

SAFETY EQUIPMENT AND SUPPLIES

Equipment and supplies necessary to teach inquiry science must be supported by an adequate budget. The purpose of this chapter is to provide information on the safety equipment and supplies needed for science instruction. Refer to Appendix H for a list of the minimum equipment and supplies needed to teach science in kindergarten through grade 12.

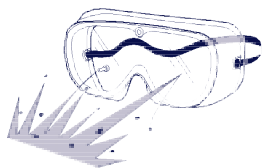
PERSONAL PROTECTION

The use of personal protection equipment is recommended and, in some cases, required, as an additional safeguard against laboratory and field hazards. Personal protection equipment includes eyewear, laboratory aprons, laboratory coats and protective gloves. Eyewear should meet the ANSI Standard Z87.1: Practice for Occupational and Educational Eye and Face Protection. Eyewear meeting this standard will bear markings such as “Z87.1” on the frames, and the lenses will be marked with the manufacturer’s trademark.

EYE PROTECTION DEVICES

Safety goggles are required for science laboratory and field activities involving ANY hazardous chemical that could damage a person’s eyes if it were to come into contact with them. Goggles provide eye protection from fine dusts, liquids, splashes, mists, and sprays. They also prevent splashes and sprays from body fluids and dangerous chemicals. Reusable goggles should always be disinfected before being used by another student.

Safety goggles should be large enough to protect and form a seal around the eyes. If not able to form a



seal, goggles should contain side shields to prevent contamination to the eyes.

Sanitization is required for any piece of safety equipment that is shared with another person. There are several ways to sanitize goggles, including placing them under ultraviolet lamps in goggle cabinets for an appropriate amount of time. Other methods of sanitizing may be found in Appendix A.

Eye protection may also be provided by safety glasses with shatterproof lenses. However, safety glasses with sideshields will NOT provide adequate protection for chemical splashes; they are designed primarily to protect the eyes from flying objects.

Face shields can provide additional facial protection, especially if coupled with safety goggles. However, plastic-type lenses or devices may be severely affected by certain chemicals and, in some cases, easily scratched.

PROTECTIVE GLOVES

Gloves protect hands from heat, absorb perspiration, and provide a shield from corrosive chemicals and body fluids. They also prevent the transmission of microorganisms from one person to another.

Certain gloves can dissolve when they come into contact with solvent. The correct glove should match the nature of the job. Always check your gloves to be sure that there are no tears, punctures, and holes, especially if the gloves are made of latex.

To remove gloves, peel them off your hands starting at the wrists and working toward the fingers. Keep the working surface of the gloves from making contact with the skin during removal.

PROTECTIVE GLOVES AND THEIR FUNCTION

GLOVE TYPE	FUNCTION
Plastic	Protects against light corrosives and irritants.
Latex	- Provides protection against biological materials. - Should be changed as soon as they become soiled. - Note: Some people may have an allergic reaction to latex, which can lead to a serious medical condition.
Natural Rubber	Protects against electric shock and light corrosive material.
Neoprene	Great when working with solvents, oils, or light corrosive material.
Cotton	- Absorbs perspiration. - Great for wearing under latex gloves.
Asbestos	- Insulates against heat. - Note: Asbestos gloves are labeled with a warning sign about the danger of cancer. Asbestos is a known carcinogen.

LABORATORY APRONS AND COATS

Laboratory aprons and coats are designed to protect clothing and skin from splashed and spilled chemicals and biological materials. They should fit the wearer properly to provide maximum protection. A laboratory coat or an apron should be worn at all times in the laboratory.

There are no ANSI standards for the manufacture of laboratory aprons. Therefore, selection of the appropriate apron must be based on the hazards with which it is likely to come into contact. Apron materials vary widely and may be used in single or multiple layers. Multiple-layered aprons decrease the rate of permeation. They are usually made of plastic or rubber to protect against corrosive materials and irritating chemicals.

Aprons are usually listed as “bib type,” which are suitable for laboratory use. Aprons should be worn over clothing that covers the arms and body.

Laboratory coats are usually fire retardant and made of cotton or paper. They provide protection against flying objects, sharp or rough edges, splashes and spills, and fire.

FIRE PREVENTION AND CONTROL

Fire is one of the most frequent mishaps in the science laboratory. Fire prevention, therefore, is essential. Effective fire prevention centers on the understanding that as long as air is present, oxygen will be available for combustion to take place. The best areas to exercise preventive measures are at the fuel and ignition sources.

Fires are classified by the chemical properties of the fuel. The basic fire classifications are as follows:

- ☼ Class A – Ordinary combustible (paper, wood, etc.)
- ☼ Class B – Organic solvents (acetone, alcohols, ethers)
- ☼ Class C – Electrical wiring or static charges
- ☼ Class D – Active metals (sodium, potassium, magnesium)

The symbols A, B, C, and D are accepted for the different classifications of fire. They are applied to fire extinguishers and extinguisher locations to indicate their suitability in extinguishing the different types of fires (see Appendix G).

FIRE PREVENTION

The following precautions should be taken to prevent fires from occurring in the science classroom, laboratory, storage room, and preparation area.

- ☼ Be aware of ignition sources in your laboratory area (open flames, heat, and electrical equipment).
- ☼ Purchase and store flammable reagents in the smallest quantities possible.
- ☼ Do not store flammable liquids in standard refrigerators (use only spark-proof refrigerators).
- ☼ Store flammable liquids in appropriate safety cabinets and/or safety cans.
- ☼ Do not store incompatible reagents together (e.g., acids with flammables). A list of incompatible reagents can be found in Appendix F.
- ☼ Do not store ethers for extended periods of time, as explosive peroxides could form.

- ☼ Make sure that all electrical cords are in good condition. All electrical outlets should be grounded and should accommodate a three-pronged plug.

Each science classroom, laboratory, storage room, and preparation area should be equipped with a fire blanket and fire extinguisher.

Remember . . .

R	Rescue anyone in immediate danger.
A	Turn in an Alarm by calling 911.
C	Close the doors and windows.
E	Extinguish the fire.

Even after practicing fire safety and prevention, a fire may still occur in a science classroom laboratory, storage room or preparation area. Actual fire control requires the proper use and types of control devices, such as fire extinguishers and blankets.

FIRE EXTINGUISHERS

In most school environments hand-held, portable fire extinguishers are the first fire-extinguishing agent that people use. Therefore, a multipurpose ABC fire extinguisher must be located in each science classroom, laboratory, storage room, and preparation area.



Extinguishers must be . . .

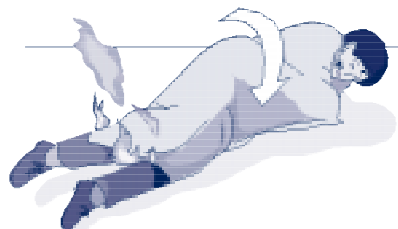
- ☼ located in a clear area where they can be easily seen,
- ☼ inspected on a regular basis, and
- ☼ handled by teachers and students who have been trained in their use.

Fire extinguishers are labeled in accordance with NFPA standards (see Appendix G).

FIRE BLANKETS

Fire blankets are made of specially treated fabric and should be located in accessible areas in all science laboratories where hazardous chemicals are stored and used. Fire blankets should be used if one is unable to reach the safety shower.

To use a fire blanket, follow the recommended technique of wrapping the victim in it to extinguish the fire.



PROTECTION FROM CHEMICALS

FUME HOODS

Develop procedures for the proper use of laboratory fume hoods for students taking chemistry, physical science, or any course in which chemicals are used.

Post written instructions on the use of fume hoods, and include in these instructions the laboratory safety training that each student is to receive.

“A fume hood is required for every chemistry, physical science, or other science laboratory where hazardous or vaporous chemicals are used. Most middle schools need a fume hood in the preparatory rooms.”

NSTA, *Guide to School Science Facilities*, 1999

GENERAL USE OF FUME HOODS

Each laboratory facility where chemicals are used in experiments, as well as each preparation room, should be equipped with a fume hood. However, even an open-face fume hood with a low-face velocity can not provide complete safety against events that take place in the hood. However, a well-designed hood in a properly ventilated room can provide adequate protection against fumes. To ensure proper protection, follow these recommended guidelines.

- ☼ Keep the interior light on so that the working area is properly illuminated.
- ☼ Check the exhaust system—air movement should be inward and upward in the hood.
- ☼ The exhaust should be vented to the outside above the roof and away from air vents.
- ☼ Conduct inside the hood all portions of the experiment that cause contaminants to form.
- ☼ Do not place large objects directly on the hood's working surface. Place blocks under the large object to allow proper airflow under the object.
- ☼ Locate the fume hood in an area of low traffic.
- ☼ Move the vertical sash to the lowest position that allows access so that manipulation is possible. The sash should protect the head and upper body in case of an explosion. (Safety goggles are required.)
- ☼ Do not place your head in the hood when contaminants are being generated.
- ☼ Do not use the fume hood as a waste disposal unit except to dispose of small amounts of volatile chemicals.
- ☼ Do not store chemicals or apparatuses in the working area of the hood.
- ☼ Keep the slots in the hood baffle (air intake) free from obstructions.

- ☼ Keep the laboratory door closed unless the manufacturer indicates otherwise.
- ☼ Do not place electrical receptacles, or other sources that may produce a spark, in the fume hood while using flammable chemicals or when gases may be present.
- ☼ The hood's sash should be marked for the appropriate closure point when it is necessary to partially close the sash during an operation.
- ☼ The sash should be closed when the hood's exhaust system is not operating.
- ☼ Provide regular maintenance on the hood's exhaust system. Use static pressure gauges on the hood throat and across filters in the exhaust system to ensure proper exhaust flow.

Texas Education Agency, *Science Laboratory and Chemical Waste Disposal for Texas Teachers*, 1990

Eye/Face Wash Stations

The first response (prior to medical treatment) for a student or teacher who has hazardous material in their eyes or on their face should be to flush the affected area with water to dilute chemicals, wash off debris, and irrigate the eyes. It is very important to hold the eyelids open and roll the eyeballs so that water can flow over all surfaces of the eyeballs and in the folds surrounding them.

An eye/face wash station that can wash both eyes simultaneously is required in every science laboratory, classroom, and preparation room where hazardous materials are used.

Squeeze-bottle eyewashes are NOT sufficient and should NOT be used as eye/face washes in any science laboratory.

There are several different designs for eye/face washes. To ensure that the eye/face wash stations in your science facilities meet safety requirements, they should . . .

- ☼ be clearly marked and unobstructed for immediate use;
- ☼ be flushed for five minutes once a week to remove any harmful contaminant that may form or grow in the eyewash.
- ☼ be located no more than 10 seconds or 25 feet from any student workstation;
- ☼ comply (one eye/face wash) with ADA regulations on accessibility;
- ☼ be provided with sufficient water pressure to operate correctly (0.4 gpm);
- ☼ wash both eyes simultaneously and the face with tepid water (60–90°F);
- ☼ supply an instantaneous flow of tempered (recirculated) water for at least 15 minutes;
- ☼ have a water control valve that remains on, allowing the user to use both hands;

“For the first time ever, a student had to use one of our eye washes. The eye washes, as in many schools, only have cold water going to them. As a result, the 15 minutes of eye irrigation became quite painful to the student. Fortunately, the student suffered no eye damage from either the material that got into her eye or from the cold water. The cold water diminished the student’s willingness to continually irrigate her eyes. I wonder how many schools have thought to ensure that the water is at an appropriate (60–90°F) temperature?”

David Hoyler, Director
Middle and Upper Schools
Locust Valley, NY

The hand-held drench hoses are listed in the American National Standards Institute's (ANSI) Standards for Showers and Eyewash Equipment (ANSI Z358.1), but carry instructions that they are ***not intended to replace emergency shower or eyewash units.***

For more information, see the American National Standards Institute's standards for eyewash equipment.

SAFETY SHOWERS

A safety shower is required in chemistry and integrated physics and chemistry, as well as in any laboratory where hazardous chemicals are used. Safety showers . . .

- ☼ must meet the standards for height, spray pattern, tepid water temperature (60–90°F), and water flow of 20 gallons per minutes at 30 PSI.
- ☼ must have a control valve that can remain on (15 minutes) without requiring the use of the operator's hands.
- ☼ should be located no more than 25 feet from any student workstation or no more than 10 seconds away.
- ☼ should each be marked with a highly visible sign.
- ☼ should be large enough to accommodate the injured person and a teacher assisting with the emergency.
- ☼ should have a fixed valve handle or a chain with a large ring that can be pulled to start the flow of water.
- ☼ must have sufficient water flow and pressure to function properly for immediate use.
- ☼ should be ADA compliant.
- ☼ must be flushed once a week to eliminate contamination and be checked for proper working conditions.

VENTILATION

A well-maintained ventilation system contributes to a healthy environment in science classrooms and laboratories. The following recommendations appear in the NSTA's *Guide to School Science Facilities*.

“Forced ventilation at a minimum rate of four changes of air per hour should be provided for science laboratories, and continuous ventilation at six changes per hour for chemical storage rooms. Assuming that there is a fume hood in each preparation room, four air changes per hour is adequate. All exhausts should be vented to the outside of the building, not recirculated in the building's ventilation system.

Chemical storage rooms need systems that vent directly outside, usually to the roof, and away from fresh-air intake pipes. Stage cabinets for flammables should not be ventilated to the outside.

Every science room should be equipped with exhaust fans designed for the rapid venting of smoke or bad odors created by an investigation.”

Additional information on ventilation can be found in the American National Standards Institute's standards for laboratory ventilation (ANSI Z9.5-1992).

UTILITY CARTS

Chemicals should be transported from the preparatory room to the classroom or laboratory via heavy-duty utility carts with raised sides to contain spills. Carts composed of noncorrosive materials (plastic or stainless steel) are recommended to reduce rusting and deterioration. Heavy-duty wheels or casters approximately five inches in diameter are recommended to ensure the smooth transportation of chemicals.

Each laboratory and preparatory room should have at least one utility cart for transporting chemicals and other materials.

ELECTRICAL EQUIPMENT SAFETY

Electrical safety needs must be considered for all new, old, and renovated science classrooms, laboratories, storage rooms, and preparation areas. The focus of electrical safety should be on prevention.

The minimum considerations for electrical safety include the following.

- ⚡ Ground-fault circuit interrupters (GFCI's) should be installed to protect against major shock and electrical fires by preventing short circuits.
- ⚡ All outlets must be grounded to prevent electrical accidents. A sufficient number of outlets should be provided to eliminate the need for extension cords. If floor boxes are used, they should not be located near water sources or areas where water is used.
- ⚡ Use surge protectors to protect computers and other electronic devices from power surges.
- ⚡ Locate emergency shut-off controls (for electricity, gas and water) in an area that is not easily accessible to students.
- ⚡ Do not overload electrical circuits.
- ⚡ Use only spark-free refrigeration in laboratories, storage rooms, and preparation areas when storing flammable chemicals.
- ⚡ Avoid using extension cords.

In developing the school's safety program, include provisions for handling electrical emergencies. All science teachers should know where the master electrical cutoff switch and the control box are located, and how to operate both of these.

Before conducting an activity that requires the use of an electrical device, the teacher and students should familiarize themselves

with the device's operation and safety features.

As a safety precaution, examine the wiring for frayed or bare wires, and examine the electrical plugs to make sure the wiring is secure. If a problem occurs . . .

1. Remember to remain calm and consider the evidence.

- ⚡ Was a pop or a spark made when you attempted to operate the equipment?
- ⚡ Were you able to see where it happened?
- ⚡ Is there an explanation for the situation?

2. Consider whether any action is warranted.

- ⚡ Will this action be safe?
- ⚡ Could there be too many electrical devices on one circuit?
- ⚡ Use the master electrical utility cutoff and check the devices. Are the devices still warm?
- ⚡ Is there an odor that smells like burning electrical insulation?
- ⚡ Are the wires to the equipment warm or hot?

3. Direct students not to touch anything.

- ⚡ All electrical hazards are not directly due to an electrical situation.
- ⚡ Special attention must also be given to the proper use and handling of laboratory equipment.