 10, N. Y.

Reynolds Metal Company, Louisville, Ky.

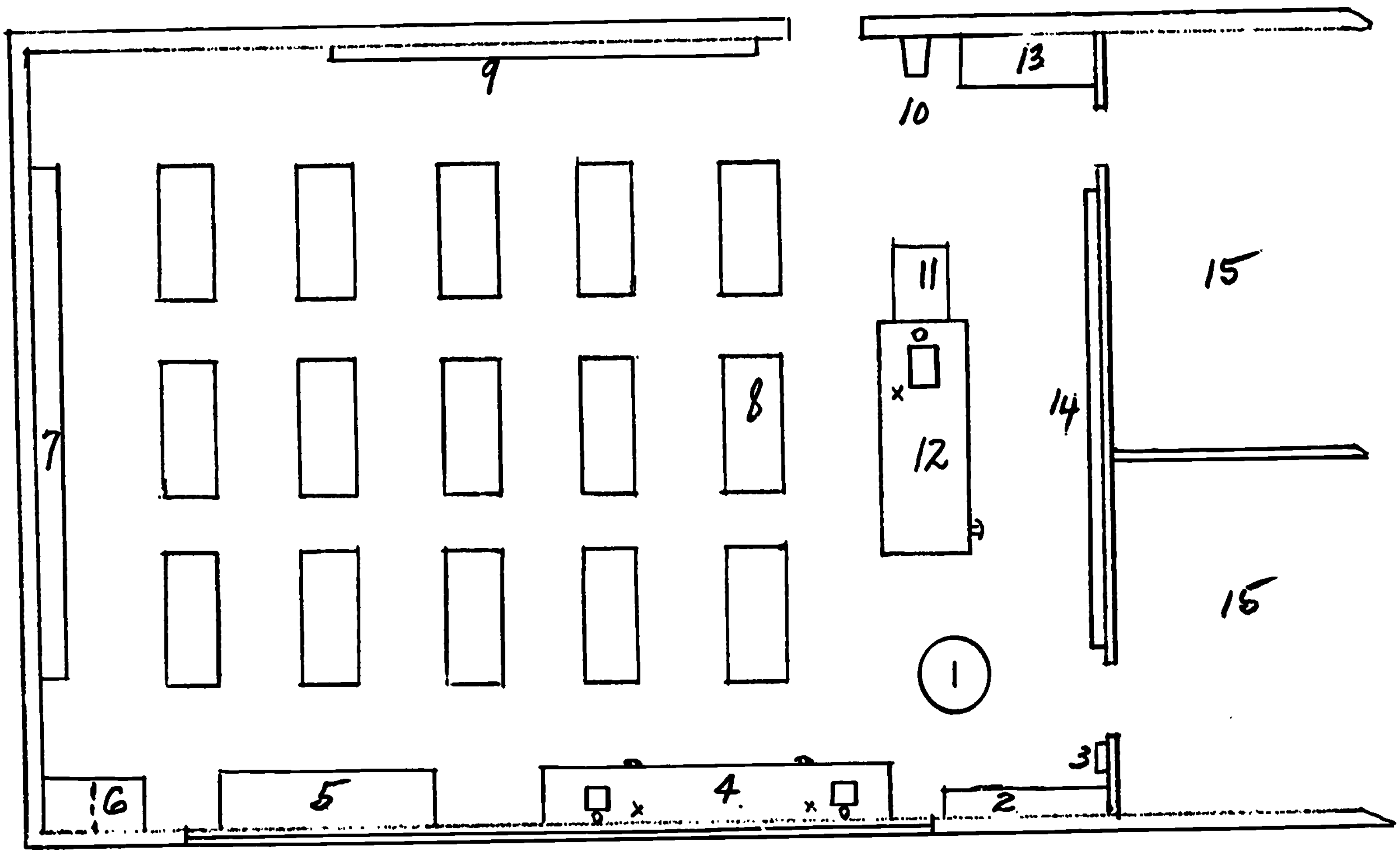
Science Clubs of America, 1719 N. Street, N.W., Washington 6, D. C.

Standard Oil Company, 910 S. Michigan Avenue, Chicago 80, Illinois

Turtox Service Leaflets, 8200 S. Hayne Ave., Chicago 20, Ill.

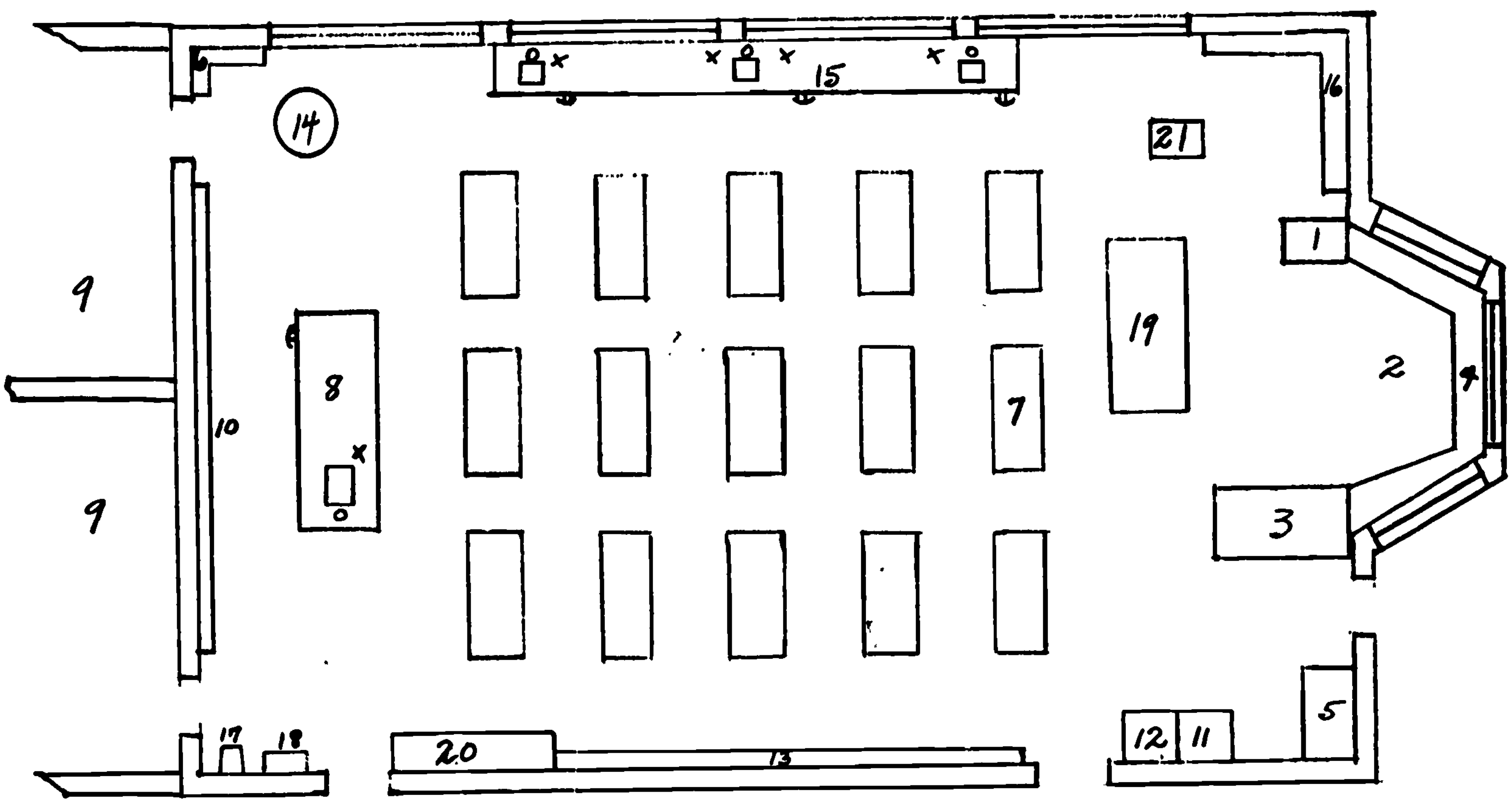
Union Carbide and Carbon Corporation, 30 E. 42nd St., New York 17, N. Y.

U. S. Steel Corporation, Public Relations Dept., 1420 Brown Avenue, Birmingham 3, Ala.



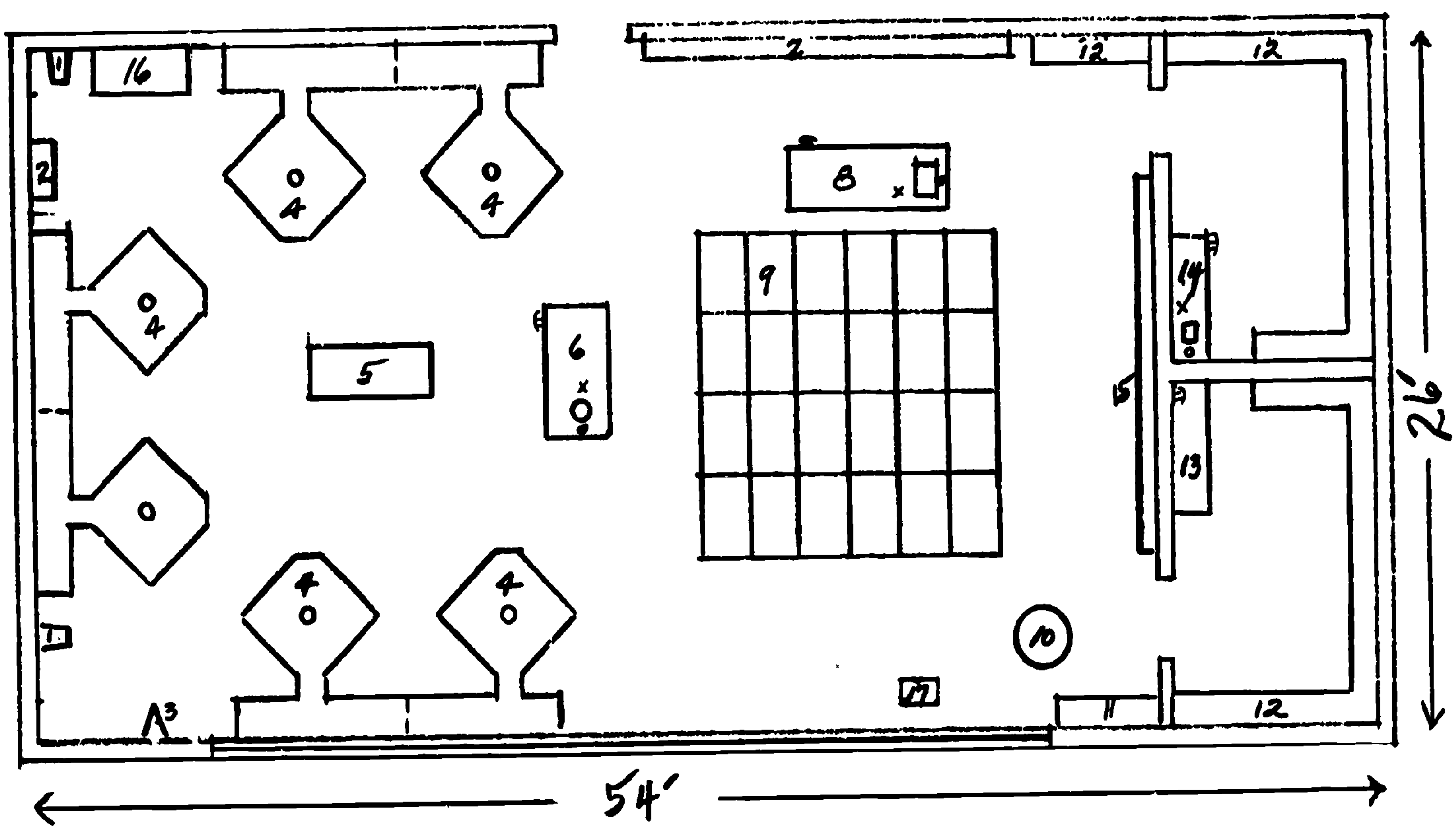
General Science Classroom

1. Reading Table
2. Book Shelf
3. First Aid Cabinet
4. Student Work Area
5. Germinating Bed
6. Animal Cage
7. Display Shelf
8. 2-Student Table
9. Bulletin Board
10. Fire Extinguisher
11. Aquarium
12. Demonstration Desk
13. Storage Cabinet
14. Chalkboard
15. Storage Room



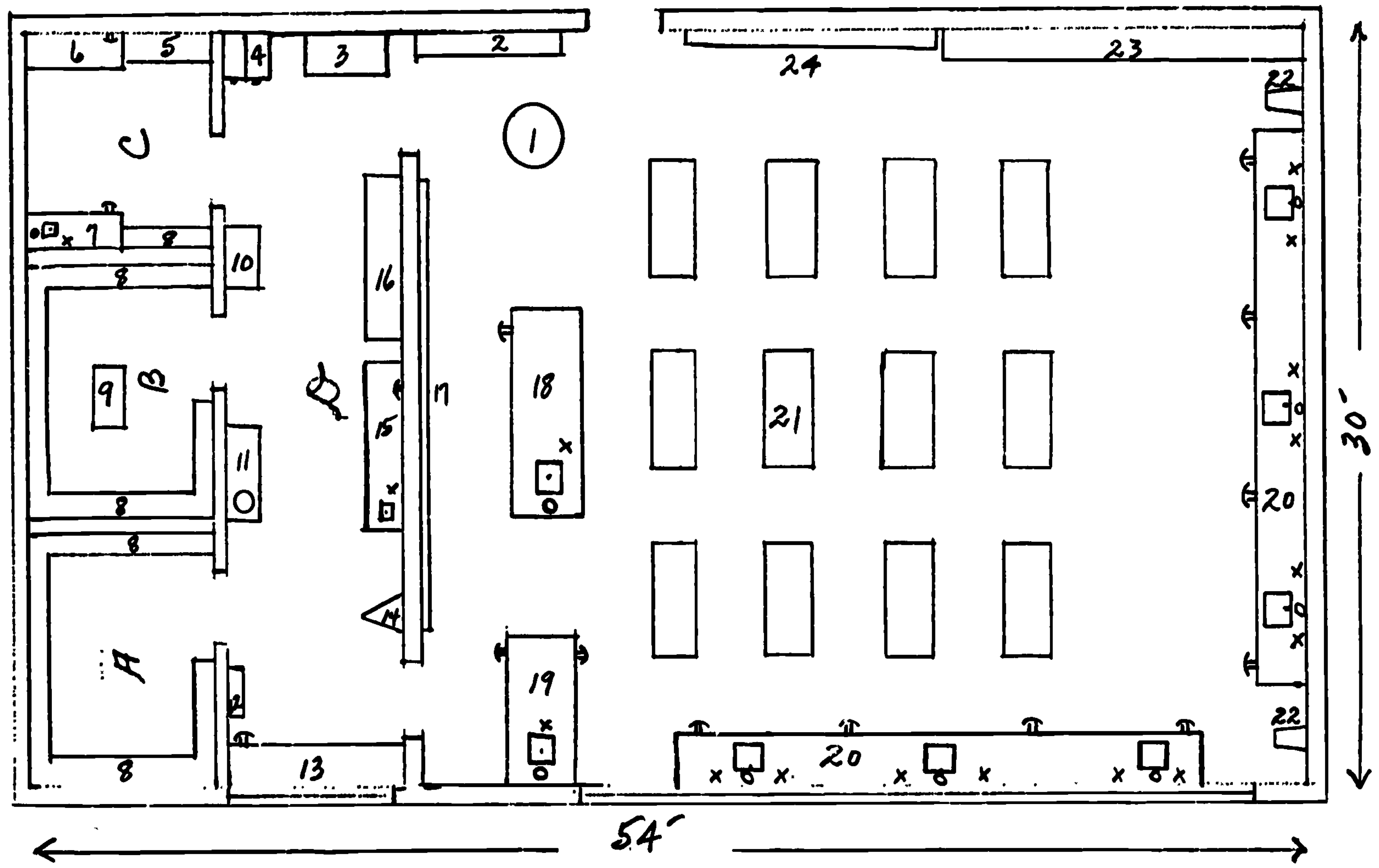
Biology Classroom Laboratory

1. Soil Bin
2. Plant Alcove
3. Work Bench
4. Plant Ledge
5. Animal Cages
6. Book Shelf
7. 2-Student Table
8. Demonstration Desk
9. Storage Room
10. Chalkboard
11. Torso Case
12. Skeleton Case
13. Bulletin Board
14. Reading Table
15. Student Work Area
16. Display Shelf
17. Fire Extinguisher
18. First Aid Cabinet
19. Project Table
20. Tote Tray Cabinet
21. Aquarium



Chemistry Classroom - Laboratory

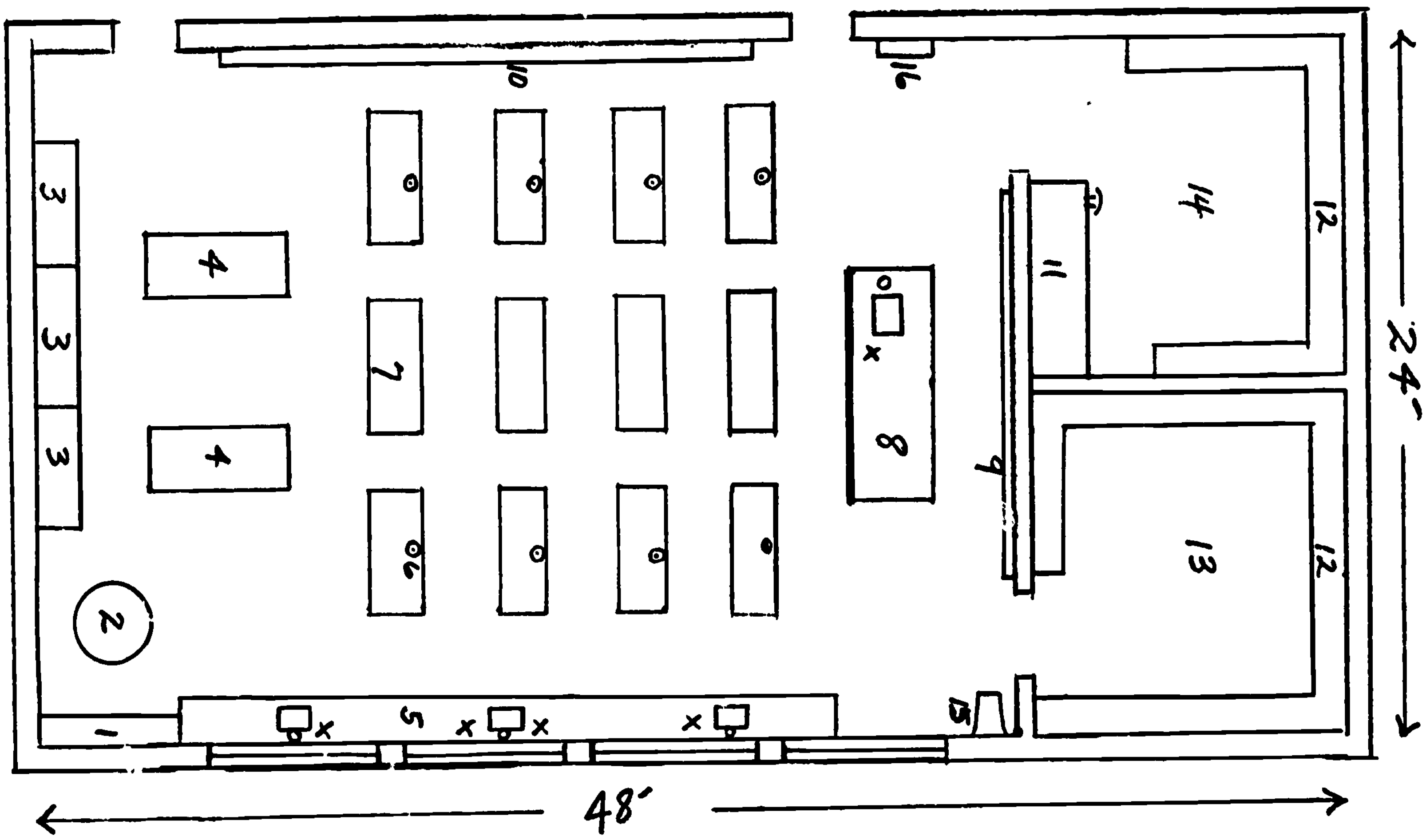
1. Fire Extinguisher
2. First Aid Kit
3. Emergency Shower
4. Student Work Area
5. Balance and Centrifuge Table
6. Hood
7. Chalk Board
8. Demonstration Desk
9. Chairs
10. Reading Table
11. Bookshelf
12. Shelving
13. Work Bench
14. Preparation Table
15. Bulletin Board
16. Condenser
17. Laboratory Cart



Chemistry Classroom - Laboratory

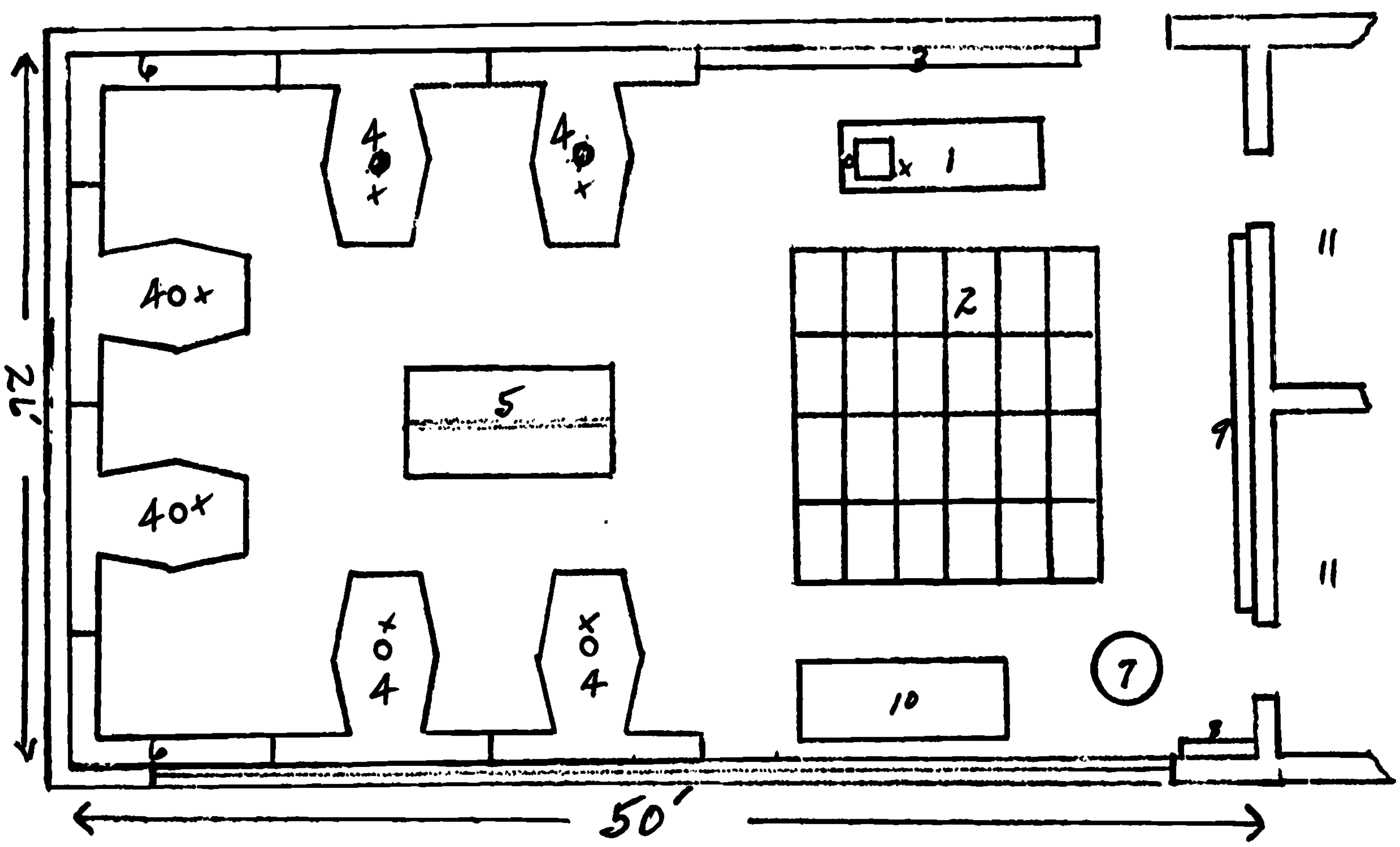
1. Reading table
2. Book shelf
3. Desk
4. Filing cabinets
5. Utility table
6. Printing area
7. Developing area
8. Shelving
9. Laboratory cart
10. Refrigerator
11. Condenser
12. First aid cabinet
13. Work bench
14. Emergency shower
15. Preparation table
16. Balance table
17. Chalkboard
18. Demonstration desk
19. Hood
20. Perimeter work area
21. 2-student table
22. Fire extinguisher
23. Display shelves
24. Bulletin board

A. Physical storage
B. Chemical storage
C. Darkroom
D. Preparation area



Physics Classroom - Laboratory

1. Book shelf
2. Reading table
3. Cabinet
4. Project table
5. Student work area
6. A-C outlet
7. Two student table
8. Demonstration desk
9. Chalkboard
10. Bulletin board
11. Work bench
12. Shelving
13. Storage room
14. Work room
15. Fire extinguisher
16. First aid



Physics Classroom - Laboratory

1. Demonstration Desk
2. Chairs
3. Chalkboard
4. Work Stations
5. Electrical Panel and Table
6. Cabinets
7. Reading Table
8. Bookshelf
9. Bulletin Board
10. Project Table
11. Storage Areas