SAFETY FIRST

Guidelines for Safety in Science
Of Science Oriented Classrooms in Delaware
For Middle and Senior High Schools

Developed by:

The Delaware Department of Education

August 2000

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FOREWORD

Science education in the 21st century includes active, hands-on learning activities that require great care and prudent planning. The Delaware Department of Education is committed to the safety and well being of all students and teachers in our state's science classrooms. Developed through the collaborative efforts of teachers and administrators as well as business and industry experts the Science Safety Manual is provided to all science educators to guide and support their efforts to ensure safe and appropriate classroom practices and procedures.

To realize the maximum value of this manual, it is imperative that all science educators:

- Become thoroughly familiar with the content of this manual, specifically the portions pertaining to their subject areas,
- Follow safety procedures and ensure that students understand and use those procedures as well,
- Inform the State Education Associate for Science of any errors or omissions they find in the manual,
- Notify their building principal and the State Education Associate for Science in writing of any science materials or laboratory/classroom conditions that may be unsafe. Together the DOE and local districts will work to resolve those issues,
- Continue to update their knowledge and expertise by attending local, state, and national workshops regarding safety in science classrooms and laboratories.

Valerie A. Woodruff
Secretary of Education

INTRODUCTION

The principal is responsible for the overall supervision of the safety program in the school. The science teachers, as his immediate representatives, are responsible for the direct supervision of safety in the science rooms. Department chairpersons should provide any necessary leadership, orientation of new teachers, and liaison with the principal.

In preparing this manual, we have attempted to facilitate both the administration and supervision of safety by investigating the potential hazards arising out of the teaching of science and by providing procedures and precautions which should be followed if injury to personnel and damage to equipment are to be kept at a minimum.

No manual could be written which would provide for every eventuality. Prudent foresight and care must be constantly exercised in the application of the principles set forth herein to cope with individual situations as they arise. Science can be effectively taught without danger to equipment or personnel, provided everyone involved is safety-conscious. There is no accident that cannot be prevented. It is the purpose of this manual to make science teaching safe without making it difficult. Restrictions and precautions imposed are intended to facilitate rather than inhibit legitimate science activities.

If science safety becomes a method of instruction and not a "one-day lecture at the beginning of the year," then a science teacher can show that "reasonable and prudent" judgment has been used, as is required by law. Labs should not be carried out in unsafe conditions, whether these exist because of facility or circumstance. A teacher must notify the principal, *in writing*, when conditions or facility need attention and the teacher must adjust the laboratory assignments to fit the existing conditions. Under the above circumstances, both accidents and liability will be minimized.

There are no accidents that cannot be prevented.

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THE GENERAL SAFETY PROGRAM

A. Types of Accidents

In teaching science, personnel may be involved in any of five general types of accident.

1. Chemical

Chemical substances can be ingested, inhaled, or absorbed through the skin. Chemical contamination can result in medical effects ranging from rashes and burns to incapacity or death. Degree of damage is proportional to duration and concentration of exposure. Chemical substances include substances designated carcinogens, mutagens, teratogens, toxins, etc. These substances pose a major biological hazard to students and teachers alike.

2. Physical

Physical hazards include broken glass, hot objects, falling objects, slippery floors, and animal bites.

3. Biological

Contact with certain plants, micro-organisms, or animals may result in allergic reactions and poisoning.

4. Radiological

Exposure to radiation may cause varying amounts of damage to the organism based on the type of radiation and the method and duration of exposure.

5. Medical

In some cases, human beings react unfavorably in unexpected ways even to materials that are considered "safe". In cases where pre-existing medical conditions are present, teachers and supervisors necessarily have to be prepared for the unexpected. Diabetes, hypo/hyper glycemia, asthma, even wearing of normal contact lenses may present hazards in a science classroom/laboratory that can lead to harm.

B. Causes of Accidents and Their Countermeasures

Accidents happen! And though we don't like to think about it, all accidents are "caused" by something or someone. Most of the potential causes or accidents can be detected and eliminated by proper education, planning and preparation.

REVIEW OF NUMEROUS REPORTS OF ACCIDENTS OCCURRING IN HIGH SCHOOL SCIENCE ROOMS INDICATES THAT THEY WERE GENERALLY CAUSED BY THE LACK OF A PROPER EDUCATIONAL SAFETY PROGRAM, IMPROPER SUPERVISION OF STUDENTS AGGRAVATED BY EXCESSIVE CLASS SIZE, FAULTY LABORATORY TECHNIQUES, AND POOR HOUSEKEEPING.

1. General Supervision of the Educational Program

To teach science effectively, safety in science must be taught as an integral part of the instructional program. Instruction must extend throughout the year rather than merely consisting of a "beginning of the year lecture." It is never a good idea to try to give students too much information at one time. Better to give them a little bit at a time, review it again and again, and build on it as the year progresses.

Decide what is **most** important for you to begin your program with your students then break it up into sections (if you have to) and present it to the students one section at a time. Once they have the basics … build on those basics throughout the year. And remember; **model** the behaviors you want the students to learn.

Here are some steps that will accomplish the integration of safety into everyday activities throughout the year.

SUCCESSFUL SAFETY PROGRAMS DEPEND ON THE TEACHER'S ATTITUDE TOWARD SAFETY.

a. Each school and its science department must establish an effective safety program that is consistent and complete for each level of instruction.

b. Teachers and students alike must think and practice safety at all times.

c. Introduce the program by providing students with a **personal copy** of the General Safety Precautions to be followed in your course. It is suggested that a **core** set of precautions be used with all students in all courses. **Additional** precautions, specific to a course, or a laboratory experiment should be added as needed. An example of a core set of precautions is included in ***Appendix A.***

d. Before beginning any activity, review the particular safety rules and procedures most appropriate to the activity. **Answer** all student questions prior to beginning and monitor their activities throughout.

e. Though not an extensive collection, the safety films that were once offered by the State Film Library have been redistributed to the three State Teacher Resource Centers. Contact your local resource center for a list of available films/videos.

f. It is suggested that the students be required to take periodic quizzes (written, oral, or practical) on safety rules and related topics ad presented to them.

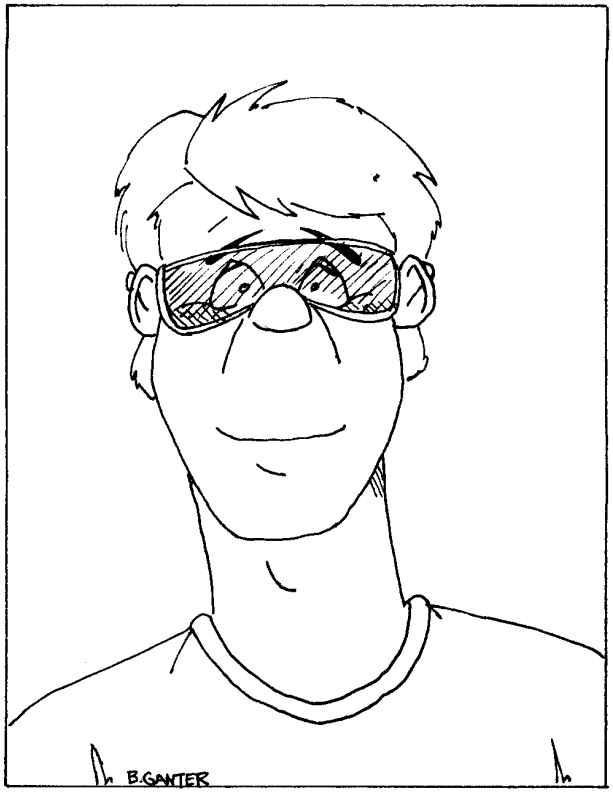
g. It is also a requirement under the Delaware Hazardous Materials Communications Act (the **Right-To-Know Law**) that students know their rights and responsibilities under this act when dealing with hazardous materials. Proof of such knowledge should be in the form of a document that notes the students' statement of having received instruction in the law and their scores on the subsequent assessment (see page 93).

h. **Delaware law requires** that teachers and students wear **approved safety goggles** when "caustic or explosive chemicals, or hot liquids or solids" are being used. There are no exceptions.

i. The state of Delaware requires that a school nurse/medical staff member be present in the building when laboratory experiments are being carried on. Be sure to have "coverage" if you have make-up labs or experiences outside the school day.

j. When a teacher is **absent** for any reason during a school day, students should not be allowed to do/continue labs.

k. **Students should never be left unsupervised during a laboratory activity.**



l. Safety consciousness must be continued throughout the year. A periodic quiz should be given and each laboratory activity prefaced by specific safety precautions. For ongoing reinforcement, the grade for each experiment should include an element for safety.

m. When laboratory work is in progress, the teachers should circulate and remain alert for students using faulty or dangerous techniques. This action allows the teacher to take necessary corrective action and to be immediately available in an emergency.

n. Teachers must not be hampered from discharging their safety duties by excessive class size. Principals are urged to insure that the size of a science class never exceed the number of permanently installed facilities or "stations" in the room. NABT position statement "Role of Laboratory & Field Instruction in Biology Education" http://www.nabt.org/Laboratory.html

o. **Visitors to a science room** must also comply with the use of safety goggles should they enter during an experiment. A sign stating such should be posted at the door.

p. Field trips and other science activities must be carried on in a safe manner, observing applicable school, state and local regulations. It is important for the teacher to have student emergency information available on a field trip. This information may be obtained from the emergency Cards filed in the school nurse's office. The teacher must also follow the emergency procedure as outlined in the School Nurse Handbook in the event of an accident or emergency.

q. Science teachers have an obligation to keep abreast of the new developments in the field of safety. Current journals, bulletins, and other publications provide continual updating, as do safety workshops and symposia. Science department chairpersons, state and district science supervisors should provide information regarding safety, inservice training and leadership for the classroom teacher.

r. In all cases, teachers should always specify and use all necessary personal protective equipment required such as aprons, gloves, cots, and respirators.

2. The Science Laboratory and/or Classroom

To insure the continuation of a safe laboratory environment, the following recommendations are made:

a. **Science teachers must conduct a self-assessment at least once a year, preferably in the fall.** ***Appendix A***, page 94, contains a checklist that may be modified if it is not appropriate. The assessment should include facility and equipment.

b. Prior to all laboratory exercises, the science teacher must insure that the procedures employed are safe **by personally performing both student experiments and teacher demonstrations prior to their use in the classroom.** All equipment and materials must be checked for defects, as well as checking chemicals for contamination and/or expiration. Conditions change from year to year, therefore, the instructor should not assume a demonstration or student activity will work properly just because it has in the past.

c. **Inspect all materials.** Glassware should be checked for chips and stress imperfections; electrical equipment should be checked for frayed wiring and working condition.

d. **A teacher is responsible for safeguarding students and visitors from harm.** Student carelessness is a trait that must be discouraged in a purposeful manner. Carelessness has no place in a science room or laboratory. All visitors to the lab area should be required to use the safety equipment provided.

e. **Prior to a laboratory exercise, the teacher should clarify student instructions and procedures.** Students may read the instructions without fully understanding them. The success of a safety program is enhanced when the students realize that safety measures provide them and their classmates protection from harm and are an essential part of doing things correctly.

f. Any procedures that are complicated or require special technique should be demonstrated by the teacher, prior to the activity.

3. Fire Prevention Program

It is of the utmost importance for students to receive instruction and training in fire and explosion prevention. Basically, this training requires familiarizing the students with the dangers involved in handling and storing flammables, explosives, and other dangerous materials. However, it is of equal importance for all teachers to have knowledge of the types of fires which can occur in a science room and of the approved methods of combating such fires. This will require familiarity with both the proper use and location of all fire fighting equipment, fire extinguishers, fire alarms, etc. In the schools, the use of sand, and/or the carbon dioxide (CO_2), and dry chemical extinguishers has been authorized. The discussion of extinguishing equipment in this manual is restricted to the authorized types. Fires are generally classified as follows:

FIRE PREVENTION

a. **Class "A" fires:** This type includes those occurring in ordinary combustible materials such as wood, coal, paper, textiles, etc., and to be extinguished usually requires cooling and smothering. It may be smothered by sand or a fire retardant woolen fire blanket, or extinguished by water spray, carbon dioxide, or dry chemical powder fire extinguisher.

b. **Class "B" fires:** This type includes those produced by flammable petroleum products such as oils, paints, greases, alcohol, gasoline, etc. To be extinguished, this type usually requires smothering with sand, carbon dioxide, or dry chemicals. **Water or soda-acid extinguishers should never be used on Class "B" fires.** Care should be taken that rags or waste saturated with oils, paints, linseed oils, tung oil, kerosene, varsol, or other Class "B" fire materials are disposed of in the incinerator and not allowed to accumulate because of the danger of spontaneous combustion, particularly in an enclosed area.

c. **Class "C" fires:** This type includes those fires which occur in energized electrical equipment, where the danger of electrical shock would be great if a conductor type extinguisher were used. The Class "C" fire should be extinguished with a carbon dioxide or dry chemical type extinguisher, neither of which will damage the electrical equipment or act as conductors. The CO_2 is preferred in some cases because no clean-up is required after use. If de-energizing of the circuit is possible, then the fire may be treated as a Class "A" fire, unless flammable petroleum products are involved, in which case it would fall into the Class "B" category and be treated accordingly.

d. **Class "D" fires:** This type includes fires produced by certain metals which are reactive and combustible. This group includes sodium, potassium, lithium, magnesium, zirconium, titanium, their various alloys, and metallic hydrides and alkyds. The flammable material may exist as solids, chips, turnings, or powders. Some of the metals such as sodium and potassium react violently with water to form flammable hydrogen gas if water is used to extinguish the fire. Others, such as magnesium, will burn in carbon dioxide gas. To combat Class "D" fires, use dry sand or commercial dry powder, which will not adversely react with the flaming material.

4. **Equipment Handling Procedures-General**

Each discipline within the science department is equipped with special types of apparatus requiring specific safety precautions for operation. Instructions for this equipment are set forth in the remaining Chapters of this manual and shall be followed in all cases. In addition to the special equipment there are other general types of equipment, which are used in all laboratories. The general instructions for handling this equipment are as follows:

a. **Glassware:** Laboratory work in most science rooms, particularly in chemistry, requires the use of glassware. To prevent serious injury from cuts caused by broken glass, it is imperative that vigilance be shown in the use of such material. Students should be instructed to inspect all glassware for cracks, chips, etc., before using it. Any defective pieces should be given to the instructor and never used.

(1) **Safe Handling Techniques**

(a) **Handling glassware:** Glass has many properties that make it eminently suitable for laboratory work. A large proportion of laboratory accidents from minor cuts to serious injuries are caused by improper or careless handling of glass equipment.

1. **Cutting glass tubing and rods**: To cut glass tubing or rods, support the tubing flat on the bench top, make a small deep scratch on the tubing with a single stroke or a file or glass cutting knife, place a towel over the piece to protect the hands and fingers, or use fabric type gloves, then make the break by placing the fingers around the piece with the thumbs together opposite the scratch and bend toward the body.

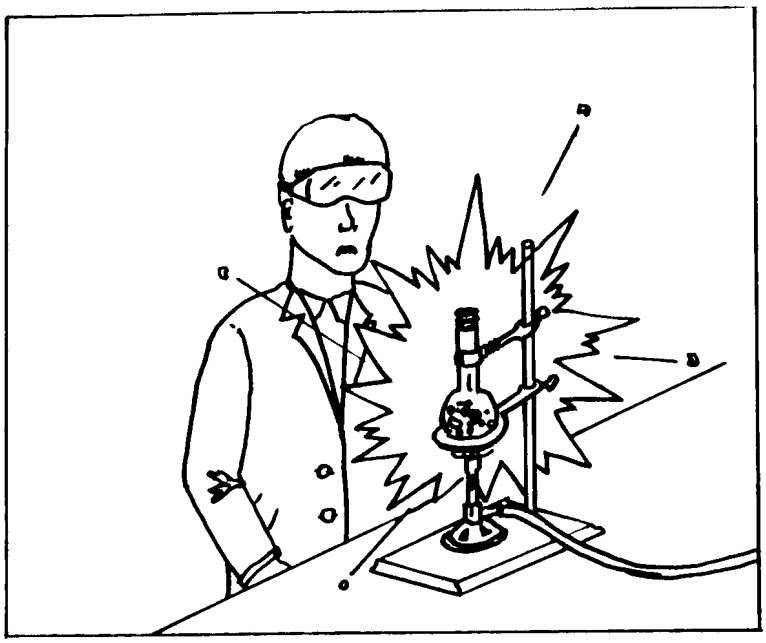
The ends of all glass pieces used in the laboratory should be squared and fire polished. Glass tubing or rod cut in the fashion described above is very sharp and can cause nasty cuts if not fire polished.

CAUTION

2. **Inserting tubing, thistle tubes, or thermometers into rubber stoppers**: When assembling glassware and rubber stoppers, be sure that the hole is the proper size, and lubricate both the rubber and the glass with water, glycerin, or silicone stopcock grease. Holding the glass with a towel or glove close to the end being inserted, gently insert the glass with a back and forth rotating motion. Keep the hand holding the stopper out of the line of the tubing being inserted. Another good method is to first insert a cork borer of a larger size than the tubing, and withdraw the borer over the tubing. The above instructions also apply to the insertion of thistle tubes, sidearms, and thermometers into stoppers.

If the tubing cannot be readily and safely removed, it is advisable to cut the stopper and discard it. Be sure the stopper is held on the bench top, not in the hand, during this operation. To prevent tubing and stoppers from "freezing" together, remove the glass immediately after use.

3. **Heating glassware**: Glass stays hot for a long time after the heat source is removed. Treat all glassware as though it were hot. After bending or fire polishing tubing, allow it to cool thoroughly on a wire gauze. Before touching it, test cautiously for heat radiation.



When heating a flask or beaker over an open flame, put the container on wire gauze and do not allow the flames to lap over the edge of the gauze. Localized overheating can crack glassware. Only borosilicate glass Pyrex®, Kimax®, etc. vessels should be heated. Hot beakers should be allowed to cool before handling. Beaker tongs, not towels or crucible tongs, should be used for handling glassware.

Soft glassware should not be used for reactions which produce heat, such as mixing acid and water.

Most graduated cylinders are of soft glass with a heavy base, which makes them particularly liable to breaking when heated in this way. **Hot liquids should never be poured into a graduated cylinder.**

4. **Special precautions with glassware**: Glassware should not be used for the mixing of explosive compounds or chemical reactions.

When cleaning a flask, the common practice of rinsing a flask with volatile solvents should be avoided. Air-drying is always recommended and preferable – but if solvents are used, be sure that the solvent is completely evaporated before using the vessel. Even a small amount can cause a serious explosion if the flask is put over an open flame

Glass apparatus should not be put under pressure or high vacuum without a screen or shield in case of explosion or implosion.

Long pieces of glass tubing should be cut before carrying them any distance. Tubing should be carried vertically with particular attention to clearance of obstacles.

Beakers and flasks, especially large ones, should be carried firmly by the sides or bottom rather than the top or lip. Glass bottles should never be carried by the neck. Large bottles should be transported on a cart or in a safety-carrying container.

Each classroom should provide a properly marked, covered waste container for discarding glassware. Never discard in the regular trash basket.

Chipped or cracked glassware should not be used. It should either be repaired or discarded. The sharp edge of a piece of broken glassware can be effectively smoothed by firm, repeated stroking with wire screen. The edges of glass cover plates may also be smoothed by this method. Goggles and a face shield should be worn while performing this operation. FIRE-POLISHING can be used to smooth a small chip.

Freeing glass frozen to glass such as stoppers or stopcocks is very difficult and should never be attempted by a student. Gloves or a towel should be used to protect the hands. A stream of hot water or light tapping may help. A specially designed clamp may be procured to free glass stoppers.

Glassware should be clamped firmly but not too tightly, preferably with fiberglass or rubber padding between the glassware and the clamp. Obviously rubber should not be used if the assembly is to be heated.

(b). **Bunsen burners**: Bunsen burners, if improperly handled, are dangerous. They should be kept well back from the front of the laboratory bench and secured from tipping. It is suggested that only soft rubber hose be used for Bunsen burner connections. Semi-rigid, woven-cover type connectors aggravate the risk of tipping and are not recommended. Prior to using the Bunsen burner, the hose and hose connections should be checked for possible wear, decomposition, or leaks.

The spark lighter should be ready before turning on the burner so that it can be lighted promptly before there is a dangerous accumulation of gas. Since there is a constant risk of clothing catching fire, students should be cautioned of the danger of leaning over or reaching over a lighted burner. Hair sprayed with aerosol setting preparations is especially flammable and creates a special hazard when working with Bunsen burners. Loose clothing must not be worn.

Students should be taught to recognize when the burner "strikes back" (burns at the spud) and warned to shut off the gas immediately, and not to touch the barrel of the burner. Flame spreaders (wing tops) become very hot during operation and should be allowed to cool thoroughly before being removed.

Lighted burners should never be left unattended; furthermore, it should be required that the student check the gas valve before securing his station. **Students should be given instructions that burners must be turned off at the gas jet and not on the burner itself. A master gas valve should be installed in each science room**. It is excellent practice for the teacher to keep this valve closed except when laboratory work is in progress.

(c). **Refrigerators**: Many of the laboratories in the schools have refrigerators for the storage of perishable materials. Unless these machines are equipped with the necessary "explosion-

proof" features required for the storage of flammable solvents, such material shall not be stored in these refrigerators at any time. No food shall be stored in any refrigerator used for the storage of laboratory supplies or experiments. As a reminder, decals labeled "NOT FOR STORAGE OF FOOD", and "NOT FOR STORAGE OF FLAMMABLES" should be placed on the door of the refrigerator.

d. **Carbon dioxide and dry chemical fire extinguishers**: All laboratories are to be equipped with these types of extinguishers. Science department chairpersons should insure at the beginning of the school year that these extinguishers are in place, are filled, and that the science teachers have been properly instructed in their use. Proper wall brackets should be installed for each extinguisher. Extinguishers should be located so that they are immediately available in the classroom, the laboratory, and the storeroom. When using the CO_2 fire extinguishers, precautions should be observed to prevent injury by the low temperature gas emitted from the instrument. Neither the hands nor any other part of the body should be exposed to the spray. Care should be exercised to prevent accidental dropping of the cylinder on the floor. Such a mishap could fracture the nozzle connection and instantly convert the extinguisher into a lethal jet propelled projectile. **Whenever a CO_2 extinguisher is discharged, even for a short period, a replacement should be obtained**. Although routine periodic inspection of the fire extinguishers is the responsibility of the Fire Marshall, all teachers should take action through the school custodian for replacement of extinguishers with outdated inspection tags, broken seals, or pulled pins.

e. **Electrical appliances**: Electrical appliances such as hot plates, lamps, blenders, ovens, drills, motion picture projectors, etc., are used in many science rooms. Such equipment should be either of approved "double insulated" design or equipped with a 3-prong grounded plug or otherwise electrically grounded. **Hot plates should be of the laboratory design rather than the common household type**. When ordering such equipment, teachers should check the specifications to make sure that the hot plate will be provided with an "ON" and "OFF" switch as well as a pilot light. Bi-monthly inspections should be made of the permanent wiring and extension cords in use to ensure that electrical hazards and dangers of fires are eliminated. Attention should be given to the placement of electrical cords so that they don't become damaged or present a physical hazard. Frayed wires or any other defects in insulation should be remedied before using.

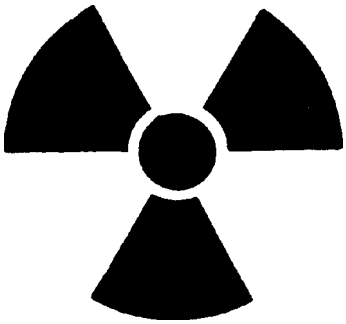
Circuits should never be overloaded. If a circuit-breaker trips or a fuse burns out, an overload is indicated. This may be due to a short circuit or other causes. Before resetting the circuit breaker or renewing the fuse, the cause of the overload should be investigated.

When disconnecting an appliance, students should be taught to pull the plug and not the wires. They should be instructed to use caution in handling electrical equipment that was recently in use and has just been disconnected. The appliance may still be hot enough to produce a serious burn. Vacuum tubes and resistors, for example, will get very hot after a few minutes of operation and should be allowed ample time to cool before touching. Students should be warned that electrical cal capacitors can hold dangerous charges for hours after the equipment is turned off.

No person should connect, disconnect, or operate electrical equipment with wet hands or while standing on a wet floor. Water greatly reduces the resistance to the flow of electricity and serious injury or death can result. The familiar case of the individual who was electrocuted while trying to operate a radio while in the bathtub should serve as sufficient evidence of this danger.

f. **Radioactive mater**ials: (This does not include electronic equipment capable of producing harmful radiation, which is covered in Chapter III, Section C, page 52).

The properties of radioactive materials are such that they have numerous applications in scientific research, medicine, and industry. It is anticipated that these applications will not only continue, but increase dramatically in number and in kind. The science program of some schools may wish to provide students with an opportunity to investigate radiological theory, use limited quantities of radioactive materials, and to develop techniques and skills in handling such materials safely.

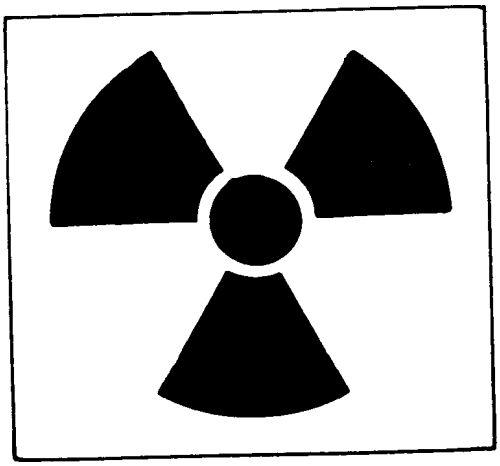


The safe use of radioactive materials depends on a respect for their potentially hazardous nature and adequate training.

The use of sealed sources of radiation in generally licensed quantities is authorized for all science teachers. The use of unsealed isotopes in generally licensed quantities for tracer experiments should be undertaken only by those teachers who have had formal training in radiation biology and radioisotope handling techniques by either attending Nuclear Regulatory Commission or National Science Foundation radiation biology institutes, or by taking courses in radiation biology offered by accredited colleges and universities.

The use of radioactive isotopes is regulated by the Federal Government and by laws and regulations of the states. Teachers or other prospective users of radioactive isotopes should obtain the Delaware publication "Delaware Radiation Control Regulations" and should be aware that some school districts prohibit their use. Teachers considering using radioactive materials should be fully aware of all the potential hazards involved and the limits on the use of such materials with minors, students under the age of eighteen.

Sufficient amounts of radioactive isotopes for high school laboratory use are covered by a general license. Since all teachers have been automatically granted this license, there is no need to submit formal application to the Nuclear Regulatory Commission. The following table is a partial list of the more commonly used isotopes and the generally licensed amount of each as sealed and unsealed sources:



Radioisotope	Generally Licensed Amount Sealed (uc)	Unsealed (uc)
Calcium 45	10	10
Carbon 14	50	50
Cesium-Barium 137	1	10
Cobalt 60	1	10
Gold 198	10	10
Hydrogen 3	250	250

Radioisotope	Generally Licensed Amount Sealed (uc)	Unsealed (uc)
Iodine 131	10	10
Iron 59	1	10
Phosphorus 32	10	10
Sodium 22	10	10
Strontium 89	1	10
Strontium-Yttrium 90	0.1	1
Sulfur 35	50	50
Zinc 65	10	10

Quantities of radioactive materials are available which generally conform to the restrictions of the general license. Example of maximum unit quantities are: Carbon-14, 50 uc (microcuries); Phosphorus-32, 10 uc; Iodine-131, 10 uc. **Under a general license, a user may possess at any time no more than ten such unit quantities of material**. For example, a user may possess at one time 500 uc of Carbon-14 in ten separate sources, or 450 uc of Carbon-14 (in nine units) and ten uc of Iodine-131. Users may possess fractional scheduled quantities of as many isotopes as needed to the extent that the total of all quantities does not exceed ten scheduled quantities. The degree of decay of each example may be considered when totaling the quantities in possession. Individual teachers should coordinate their purchase through their departments and school principal so that the school as a unit does not exceed these quantities. Although these quantities of material may be purchased without need for a specific license, the user is not exempt from adhering to the regulations pertaining to their use.

The nature of radioactivity is such that even though very small potential hazard quantities are used, carefully planned and executed safety precautions must be accomplished. **Each teacher who receives radioactive materials must assume responsibility for supervising their use and/or safe storage, observing the following safety practices:**

(1) **Records**: The importance of keeping complete, permanent records of all events associated with radioactive materials cannot be overemphasized. Such records will serve as exemplary procedures for instructing students as well as provide significant permanent information. A bound notebook may serve as a logbook in which is recorded the following kinds of information:

(a) Kinds and amounts of radioactive materials possessed, the date of receipt, the use made of them, the name of the user, and the method and date of their disposal.

(b) Class rosters--when students actively participate in investigations relating to ionizing radiation. These records should clearly indicate the presence of absence of the student on a given day, and, if present, the amount of exposure to radiation.

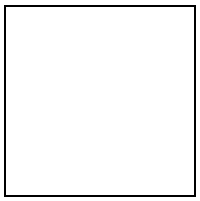
(c) Details of unusual incidents that may occur, such as a spill.

(d) Monitoring records.

(2) **Monitoring**: All people, places and equipment that have been in contact with radioactive materials should be monitored to determine the absence of contaminations.

(a) Personnel exposed should be recorded in the log book. If dosimeters or film badges are required by the state regulations, this data should be logged also.

(b) Equipment and places exposed should be recorded. Monitoring should be done before and after each experiment to determine that no radioactive material has been spilled and the results logged.



(3) **Signs**: On days when radioactive isotopes will be used, a large poster or sign containing the radiation symbol should occupy a prominent position where each student will see it upon entering the classroom. The sign should include both the radiation symbol and the words "RADIATION" or "RADIOACTIVE MATERIAL". The symbol should be covered or removed when isotopes are not present. This will aid in keeping students alert to potential danger. All of the students in the school should be informed of the significance of the radiation symbol. Visitors must not be allowed in the laboratory except by special arrangements.

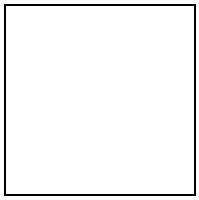
(4) **Controls**: All radioactive materials should be kept under lock and key when the responsible individual is not in the laboratory. Students should never be allowed to remain unsupervised in the laboratory with radioactive materials, not even radioactive waste solutions.

(5) **Labeling**: All containers of radioactive materials should be clearly labeled. The label should contain the date of assay and the kind and quantity of radioactive material, and should carry the standard yellow and magenta radioactivity symbol. Adhesive-backed labels with the proper legend and color are available commercially. Glassware and equipment that retains a relatively high activity should be labeled and segregated from general use. All apparatus, once it has been used with radioactive materials, is often retained for that exclusive use. Clearly label the cages/containers of all experimental animals/plants.

(6) Storage: Radioactive sources, whether exempt or not, shall be stored when not in use in a suitable location with means to prevent unauthorized use. Adequate shielding should be provided. A responsible person should be designated as source custodian. This individual should keep a continuous record of each source, its location, its original assay with date, user, and final disposition. Containers of radioactive solutions should be kept closed except when in actual use.

(7) **Protective Equipment**: Preventing contamination is easier than decontaminating furniture and equipment. Avoid spills by clamping containers such as a beaker or by placing such containers in a hole drilled in a block of wood that is not easily upset. Confine spills by working in trays lined with absorbent material having water-repellent backing. Disposable diapers, diaper paper, or similar set-up may protect the working surface from contamination. Always use a forceps or tongs to handle radioactive materials--never pipette by mouth. If inhalation of vapor or powders is possible, use the fume hood or gloved box. For beta rays, the protection of eyes, face, and body can be provided by shielding with transparent plates of moderate thickness. Shielding should be as near to the source as possible. Many sources are dual emitters, producing both Beta and Gamma radiation.

WORKING WITH GAMMA RADIATION IS NOT RECOMMENDED.



(8) **Protective Clothing**: Skin and personal clothing may be protected from contamination by wearing rubber gloves or plastic disposable gloves and laboratory aprons or coats. Wash rubber gloves before removing them.

(9) **Personal Safeguards**: Ingestion of radioactive materials is the greatest danger involved in handling generally licensed materials. Never eat, drink, smoke, chew gum, or use cosmetics in a room where radioactive materials are being used. Washing hands with soft brush, soap, and water must be standard procedure following the handling of radioactive material even though gloves are worn. No one with an open skin below the wrist (protected by a bandage or not) should work with radioactive isotopes.

(10) **Maintain Good Housekeeping**: Remove unnecessary equipment from a working area where it might become contaminated. Give immediate attention to cleaning up any contamination. The working area should have a linoleum floor and working surface covered with non-absorbent material with disposal covers.

(11) **New Procedures**: Try out all new procedures with "dry runs" not involving the use of radioactive material.

(12) **Disposal of Radioactive Waste**: Collect and label all radioactive waste. A specially labeled can lined with a waterproof disposal sack, such as a "step-on" garbage can, should be provided for disposal of radioactive waste. Personal responsibility for disposal should be assumed by the teacher. Soluble materials obtained under a general license can usually be discharged into the sanitary sewer if diluted with large quantities of water. Similar quantities of solid materials (including animal carcasses, organs, and plants) should be incinerated by special arrangements.

(13) **Decontamination Procedure**: The problem of decontaminating a particular surface will vary with the amount and kind of contamination. Caution: The assay and monitoring must be done with the proper equipment, properly calibrated.

The following procedures should be sufficient for any spill that occurs. When several steps are listed, assay after the first step and if the contamination is not removed, continue or repeat the decontamination process. The maximum radiation level of a decontaminated area is generally considered to be double background when measured with a thin-window G.M. probe less than an inch from the surface and there is no removable contamination as indicated by a wipe test.

(a) *Skin-spot Contamination*. Use a soft brush with soap and water. Repeat if necessary, but do not continue to the extent of damaging the skin.

(b) *Clothing*. Wash with detergent and hot water.

(c) *Rubber*. Wash first with detergent and hot water, then rinse in dilute nitric acid; follow with detergent or commercial cleaner and rinse thoroughly with water.

(d) *Glassware.* Wash with detergent and hot water, then with a chromic acid cleaning solution if necessary.

(e) *Metal.* Wash with detergent and hot water. If necessary, wash in dilute HNO3 or ten percent sodium citrate solution.

(f) *Linoleum*. Wash with detergent and hot water. Wash with kerosene, or ammonium citrate solution if required.

(g) *Ceramic Tile*. Wash with detergent and hot water, then with mineral acid, trisodium phosphate or ammonium citrate.

(h) *Painted Surfaces*. Wash with detergent and hot water. Wash with ten percent HCl if contamination remains.

(i) *Concrete*. Wash with detergent and hot water. Wash with thirty-two percent HCl if necessary.

(j) *Wood*. Wash with detergent and hot water. Plane the surface if contaminant is a long-lived isotope.

(k) *Laboratory Taps and Drains*. Flush with large volume of water. Scour with scouring powder or rust remover.

(14) **Sources**: A source used to produce radiation field should be sealed in a suitable container or prepared in a form providing equivalent protection from mechanical disruption.

(a) If possible, the radioactive material in the source should be of low toxicity and in such a form as to minimize dispersion and ingestion in case the container should be broken. The quantity of radioactive substances necessary for a specific purpose should be chosen as small as possible.

(b) Sealed sources or appropriate containers should be regularly checked for contamination or leakage.

(c) Sources should be handled in a way that the radiation dose to the student is reduced to a minimum by such methods as shielding, distance, and limited working time.

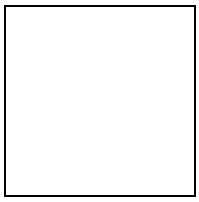
(d) Source should not be touched by hands. Appropriate tools should be used; for instance, long handled, lightweight forceps, with a firm grip.

(e) Containers should open easily.

(15) **Transporting**: State authorities should be contacted for proper precautions and legalities involved in spills or other releases of radioactive materials. When transporting a radioactive source in the room, use only the smallest amount necessary. Transportation should be done in shielded and closed containers constructed to prevent accidental release of the source material in case of spill.

C. **First Aid Program**

First aid plays an essential role in the safety program of any school. Proper first aid is as much a matter of knowing what not to do as of knowing what to do. **All science teachers should be given first aid instruction by the school nurse or other qualified persons at the beginning of the school year, and as many as possible should be qualified in first aid procedures**. Cardiopulmonary Resuscitation (CPR) should be a part of the training.



FIRST AID

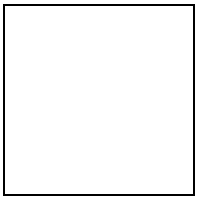
Accidents are classified under the two general headings, "major" and "minor", and the procedures to be followed for the various injuries under each heading are prescribed. Teachers should be mindful of the fact that policy **prohibits public school personnel from administering medicine in any form**. Chemistry teachers should insure that chemicals are not used by the students for medicinal purposes. If in doubt about the procedures to be followed for minor injuries, send the injured student, accompanied by a classmate, to the Health Room and the school nurse.

Should a student be involved in a "major" accident, the teacher should at once send for the school nurse and the principal. The parents or guardians of the student should be notified immediately. While awaiting the arrival of the nurse, the teacher should keep the seriously injured students lying down, warm, and comfortable, and loosen tight clothing such as ties or belts. Cases for whom ambulance transportation is required should be made comfortable at the site of the accident and NOT moved until the ambulance arrives. Emergency procedures should be followed as outlined in the **School Nurse Handbook**.

D. **Laboratory Safety Rules For Students**

All students, at the beginning of each semester, before beginning any laboratory activity, should be familiar with the LABORATORY SAFETY RULES listed in ***Appendix A***. Copies of these rules should be passed out to the students for them to keep. **It is suggested that each student sign and return to the teacher, a form indicating that they have received, read, understood, and agreed to follow these rules**. It is the responsibility of each teacher to see that these rules are strictly enforced. Such records are invaluable documentation in the event of a serious accident or lawsuit.

E. **Specific Safety Instructions**: While the general precautions previously described apply to all science rooms, the following areas require specific precautions because of the nature of the work involved and the type of equipment or materials used. Although the organization into sections on CHEMISTRY, PHYSICS/PHYSICAL SCIENCE, EARTH SCIENCE, and BIOLOGY/LIFE SCIENCE follows the pattern of primary concern, it should be realized that there is considerable area of common application. For example, the biology teacher should be familiar with the instructions on the storage and handling of certain chemicals and the proper care and use of electrical appliances covered in the CHEMISTRY and PHYSICS/PHYSICAL SCIENCE, EARTH SCIENCE and BIOLOGY/LIFE SCIENCE section. **Although cataloged under the major disciplines, all procedures apply to all science taught in the middle, junior high and senior high schools of Delaware in any discipline**. Many scientific suppliers of materials have available many excellent programs on safety that include a very wide range of topics encountered in our school systems.



CHAPTER TWO
CHEMISTRY SAFETY INSTRUCTIONS

Delaware's Hazardous Chemical Information Act (Right-To-Know Law) requires that all employees and students who may be exposed to hazardous chemicals be provided access to information regarding these chemicals effective January 1, 1985.

Many substances threaten safety and health. Unless properly handled, many materials cause injury or death, due to fire, explosion or other accident. Overexposure to certain chemicals may cause serious health problems.

Any material or product should be considered hazardous if it has a caution or warning on the label, relating to a potential physical or health hazard. KEY WORDS to look for are: CAUTION, WARNING, or DANGER. These words are often followed by warnings concerning specific hazards which include, but are not limited to: combustibility, flammability, reactivity, toxicity, sensitivity, irritation, or carcinogeneity. In the chemical stockroom, which should be accessible to teachers only, containers of hazardous chemicals must carry detailed warning labels. Reagent bottles used in the classroom will carry simplified warning labels.

Material Safety Data Sheets (MSDS) will be made available, where applicable. These sheets are provided by the manufacturer of the chemicals. They describe, in detail, the possible hazards of chemicals that are used. They also contain information concerning physical data, fire data, spill procedures, and special precautions. In the absence of a document, MSDS profiles can be found on the internet in many locations. See ***Appendix V*** for selected references apropos to science.

The Delaware Right to know law specifies three Rights (that the "employee/student" has) and three Responsibilities (that the "employer/teacher" has) that must be adhered to. The rights and responsibilities follow one from the other:

The student has the right to know:

1. What materials in their work environment are hazardous in any way.
2. How the materials are dangerous.
3. How to protect themselves against the hazards that the materials pose.

The teachers have the responsibility to:

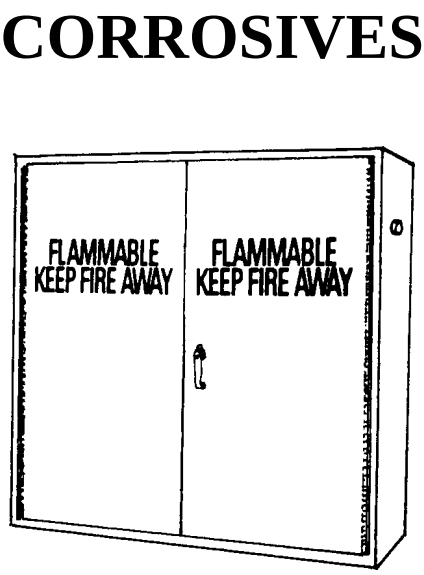
1. Tell the students about any materials and procedures they will be exposed to that may be harmful to them in any way.
2. Inform the students of the exact nature of the hazards posed.
3. Teach the students how to protect themselves against the hazards posed by materials or procedures that they will be working with.

The Chemistry laboratory is potentially the most dangerous place in the school. However, this need not constitute a serious threat if the instructor, laboratory assistants, and students have a thorough knowledge of the potential hazards, exercise prudent care and foresight, and use common sense. Accident prevention must be included in the performance of every task, and safety instruction must be an integral part of the overall program of science instruction.

The most important aspects of safety awareness in chemistry will be treated under the following categories: (A) Storage, (B) Health Hazards, (C) Fire and Explosion Hazards, (D) Safe Handling Techniques, (E) Safety Suggestions for the Performance of Specific Experiments, and (F) Disposal of Wastes.

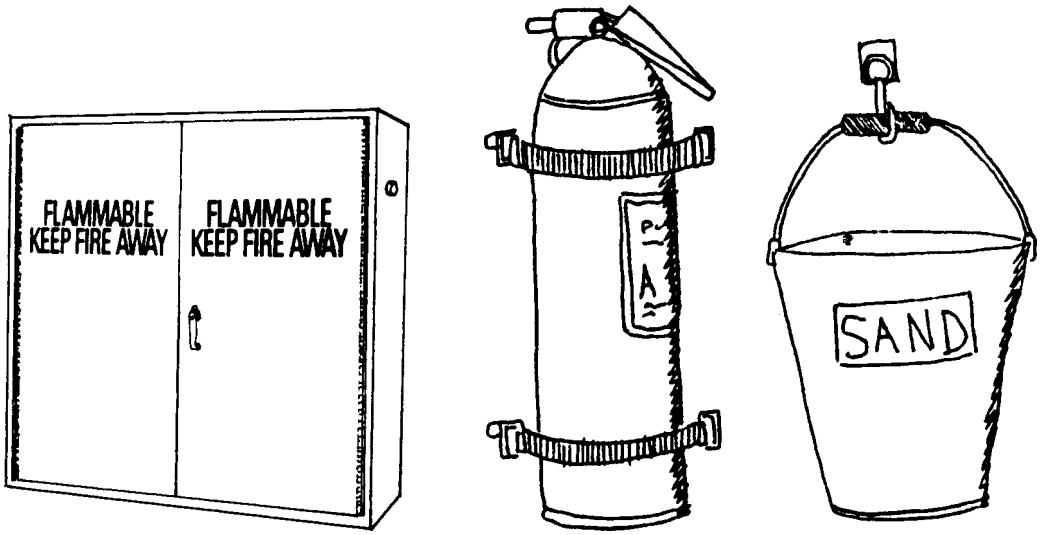
A. **Storage**

UNDER IDEAL CIRCUMSTANCES, NO CHEMICALS SHOULD BE STORED IN A CLASSROOM. A SEPARATE ROOM IS RECOMMENDED, AS DESCRIBED BELOW. If facilities do not permit storage in a separate room, chemicals should be stored in the classroom only in an opaque, lock-secured cabinet. The necessity of storing a great variety of chemicals with a diversity of properties and reactivities creates special hazards which must be readily recognized and prevented. Certain chemicals should not be stored or used in school laboratories because of potentially serious hazards associated with them. These compounds include potent carcinogens, extremely reactive and corrosive chemicals, treacherous explosives, and highly toxic compounds. Also included are intermediates to simply prepared, illegal drugs because these compounds are likely targets for theft.



1. **Storage facilities:** Any room used for the storage of chemicals should be well ventilated, dry, and protected from sunlight or localized heat (heating vents or pipes). It should have adequate explosion-proof lighting. It should be kept locked when not in use, and only the instructor or specifically designated laboratory assistants should have access to it. If storage shelves in the preparation room constitute the only chemical storage provision, there **should be a locked cabinet for storage of the more toxic chemicals and a locked metal cabinet for storage of corrosive or flammable materials.** Flammable liquids should never be kept in domestic-type refrigerators. All laboratory refrigerators not specifically designed for explosive atmospheres should be conspicuously posted: **DO NOT STORE FLAMMABLE SOLVENTS IN THIS BOX.**

2. **Fire protection:** A carbon dioxide or dry chemical fire extinguisher should be available in the immediate vicinity of the stockroom. It is also strongly recommended that a bucket of sand be kept in the stockroom for smothering alkali metal, alkaline earth, calcium hydride, and calcium carbide fires where the use of carbon dioxide or water is inadvisable. A plastic bucket is preferred since it will not corrode. Sand is also useful for sopping up spilled liquids, especially corrosive ones. Commercial spill kits are available as well.

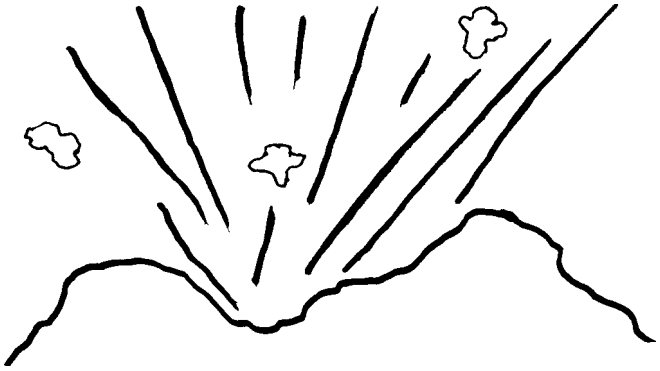


3. **Arrangement of stock:** In the planning and arrangement of chemical storage the specific properties of the chemicals should be considered so that the danger of interaction is minimized. There are many compounds that are incompatible with each other and will react violently or cause a fire if they accidentally come together. **The common method of storing chemicals in alphabetical order often results in incompatible neighbors.** For example, storing strong oxidizing materials next to organic chemicals can present a hazard. A safer method of storage is to separate the chemicals into their organic and inorganic families and then to further divide these families into smaller related and compatible families.

   A wonderful resource (free to teachers) is the Flinn Chemical Catalog. It not only lists how chemicals should be stored, but has a comprehensive guide to the disposal of hazardous waste in appropriate and approved ways. This sales catalogue has so many good features in terms of lab safety and information that it is highly recommended as a first source for storage and disposal techniques.

4. **Quantity and type of container:** Security against accidents with chemicals is greatly enhanced by storage in suitable containers. Large (one gallon or more) glass containers of corrosives, toxics, or flammables should be kept and transported in metal or plastic secondary containers. Excessive amounts of hazardous chemicals increase the risk and hamper confinement of camage by fire or explosion in case of accident. For these reasons, the following prescriptions regarding the type of container and the maximum amount of chemical which may be stored are to be followed.

Note: Glass means glass stoppered bottle or glass bottle or jar with plastic screw cap. Lecture bottle means a hand portable steel cylinder.



EXPLOSIVE

ITEM	CONTAINER AND RESTRICTIONS	MAXIMUM QUANTITY
Explosives		
Ammonium nitrate	Glass	1 lb.
Hydrogen peroxide, 30%	Original vented container	2 qts.
Perchloric acid	Glass	1 lb.
ITEM	**CONTAINER AND RESTRICTIONS**	**MAXIMUM QUANTITY**
***Picric acid**	Glass	**None**
Compressed Gases		
Ammonia (anhydrous)	Steel cylinder	Lecture bottle
Carbon dioxide	Steel cylinder	Lecture bottle
Chlorine	Steel cylinder	Lecture bottle
***Fluorine**	Steel cylinder	**None**
Helium	Steel cylinder	Lecture bottle
Hydrogen	Steel cylinder	Lecture bottle
Hydrogen sulfide	Steel cylinder	Lecture bottle
Nitrogen	Steel cylinder	Lecture bottle
Sulfur dioxide	Steel cylinder	Lecture bottle
Other compressed gases	Steel cylinder	Lecture bottle
Flammable Liquids		
Acetaldehyde	Glass	2 lbs.
Acetone	Metal can or glass	5 lbs.
Amyl acetate	Glass	2 lbs.
Aniline	Glass	1 lb.
Benzene or naphtha	Metal can	2 pts.
Carbon disulfide	Glass	5 lbs.
***Coal tar**	Metal can	**None**
Crude petroleum	Metal can	2 pts.

Flammable Liquids (continued)

Essential oils	Glass	2 lbs.
Ethanol	Metal can or glass	2 gals.
Ether, ethyl	Metal can	
Magnesium (powder)	Glass or metal can	1 lb.
Magnesium (ribbon)	Glass or metal can	1 lb.
Naphthalene	Glass	5 lbs.
Phosphorus (white)	Glass (under water)	1/2 lb.

ITEM	**CONTAINER AND RESTRICTIONS**	**MAXIMUM QUANTITY**
Phosphorus (red)	Glass	1 lb.
Pitch (coal tar)	Glass	1 lb.
Powdered charcoal	Glass	5 lbs.
Resins, Balsams, or other gums	Glass	1 lb.
Sulfur	Metal, glass, or composition container	5 lbs.
Tar, refined (wood)	Glass	1 lb.
Zinc dust	Glass or metal can	2 lbs.

Dangerously Corrosive or Caustic Chemicals

Acetic acid (glacial)	Glass (5 pt. cap.)	2-1/2 gals.
Bromine	Glass	100 ml.
Chromic acid	Glass	1 lb.
Hydrochloric acid	Glass (5 pt. cap.)	5 gals.
Hydrofluoric acid	Polyethylene bottle	2 lbs.
Hydrogen peroxide, 30%	Original vented container	2 qts.
Nitric acid	Glass (5 pt. cap.)	2-1/2 gals.
Perchloric acid	Glass	1 pt.
Phenol	Glass	1 lb.
Potassium hydroxide	Glass	10 lbs.
Sodium hydroxide	Glass	10 lbs.
Sulfuric acid	Glass (5 pt. cap.)	5 gals.

Oxidizing Agents

Ammonium nitrate	Glass	1 lb.
Barium nitrate	Glass	1 lb.
Barium peroxide	Glass	1 lb.
Bismuth subnitrates	Glass	1 lb.
Cobalt nitrate	Glass	1 lb.
Ferric nitrate	Glass	2 lbs.
Hydrogen peroxide, 3%	Glass	1 gal.
Hydrogen peroxide, 30%	Original vented container	2 qts.
Mercuric nitrate	Glass	1 lb.
Mercurous nitrate	Glass	1 lb.
Metallic chlorates	Glass	1 lb.

Oxidizing Agents (continued)

Metallic nitrates (other)	Glass	1 lb.
Metallic permanganates (other)	Glass	1 lb.
Potassium chlorate	Glass	1 lb.
Potassium nitrate	Glass	5 lbs.
Potassium permanganate	Glass	2 lbs.
Silver nitrate	Glass	2 lbs.
Sodium nitrate	Glass	1 lb.
Sodium nitrite	Glass	1 lb.
Sodium peroxide	Metal can	1 lb.

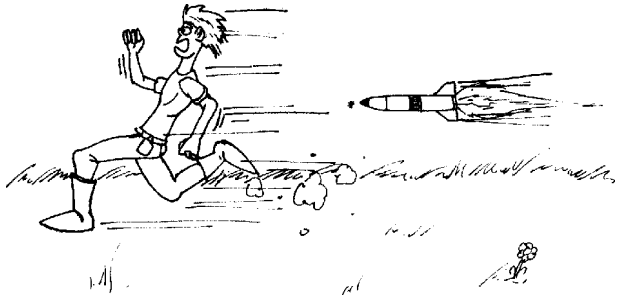
ITEM	**CONTAINER AND RESTRICTIONS**	**MAXIMUM QUANTITY**
Strontium nitrate	Glass	1 lb.

Substances Dangerous in Contact with Water

Calcium	Glass (under kerosene)	1 lb.
Calcium carbide	Metal can	2 lbs.
Calcium hydride	Metal can (sealed)	2 lbs.
Calcium oxide	Glass or metal can	2 lbs.
Lithium	Glass (under kerosene)	4 ozs.
Sodium	Glass (under kerosene)	1 lb.
***Potassium**	Glass (under kerosene)	**None**

5. **Specific instructions:** No chemical should be stored directly on the floor. This precaution will preclude contact with water from flooding, mopping, or condensation, and the puddling of liquid contents of a defective or broken container around adjacent stored chemicals. Large containers should be stored on the lowest shelves to minimize the danger of breakage or spillage when being removed or replaced.

Compressed gases will not be procured in quantities larger than portable steel cylinders (lecture bottles). These should be stored in such a manner that there is no possibility of tipping or falling. If the fitting is broken off by such a fall, these cylinders become lethal rocket projectiles. Some other points to remember are:



* Cylinders of gases should be handled as high energy sources and, therefore, as potential explosives.

* Always protect the cylinder valve stem.

* Fittings should fit only the proper cylinder: this will prevent connecting the wrong cylinder.

* Avoid exposure of cylinders to heat.

* Never lubricate, modify, force or tamper with a cylinder valve.

* Cylinders of toxic, flammable or reactive gases should be used only in a fume hood.

* Cylinders of oxygen or chlorine should not be stored in the same cabinet with cylinders of combustible gases such as hydrogen, hydrocarbon gases, or hydrogen sulfide.

FLAMMABLES

Flammable liquids in quantities exceeding one pint should be stored in the original shipping container or in metal safety cans. Concentrated acids should not be stored in bottles of greater than five pint capacity.

Carbon storage containers are prohibited.

Sodium, potassium, lithium, and calcium metals should be stored under water-free kerosene or toluene. **White phosphorus** should be stored under water. It should be handled with forceps, never with the hands, and should be cut under water.

All containers should bear labels which should not be removed or obliterated so long as the chemicals named on the labels remain in the container. Unlabeled chemicals should be disposed of immediately! Contact your local approved Hazardous Materials Waste Hauler (as per EPA list.) Labels should carry the proper information as mandated by the Delaware Right to Know law and any applicable Federal regulations.

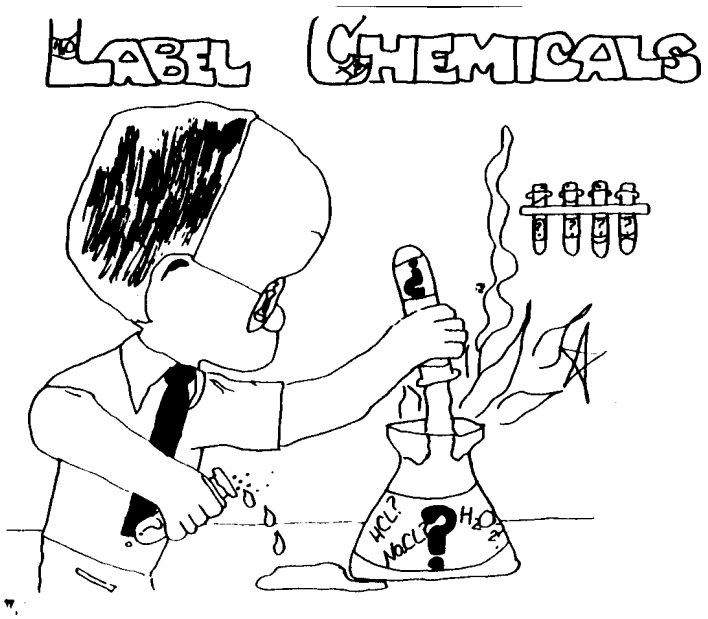
Please note: The **Delaware Solid Waste Authority** does have hazardous materials disposal at no cost to you. Contact the authority and ask which landfill site closest to you will be having a hazardous materials collection and on what date. They will literally take anything you need to dispose of – labeled or not – in whatever condition you have it. Be careful in transporting the materials to the site, though – and follow all necessary safety precautions along the way.

Many organic chemicals, including aldehydes, ketones, esters, higher alcohols, benzene, toluene, certain oils, fluid silicones, and chlorinated hydrocarbons, penetrate through polyethylene bottles and should not be stored or dispensed in such containers. Such containers that have ever been used to hold or store such chemicals should be disposed of as hazardous waste themselves.

6. **Housekeeping in the stockroom:**

The habit of order and cleanliness necessary to insure safety in the laboratory as a whole is especially important in the stockroom. No waste or dirt must be allowed to accumulate anywhere. Spills of solid or liquid chemicals should be cleaned up immediately. The outside of containers should be kept clean. The exterior of corrosive or caustic chemical containers should be flushed with water and dried before being returned to the stockroom. Chemicals should be promptly replaced and not left where careless or mischievous students can have access to them. Common use reagents should be placed at laboratory stations or on the supply table for specific experiments only, and not left out in the

laboratory indefinitely. No chemical should be dispensed into an unlabeled container. Good practice dictates labeling all containers before putting chemicals into them.



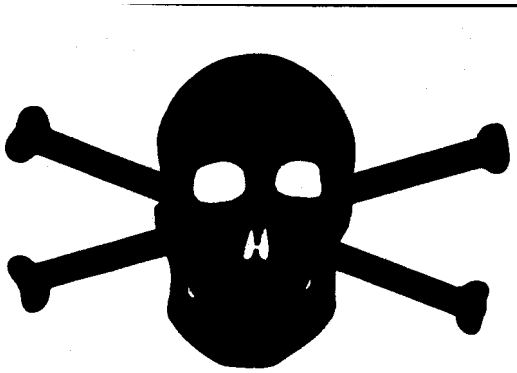
7. **Inventory of chemicals:**

The Right-to Know (RTK) law requires that any facility that stores and uses hazardous materials must keep a "Chemical Workplace Inventory." Science teachers and the school principal should be aware of the chemical substances in the school – and that includes those substances used for cleaning, painting, and maintenance in genera. In a fire or explosion, the possibility of interaction by materials from one area to an adjacent area is real and has to be protected against. No less important than the storage and inventory of your lab supplies is the storage and inventory of all other such materials in and around the school.

An inventory updated at least once a year should be taken to fulfill the requirements under RTK. **The inventory should contain the following information:**

1. **name of the chemical,**
2. **amount on hand,**
3. **location on where the chemical is stored,**
4. **date purchased,**
5. **date for discard,**
6. **potential hazards,**
7. **appropriate method for disposal,**
8. **notes on storage, and**
9. **Safety Alert Code.**

This type of information allows for rapid identification of a hazardous chemical. **A suggested inventory form is included in *Appendix B***. The inventory could be kept in a crd file or a computer file, or even a loose-leaf binder. It is also a facet of RTK that in the event of a fire alarm (drill or real), this Workplace Chemical List is to be taken out of the building and kept ready for use by the fire fighting personnel.



B. **Health Hazards (Poisons and Carcinogens)**

Intelligent, safe handling of toxic or corrosive chemicals is promoted by an understanding of their physiological effects and the way in which they act to produce harmful results.

1. **General:**

a. **Ingestion:** Harmful substances taken by mouth may damage the tissue of the digestive tract or find their way into the bloodstream. Small quantities of some poisons may be neutralized by the digestive juices or removed by the liver and kidneys without causing damage.

No substance in the laboratory should ever be tasted.

Laboratory glassware should never be used to contain food or drinks for human consumption.

b. **Absorption:** Under certain conditions, the human skin can be penetrated by many substances. Liquids particularly organic solvents which dissolve the fatty oils in the skin can be absorbed through the skin more easily than gases or dusts. For example, the solvent, dimethyl sulfoxide (DMSO) is notorious for its ease of penetrating through the skin, and can even carry substances dissolved in it through the skin and into the blood stream. Skin punctures or wounds may allow the introduction of harmful substances directly into the bloodstream. Keep this in mind and wash the hands frequently, especially at the conclusion of the laboratory period. Avoid contact with materials or wear rubber or plastic gloves and protective clothing if contact is probable.

toxic vapors

c. **Inhalation:** One of the most common methods of introduction of poisons into the body is through the respiratory tract. Gases and dusts are generally more easily absorbed into the bloodstream through the lungs than by ingestion or absorption. Gases, fumes, and dusts which may cause harmful effects when inhaled may be classified as follows:

(1) **Asphyxiants** do not directly injure the respiratory tract but cause oxygen deficiency in the body tissues. Simple asphyxiants like nitrogen or hydrogen are harmful only to the extent that they displace the oxygen. Chemical asphyxiants such as carbon monoxide reduce the oxygen carrying capacity of the blood. Cyanide and cyanogen compounds stop oxidation in the tissues by poisoning the oxidation catalysts.

(2) **Tissue irritants** damage the tissues of the respiratory tract and cause inflammation of the respiratory passages. Among these are ammonia, hydrogen sulfide, methyl isocyanate, chlorine, bromine, hydrogen chloride, and phosphorus halides.

(3) **Metal fumes** have a wide diversity of harmful actions. Some, such as mercury and lead, are essentially tissue poisons and can cause serious illness and death. Others such as zinc may produce nausea and fever. If there is reason to heat mercury, it should be done only in the hood.

THE USE OF THIS PROCEDURE OR USING MERCURY IN GENERAL IS NOT RECOMMENDED.

d. **Skin irritants** have a direct chemical or physical action on the skin, combining with it to form new compounds or extracting from the skin some of its essential constituents. Skin irritants operate by one or more of the following mechanisms:

(1) Dissolve the keratin (alkalies, strong soaps, sulfides)

(2) Dissolve or emulsify the fat and cholesterol (organic solvents, alkaline detergents)

(3) Precipitate proteins (tanning agents and salts of heavy metals)

(4) Oxidize the skin (bleaches and strong oxidizing agents such as perchlorates and permanganates)

(5) Dehydrate the skin (inorganic acids, anhydrides, and hygroscopic chemicals)

(6) Act as reducing agents (some organic acids and sulfides).

2. **Health Hazards of Common Classes of Chemicals:**

a. **Poisonous compounds of sulfur, phosphorus, and nitrogen:** The strong mineral acids (hydrochloric, nitric, phosphoric, sulfuric, etc.), in addition to being extremely corrosive to the skin, give off fumes which are very irritating to the respiratory tract. Phosphorus halides are strong respiratory irritants. They form strong acids on contact with water and therefore cause severe tissue burns when inhaled.

Hydrogen sulfide is nearly as toxic as hydrogen cyanide.

At toxic levels of concentration, the gas paralyzes the respiratory center of the brain. Dimethyl sulfate is an odorless powerful lung irritant, a powerful lachrymator and desiccant as well as a potent carcinogen. It can be absorbed through the skin.

Nitrogen oxides are extremely dangerous because of their delayed action. Harmful or even fatal quantities can readily be inhaled without immediate noticeable results.

Pulmonary edema usually results from extended inhalation.

b. **Halogens:** Chlorine is a strong and dangerous lung irritant. Bromine is corrosive to the skin, causing burns which may ulcerate and heal slowly. Its vapor is highly irritating to the respiratory tract.

c. **Carbon monoxide:** Carbon monoxide is a chemical asphyxiant since it combines with the hemoglobin of the blood and renders it ineffective for the transport of oxygen.

d. **Cyanides:** Hydrogen cyanide is a highly toxic, colorless gas with the odor of bitter almonds. It is readily absorbed through the skin at high concentrations. Hydrocyanic acid and its simple soluble salts are among the most dangerous of all poisons because of their rapid action.

e. **Hydrocarbons:** Saturated aliphatic hydrocarbons are relatively harmless from the toxicological point of view, the lower homologues being less harmful than the higher ones.

From pentane on up they are narcotic, convulsive, and irritant in high concentrations.

Unsaturated aliphatic hydrocarbons, including acetylene, have simple asphyxiant and anesthetic properties.

Cyclic hydrocarbons are more potent than open chain ones. **Cyclohexane** has about the same toxicity as hexane but a stronger narcotic action.

Aromatic-hydrocarbons are much more toxic than the aliphatics. Some, including **benzene**, have been shown to be suspected carcinogens. Prolonged exposure to **benzene and toluene** has a destructive influence on blood cells and blood forming organs. They also have an acute narcotic effect.

toxic vapors

Halogenated hydrocarbons as a class are anesthetic and narcotic. Permanent damage to the liver and kidneys may result from chronic exposure.

Many of the halogenated hydrocarbons, such as **chloroform and carbon tetrachloride**, are suspected to be carcinogens. Prolonged exposure to carbon tetrachloride vapor should be avoided.

f. **Alcohols:** The alcohols, methanol excepted, increase in anesthetic power with increasing molecular weight. Butanol and pentanol, in addition, are irritant and have a poisoning action on protoplasm. Methyl alcohol (methanol) is poisonous and contact as well as inhalation is to be avoided. Ingestion or prolonged inhalation can cause blindness.

g. **Aldehydes and ketones:** The aldehydes are primarily irritants but they have some narcotic action. Formaldehyde is a strong irritant and an alleged carcinogen; avoid skin contact and avoid breathing the vapor; always handle in a hood and wear gloves. The ketones are narcotic, but in comparison to other volatile liquids, are relatively harmless.

h. **Ethers:** Ethers are powerful narcotics acting rapidly on the central nervous system. They are dangerous if inhaled in large quantities.

i. **Esters:** Esters vary widely in anesthetic and irritant properties from the very mild action of ethyl acetate to the poisonous, irritant and vesicant action of formic acid esters and dimethyl sulfate.

SAFETY WITH ACID

j. **Acids:**

(1) **Acetic acid is considerably more corrosive to the skin than is generally believed.** Even at room temperature the vapor is highly irritating to the eyes, nose, and throat. It is one of the few materials that expands upon freezing. Full bottles of glacial acetic acid must be stored above their freezing point of 60^{o}F. (15.5^{o}C.) to prevent bursting the bottle on freezing.

(2) **Chromic acid** is a strong oxidizing agent but not a strong acid. Precautions should be taken to avoid skin contact or inhalation of the dust. This acid will ignite ethanol and similar liquids on contact. It has also been reported to be a carcinogen.

(3) **Hydrochloric acid** (concentrated) fumes strongly. Both the solution and the fumes are corrosive to the skin and the respiratory tract.

(4) **Hydrofluoric acid** is extremely irritating and corrosive. It produces severe skin burns which are slow in healing. Because the damaging effect may be considerably delayed, it is possible to spill enough on the hands to cause serious injury without any discomfort for several hours.

After using hydrofluoric acid it is advisable to wash the hands thoroughly even though no contact is evident.

(5) **Nitric acid** is a powerful oxidizing agent. Concentrated solutions may cause combustion of reducing agents. In addition, it reacts with many materials to produce dense fumes of highly toxic red/brown oxides of nitrogen. Because of their delayed reaction, it is possible to inhale a dangerous concentration of these oxides without much initial discomfort or apparent injury.

(6) **Sulfuric acid** (concentrated) chars and destroys tissues on contact because of its avidity for water. Its fumes are irritating to the respiratory tract. The use of concentrated sulfuric acid by students should be avoided if possible.

(7) **Phenol** (carbolic acid) is readily absorbed through the skin. It produces a tingling sensation followed by a loss of feeling. The skin becomes white and wrinkled and then turns brown and sloughs off. This is not a true corrosive action, but is local gangrene caused by a destruction of the blood supply to the affected area.

k. **Alkalies: Sodium and potassium hydroxide**, and their concentrated solutions, cause severe burns to the skin and eyes upon contact. Dissolving the solid alkali generates so much heat that there is often boiling and spattering even when cold water is used.

Ammonia is a strong irritant and in excessive concentration can cause death from bronchial spasm. It is not, however, particularly harmful in concentrations small enough to be just uncomfortably irritating. Its aqueous solutions are particularly harmful if splashed in the eyes.

l. **Mercury:** Mercury poisoning can occur by contact with exposed skin surfaces, ingestion, or inhalation of the vapors.

Free mercury vaporizes at room temperature and if quantities are left exposed or Spills are not thoroughly cleaned up; inhalation of these vapors can be hazardous.

Mercury spills should be referred to the Hazardous Response Team at the Department of Public Health.

Acute exposure to mercury vapors occurs when the unconfined metal is exposed to high temperatures, e.g., a broken thermometer in a hot oven or a container of hot liquid. In cases of this kind the area should be **immediately** evacuated. Cleanup operations should be undertaken only after temperature is thoroughly ventilated.

The use of alcohol thermometers is recommended to eliminate mercury spills from broken thermometers.

Students should not be allowed to amalgamate coins with mercury. Continued handling of the amalgamated coins can be harmful.

m. **Carcinogens:**

Carcinogens are compounds or substances that may produce malignant tumors or other forms of cancer upon exposure. They are insidious poisons since their harmful effects are not immediately apparent. Cancers usually do not develop until many months, or even many years after exposure to carcinogenic materials. For this reason, great care should be taken to avoid exposure to any substance expected of being a carcinogen.

In 1974 the Occupational Safety and Health Administration (OSHA) classified 14 chemicals as dangerous carcinogens and issued standards which include specific procedures for working with these chemicals. Later, 6 additional chemicals were added to the list. Subsequently, a number of other compounds were identified by the ACGIH and industrial companies such as Du Pont as being strong carcinogens that pose a very significant health risk.

THESE POTENT CARCINOGENS ARE LISTED IN TABLES I AND II. SINCE THE RISK OF USING THESE COMPOUNDS GREATLY OUTWEIGHS THE POSSIBLE BENEFITS, THE COMPOUNDS IN THESE TABLES SHOULD NOT BE STORED OR USED IN THE SCHOOL LABORATORIES, AND IF PRESENT, THEY SHOULD BE REMOVED.

TABLE I
OSHA CARCINOGENS
(THESE SUBSTANCES ARE NOT TO BE USED)

2-Acetylaminofluorine
Acrylonitrile
Arsenic, inorganic
Arsenic pentoxide
Arsenic trioxide
Asbestos
Benzidine
Bis(chloromethyl) Ether
(and salts)
Coal Tar Pitch Volatiles
Coke Oven Emissions
1,2-Dibromo-3-chloropropane (DBCP)
4-Aminodiphenyl 3,3'-Dichlorobenzidine (and salts)
4-Dimethylaminoazobenzene
Ethyleneimine
Methyl Chloromethyl Ether
alpha-Naphthylene (Naphthylamine)
beta-Naphthylene (Naphthylamine)
4-Nitrodiphenyl (aminodiphenyl)
N-Nitrosodimethylamine
beta-Propiolactone
Sodium Arsenite
Vinyl Chloride

TABLE II
OTHER CARCINOGENS BELIEVED TO BE SIGNIFICANT HEALTH RISK
(AVOID THE USE OF THESE SUBSTANCES)

Benz(a)pyrene
2,4-Diaminotoluene
1,4-Dichloro-2-buten
Dimethylcarbamoyl Chloride
1,1-Dimethylhydrazine
(and salts)
Dimethyl Sulfate
2,4-Dinitrotoluene
Hexamethylphosphoramide
Hydrazine (and salts)
4,4'-Methylene Bis (2-chloroaniline)
4,4'-Methylene Dianiline (and salts)
Monomethylhyrdazine (and salts)
N-(2-Hydroxyethyl)ethyleneimine
Nitrosamines
2-Nitronaphthalene
Phenyl Glycidal Ether
1,3-Propane Sulfone
Propyleneimine
2,3,4-Trichloro-1-butene

In addition to the strong carcinogens listed above, (Table I) several hundred other compounds have been screened, usually in animal tests, and found to have weaker carcinogenic properties (Table II). Still others show inconclusive results and are regarded as possible carcinogens.

Some of these "weak" or "possible" carcinogens are common laboratory chemicals, and are likely to be found in high school laboratories. A partial list is included in Table III. Since these compounds present a danger in themselves, and some may eventually be reclassified as "strong" carcinogens, great care should be taken when handling them to avoid ingestion and skin, eye, and respiratory contact.

Remember, the risk increases with both the level and duration of exposure, as well as the potency of the carcinogen. It is prudent to replace any compound suspected of being a carcinogen with a less toxic compound when suitable alternatives are available. For example, benzene can often be replaced by toluene or cyclohexane for solvent use, and ethyl acetate can be used instead of carbon tetrachloride for insect killing jars.

TABLE III
SUSPECTED AND/OR WEAK CARCINOGENS
(AVOID USING THESE SUBSTANCES OR USE WITH EXTREME CARE AND CONTROLLED EXPOSURE)

Acetamide
Anthracene
Aniline (and salts)
*Benzene
Beryllium Carbonate
Cadmium (and salts)
*Carbon Tetrachloride
*Chloroform
*Chromium (and III, VI Oxide, Acetate, Nitrate)
Sudan IV
Cobalt
Colchicine
1,2-Dichloroethane
(Ethylene chloride)
p-Dioxane
Ethyl Carbamate (Urethane)
Ethylene Oxide
* Formaldehyde
* Lead (IV) Chromate
* Lead Diacetate
Methyl Iodide
* Nickel (and Acetate, Carbonate, Oxide)

Tannic Acid
Thioacetamide
Thiourea
o-Toluidine

**** Commonly found in school laboratories.***

Most of the substances that have undergone formal risk assessment are industrial chemicals. Many chemicals used only in the laboratory have never been tested for their human carcinogenic potential. Indeed some may be very potent carcinogens.

Particularly suspect are the strong alkylating agents such as esters of strong acids and reactive organic halides.

n. **Reproductive Toxins**: Reproductive Toxins are compounds or substances which produce harmful effects on the female and/or male reproductive system and include:

*Embryotoxins affecting the fertilized egg or embryo during its development
*Teratogens producing malformation of the fetus.
*Reproductive toxins affecting the male reproductive system.

Like carcinogens, reproductive toxins are insidious poisons, since their harmful effects are not immediately apparent. Several common solvents and lead and its salts have been classified by OSHA, ACGIH and/or duPont's Haskel Laboratory as reproductive toxins that pose a significant health risk, and are listed in Table IV. These compounds should not be stocked or used in the school laboratories.

IT IS PARTICULARLY IMPORTANT THAT FEMALES OF CHILD BEARING AGE ARE NOT EXPOSED TO TERATOGENS OR EMBRYOTOXINS.

TABLE IV
REPRODUCTIVE TOXINS

Compound	Classification
Dimethylacetamide (DMAC)	Embryotoxin
Dimethylformamide (DMF)	Embryotoxin
2-Ethoxyethanol#	Teratogen
(Cellosolve®)	Embryotoxin and Teratogen
Ethylenethiourea	Embryotoxin
Formamide	Teratogen, Embryotoxin, and
Hexafluoroacetone (HFA)	Male Reproductive Toxin
and its Hydrates	Teratogen (mental retardation)
*Lead, Acetate,	Teratogen
Nitrate, Oxide	Embryotoxin and Teratogen
2-methoxyethanol (Methyl Cellosolve®) #	
monomethylformamide	

** Commonly found and used in experiments*
 # Karl Fisher reagent from some suppliers may contain this solvent

3. Protective Measures:

a. Eye protection: Delaware law requires that teachers, students, and visitors wear approved safety goggles when caustic, explosive, hot liquids or hot solids are in use, or any other activity that is potentially hazardous to the eye.

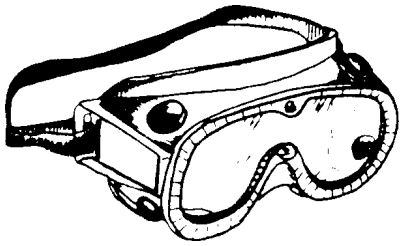
1. **GOGGLES**

a. must conform to the American Standard Institute (ANSI) Z87.1 – 1979 specifications. Goggles must bear the manufacturer's trademark plus the Z87 logo.

b. must be worn at all times during Chemistry laboratory experiments and it is strongly recommended that goggles be worn for all activities where glassware is used

c. must be of the chemical (anti-splash) type

d. goggles should be cleaned prior to other students using them. Cleaning may be accomplished by an ultraviolet disinfection cabinet or by rinsing in a good detergent. Goggles should be stored away from chemicals, dust, and excessive student handling.



(2) CONTACT LENSES

Note: ***The National Society to Prevent Blindness,*** *and many industries, have changed their position on using contact lenses in laboratories. Tests and experience have indicated that such lenses do not present the severe hazards once thought. Contact lenses may be worn with the proper protective equipment, e.g., goggles. There should be no restrictions other than to have the instructor know which students wear contact lenses so they may be promptly removed in event of foreign material in the eyes. This will permit proper flushing.*

(a) Students who wear contacts should be strongly discouraged from doing so in school laboratory situations of a chemical nature.

(b) The teacher must determine in advance which students are contact wearers and if those students also have glasses that can be worn when the contacts are removed for a lab.

(c) Contact lenses must be removed for all labs that release vapors or use substances of an alkaline nature. Ammonia, ammonium hydroxide and sodium hydroxide are particularly dangerous, commonly used substances.

(d) Should a student be temporarily unable to comply with regard to removing his/her contact lenses, **the teacher must not allow the student to perform the lab at that time.** The lab should be done at a later time or an alternate lab or assignment made.

(e) When the teachers deems it safe to perform a lab while wearing contacts, then the student should follow the same safety precautions as other students, that is, wearing anti-splash goggles.

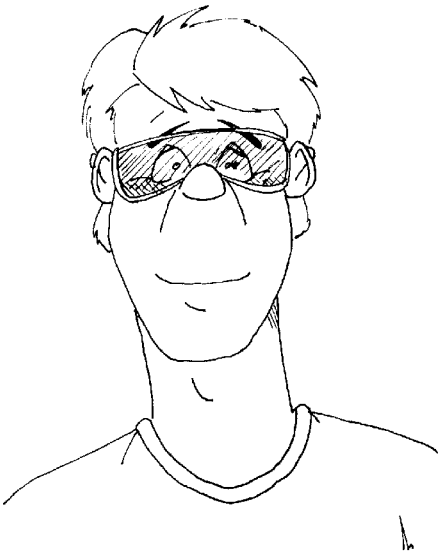
(f) Should the student be unable to wear glasses instead of contacts on a more permanent basis, a note from a doctor and the student'[s parents should be obtained and held on file. This does not mean that under any circumstances should a student perform a lab wearing contacts, if that lab is dangerous to a contact wearer.

(g) In the event of an emergency, contacts must be immediately removed in order to permit effective flushing and washing of the eyes.

(3) **SPECTACLES**

(a) Anti-splash goggles must be worn over spectacles in chemical experiments in order to afford appropriate protection.

ANTI-SPLASH GOGGLES

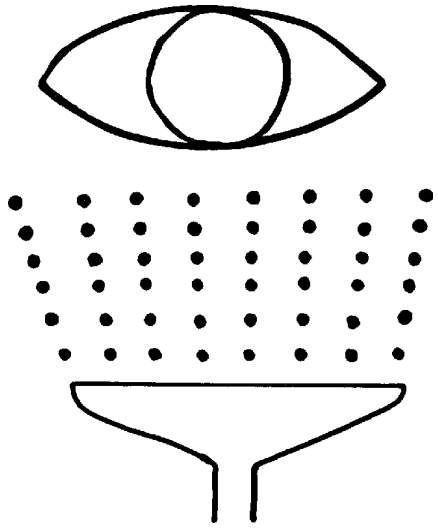


(b) When the teacher deems anti-splash goggles unnecessary, impact goggles must be worn over spectacles even though spectacles are constructed with cosmetic safety lenses.

(c) Glasses with photochromic (color changing) lenses should not be worn by students when performing laboratory procedures. In most instances, these lenses require from 30 seconds to three minutes to completely clear after being exposed to natural sunlight.

(d) Sun glasses or dark glasses should not be worn when performing laboratory procedures.

(4) **EYE WASH FACILITY**



(a) There must be some convenient provision for the copious flushing of the eyes with water in every laboratory or classroom using chemicals for student experiments.

(b) Eye wash fountains are ideal and State school construction policy requires they be included in any laboratory renovation plans.

(c) In lieu of eye wash fountains, for emergency use, each lab station should be fitted with a length of hose and an adapter. A low water-pressure or aeration caused by the adapter is necessary to prevent eye damage during flushing. Flushing of the eye or spills on other body areas needs to be continued for at least fifteen minutes.

b. **Body protection:**

(1) The wearing of loose fitting, frilly, or flammable clothing should be discouraged. **It is the prerogative of the teacher to establish and enforce any special clothing standards deemed necessary for safety,** such as prohibition of sandals, soleless footwear, lace sleeves, etc.

(2) The laboratory should be equipped with a deluge shower both for quenching clothing fires and for slushing off extensive spills of corrosive or caustic chemicals. They should be on with water pressure up to the chainpull valve whenever laboratory work is in progress. The shower should be tested at least once each quarter. If no shower is installed or the shower is inoperative, a work request should be submitted and the principal notified of the deficiency.

Clothing on which irritating chemicals have been spilled in appreciable quantity should be promptly removed. This applies especially to tight fitting articles of clothing such as stockings or hosiery. Organic chemicals may cause no skin irritation from brief exposure, but can cause severe dermatitis if dampened clothing is left in contact with the skin for prolonged periods. In case of contact of the skin with corrosive or caustic chemicals, the prompt and copious flushing of the affected area with water is indicated. If after this water treatment the skin appears irritated or inflamed, the student should be sent to the school health room.

(3) Aprons should be worn during all chemistry laboratory work.

(4) Teachers and students should wear eye protection (anti-splash goggles and face shields), aprons or laboratory coats, and rubber gloves when preparing solutions or harmful chemicals.

(5) Reagents not provided at each table or station but available at the central supply table should be used at that location and not carried through the laboratory to the individual stations. This will minimize the danger of dropping or spilling and ensure that the reagents are readily available to all students

6) **Pipetting by mouth is prohibited**. An aspirator bulb, safety pipette filler, or burette should be used to dispense precise amounts of liquid reagents.

c. **Protection against dangerous inhalation:**

(1) The laboratory, classroom, and preparation room should be well ventilated. Demonstrations or laboratory work involving the generation of irritating or noxious gases should be performed in the fume hood.

(2) If the experiment or demonstration causes an uncomfortably irritating or acutely unpleasant odor, the chances are that the concentration is too high to be perfectly safe. Solutions of fuming liquids should be mixed in the fume hood. If these precautions are taken, the laboratory need not be equipped with a gas mask.

(3) If the atmosphere of the laboratory becomes contaminated, the area should be evacuated and ventilated. Although the tradition of fetid odors has become associated with the study of chemistry, the atmosphere of the high school laboratory need not, and should not, be uncomfortable.

(4) A headache acquired in a laboratory may be nature's way of alerting you to the presence of toxic gases and vapors. A laboratory can become saturated with toxic vapors which are not always evident by an odor. When you or a student complains of a headache, it may well be time to throw open the lab windows, take yourself and your students to a source of fresh air, and allow the lab air to be changed thoroughly.

4. Skin Sensitivity

Some students have unusual skin sensitivity to chemical exposure. If the teacher cautions everyone to report any itching, burning or redness, these students can be identified and their exposure limited thereafter. The use of plastic disposable gloves is suggested for these students.

Students with conditions, such as asthma, which make them particularly sensitive should be allowed to remain away from the presence of laboratory vapors that may aggravate their conditions. The school nurse may be able to help identify these students. The teacher should ask the students to provide the information at the beginning of the year.

5. **Housekeeping for Health Protection**

Good housekeeping and a clean work area with a place for everything and everything in its place is essential to safe laboratory performance. An orderly work area with clear aisles and ready access to reagents is insurance against accidents.

a. Because of the importance of clear aisles between lab stations, the use of stools is not recommended. However, in those laboratories equipped with stools, the students should be indoctrinated to keep the stools with the four legs solidly on the floor and never to sit with the stools tilted.

b. Spills should be cleaned up immediately using plenty of water to dilute the chemical and render it harmless. Sodium bicarbonate should be used to neutralize extensive spills of strong acids. Spills on the floor are especially dangerous and the floor should be mopped DRY after cleanup to minimize the danger of slipping and falling. The outside of bottles containing strong reagents should be flushed with water frequently to prevent the contact of spilled chemicals with the hands.

c. **Equipment and chemicals shall not be transported through the hallways during class change. Students should not be allowed to carry reagents through the hallways at any time.** If chemical transport between rooms is necessary, it should be done by a teacher using a laboratory cart.

d. A rigid program of cleanup at the end of the laboratory period should be instituted at the outset. Plenty of time should be allowed for cleanup and adequate warning given so that thorough cleanup can be accomplished without rushing.

e. **Chemical reagents and equipment assemblies should not be left unattended in the laboratory. Teacher supervision of such items is required at all times if health hazards are to be eliminated and pilferage is to be kept at a minimum.**

C. **Fire and Explosion Hazards**

Many chemical reactions are extremely energetic. This energy usually takes the form of heat or the mechanical energy resulting from the production of large volumes of gaseous products. Combustible substances and potentially explosive substances are present and routinely used in the high school chemistry laboratory. Safety can be assured only if the instructor knows the properties of the reactants and takes adequate preventive precautions.

EXPLOSIVE

FLAMMABLES

1. **Flammable liquids:**
FLASH POINT BELOW 100^{0} F.

The greatest fire hazard exists when using flammable liquids. It is the vapor of the liquid that ignites or explodes when mixed in proper proportions with air. The **vapor pressure** of a liquid varies with temperature. The flash point of a liquid is the minimum temperature at which it gives off vapor sufficient to form an ignitable mixture with air. A particularly dangerous situation develops when a flammable vapor and air approach the chemical proportions for reaction. If a fire starts under these conditions, it will probably spread with such speed and violence as to constitute a dangerous explosion. There is a wide variation in this **explosive range** of vapors and gases. Another critical characteristic affecting the fire hazard is the **ignition temperature**, which may be defined as the minimum temperature required to initiate self-sustained combustion.

Appendix C is a table of the fire hazard properties of certain flammable liquids listing their flash point, boiling point, ignition temperature, and explosive limits.

It is apparent that the first risk involved in handling flammable liquids increases with the decrease in flash point and ignition temperature and becomes more acute with broader explosive limits.

Flammable liquids should never be exposed in an area where there is an open flame or the possibility of electrical sparks (including those of static electricity) especially on cold days when the humidity is low.

Hot plates, electrical mantles or water baths should be used when heating such liquids. Especially flammable liquids with low ignition temperatures, such as carbon disulfide, should be heated only with a warm water bath, since a heating mantle or hot plate could cause ignition.

Extractions and distillations, using flammable solvents, are the most common source of fires and explosions. Such operations, whenever possible, should be done in the fume hood.

When boiling flammable liquids, superheating and bumping of the apparatus should be avoided by adding glass beads or chips, or by stirring the liquid as it is heated, by filling the flask not more than half full, and by heating slowly and gradually. A sand or water bath for heating flammable liquids is often advisable to provide even heating and better temperature control.

2. **Unstable substances:** Unstable compounds or mixtures may decompose explosively. A few such compounds are stocked in high school laboratories and require special precautions and very careful handling.

a. **Ether:**

Ether, especially uninhibited ether, easily forms peroxides which are very explosive. These peroxides, having a higher boiling point that the ether, concentrate in the distilling flask during distillations or extractions, and can cause disastrous explosions. It is also possible for peroxides to form around the stopper or cap of a container of ether and be detonated by friction when opening the container.

For this reason –

1. **Ether should be procured in containers of not more than 4 oz. capacity.**

2. **Once opened, the contents should be either used or discarded.**

3. **Annual needs should be anticipated so that fresh stocks are procured each year and not held over from year to year.**

b. **Picric acid:** Because of their capriciously explosive nature, **PICRIC ACID AND ITS EVEN MORE SHOCK SENSITIVE METAL SALTS ARE PROHIBITED IN HIGH SCHOOL LABORATORIES IN THIS STATE.**

c. **Perchloric acid:** Perchloric acid may react explosively with reducing agents. The anhydrous acid may explode spontaneously.

Concentrations of perchloric acid greater than 70% should not be stocked. If the acid becomes discolored it should be discarded by pouring into cold water and flushing down the drain.

d. **Ammonium nitrate: Ammonium nitrate decomposes exothermically** above 160^{o} C producing a large volume of gaseous products. In a confined space or closed vessel, this self-sustaining reaction develops into a violent explosion.

e. **Benzoyl peroxide:** Benzoyl peroxide is prescribed for use in the CHEM Study Laboratory Manual. Extreme care should be exercised when handling this substance. The following accident is described in Chemical Engineering News, 26, (1948), 3518:

> "The accident occurred when a screw-stoppered bottle of peroxide was opened. Probably the bottle had been left open in a dusty atmosphere and the mixture of benzoyl peroxide and organic dust which had collected in the threads of the stopper detonated when the bottle was opened."

f. **Ammoniacal silver nitrate solutions**: Ammoniacal silver nitrate solutions used for silvering glass or as test solutions (Tollen's Reagent), on standing, may produce an unstable product which detonates violently, sometimes by merely stirring the solution. Such solutions should be mixed fresh whenever used and discarded after use. They should never be stored.

EXPLOSIVE FLAMMABLE

g **Sodium, potassium, and lithium:** Sodium, potassium, and lithium react violently with water to produce hydrogen which may be ignited or exploded by the heat of the reaction. Sodium and potassium are especially capricious and unpredictable.

Demonstrations of their reactivity should be done with a cover over the reacting vessel or behind a shield.

The alkali metals also react violently with chlorinated hydrocarbons, especially carbon tetrachloride, and with carbon dioxide. Because potassium can form dangerously explosive peroxides upon storage, it is recommended that sodium be used in its place when this is practical. Students should never handle these substances.

h. **Phosphorus:** White phosphorus spontaneously ignites in air at temperatures above 30^{o} C. **It should be stored, handled, and cut under water.** A large culture dish filled with water can conveniently be used for this purpose. It should never be touched with bare hands.

THE USE OF WHITE PHOSPHORUS IS STRONGLY DISCOURAGED.

i. **Nitrogen tri-iodide:** Nitrogen tri-iodide is **extremely shock sensitive and shall not be produced in high school laboratories.**

NOTE: *The attention of science teachers is directed to the notation on certain hazardous chemicals in the catalogs, to the effect that such substances are nonmailable and must be shipped by express or freight. It is wise to interpret this notation as a warning that special care should be exercised in the storage and handling of these substances.*

Flinn Scientific Inc., **Chemical Catalog**, is an excellent reference for hazards, storage, shelf life, disposal and special properties of chemical substances. It is recommended that all science teachers have easy access to this catalog. WRITE TO: P.O. Box 231, 917 W. Wilson Street, Batavia, IL. 60510.

3. **Dangerous mixtures:** A number of powerful oxidizing and reducing agents are used in the high school laboratory. Inadvertent or indiscriminate mixing of these can create a very hazardous situation. Among the various combinations which are dangerous, the following seem most likely to occur in the high school laboratory.

a. Perchloric or chromic acid with alcohol, acetic acid, glycerine
b. Sodium or potassium with water
c. Aluminum powder with ammonium persulfate and water
d. Chlorates with antimony sulfide, acids, metal powders, sulfur
e. Chlorates with phosphorus (red or white) or a cyanide
f. Ammonium nitrate with zinc powder and a drop of water
g. Nitric acid with hydrogen sulfide, acetic acid, zinc, magnesium, or other active metals
h. Potassium nitrate with sodium acetate
i. Nitrates with an ester
j. Nitrates with potassium cyanide
k. Peroxides with aluminum, magnesium, or zinc
l. Chlorates or perchlorates with sulfuric acid
m. Sulfuric acid with potassium permanganate, potassium chlorate or perchlorate, or with compounds having sodium, lithium, or any light metal
n. Potassium ferricyanide or a halogen with ammonia
o. Phosphorus (red or white) with nitric acid, nitrates, chlorates, dichromates, permanganates

p. Mercuric oxide with sulfur
q. Magnesium or aluminum with chlorates or nitrates
r. Magnesium with phosphates, sulfates, carbonates, and many oxides
s. Hypochlorites with ammonia
t. White phosphorus with air

When working with hazardous substances, use very small quantities and heat over a hot water bath, never in a flame. Carry out such reactions behind a protective screen, using a face shield or goggles. Do not keep explosive products on hand for any appreciable period. Follow safety procedures to the letter when disposing of residues from experimental reactions.

STUDENTS SHOULD NEVER HANDLE SUBSTANCES POTENTIALLY DANGEROUS OR EXPLOSIVE. THE VALUE OF USING SUCH SUBSTANCES BY THE TEACHER IS QUESTIONABLE.

CAUTION

D. **Miscellaneous handling techniques:**

1. All liquids, particularly corrosive ones, should be poured using a stirring rod. This will prevent the liquid from contaminating the sides of the container, and possibly the pourer.

2. Glass stoppers of reagent bottles should not be laid on the bench top but held between the index and middle fingers while pouring. This practice will preclude the interchange of stoppers between reagent bottles and prevent contamination of the bench top.

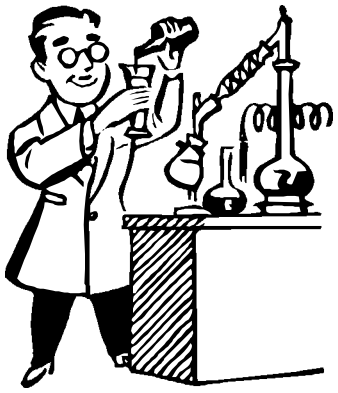
3. **STUDENTS SHOULD BE WARNED NOT TO POUR EXCESS REAGENTS BACK INTO THE STOCK BOTTLES.** The amount needed should be estimated and any excess discarded in a manner appropriate for that specific substance. The teacher should specify the method for each lab during pre-lab discussion.

4. **Pipetting by mouth is prohibited.**

   An aspirator bulb or pipette filler should be used. Siphon dispensing of dilute reagents from large bottles is very clean and convenient, but siphons should never be started by mouth.

5. When diluting concentrated acids, especially sulfuric, the **acid is always added slowly to the water with constant stirring.** The reverse process will cause the water to vaporize instantly, causing dangerous splattering.

6. Students should be taught to smell the contents of a test tube by gently wafting the fumes toward the nose with the hand. Students should smell only when it is a significant part of the experiment to learn odor characteristics. This should be rare.



7. When heating chemicals in a test tube, extreme care should be exercised. While being heated, a test tube should not be pointed toward oneself or anyone else. Heating should be done near the surface of the liquid. Never look down into a test tube containing a reagent or hot water.

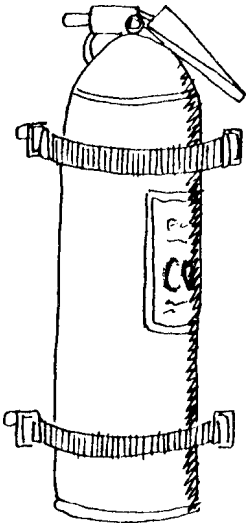
8. Spattering almost always occurs when solutions are evaporated to dryness. Although it slows the evaporation somewhat, the evaporating dish should be covered with a watch glass during this process. **Heat gently** with a back and forth motion.

9. Students should be taught to cultivate the habit of testing the temperature of glassware, iron rings, ring stands, and other laboratory equipment by bringing the back of the hand near the object before attempting to pick it up. If it is hot enough to cause a burn, the radiation will be apparent as the hand approaches the object.

10. Dry ice or liquid nitrogen should never be handled with the bare hands. Both can cause painful and slow healing frostbite. When mixing a dry ice solvent slush, **to prevent splattering, the solvent should be added to the dry ice and not the reverse.**

11. Carbon dioxide fire extinguishers when used for any purpose produce a spray of dry ice particles. No part of the body should be exposed to such spray. **After each use of a carbon dioxide extinguisher, it must be recharged.**

12. Glass wool and steel wool should be handled carefully. It is advisable to cut the desired amount from the bulk supply with scissors or shears rather than to try to pull it off. It is easy to be cut deeply by steel wool, and glass wool splinters in the skin can be very painful. Furthermore, teachers should caution students that steel wool is flammable and should not be exposed to open flame, inadvertently.



13. Instructions for the safe handling of Bunsen burners contained in the Equipment Handling Section of this manual (Chapter I-B, page 8) are to be carefully followed in the science laboratory.

14. When using a centrifuge, care should be taken to balance the sample with a similar test tube containing approximately an equal amount of water.

15. It is usually advisable to design experiments so that the smallest quantities of reagents which will give satisfactory results are used. Many phases of the laboratory program can be satisfactorily performed using semi-micro techniques.

E. **Student Experimentation**

The importance of understanding and following directions in performing an experiment cannot be overemphasized to the student. The temptation to mix reagents indiscriminately to see what will happen is strong and the teacher must exercise close supervision to ensure that the students follow instructions.

1. **Students shall not do any laboratory work either during or outside of regular class time except under the supervision of the teacher.**

2. Experimentation outside the classroom must be discouraged unless appropriate supervision is **guaranteed.**

CAUTION

1. Teacher Responsibility

Should the teacher have occasion to handle new and unfamiliar chemicals, the following properties of the reactants, solvents, and products should be determined in advance: Flash point, explosive limits, tendency to detonate, auto-ignition temperature, toxicity, carcinogenicity, corrosiveness, chemical reactivity with water, air, or other materials present, heat evolution, and radioactivity. Prudent consideration should be given these factors before proceeding. **The initial performance should never be done in the presence of the class. The teacher should try out all experiments and demonstrations in advance**. If the demonstration involves the slightest risk of explosion or spattering, a safety screen should be used and the students moved to a safe distance from the demonstration table.

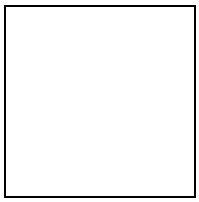
CAUTION

The intent of these instructions and precautions is not to inhibit, but rather to facilitate legitimate science activities. However, if there is any question of the extent of the hazard in a particular operation, the watchword is **DON'T.**

G. **Special Instructions for Handling of Equipment by Student Laboratory Assistants**

Some schools use student laboratory assistants to help the teacher in preparing stock solutions, dispensing chemicals, preparing for laboratory sessions or demonstrations, and other such chores. Special attention to safety is necessary with respect to laboratory assistants because the main virtue of this system is that, if properly trained; they can function with a minimum of supervision. However, **they should never be allowed to work alone in the science area. They should not be allowed access to the storerooms except when the teacher is present.** In using the laboratory assistants, the teacher should not lose sight of the fact that they are students and not employees. The teacher is still responsible for proper supervision, especially during any operation involving safety.

Laboratory assistants should be carefully selected and thoroughly trained in safe laboratory techniques. They should have completed or be currently taking the course in which they act as assistants. **They should be provided with written instructions on specific duties and operations for which they are responsible.** Good practice is to have specific instructions for each manipulation entrusted to them on indexed file cards. The cards for those particular operations which involve special safety considerations could be flagged with a red border.



H. **Safety Suggestions for the Performance of Specific Experiments**

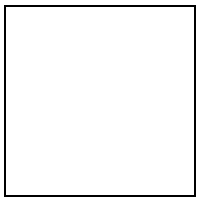
In this section, no attempt will be made to describe in detail the procedures for any particular experiment or demonstration. Instead, emphasis will be placed on those practices or procedures or their omission which have caused serious accidents in the past.

1. **Preparation of oxygen:** Using a potassium chlorate/manganese dioxide mixture requires that extreme care be taken to avoid contamination by organic or combustible material. It is strongly recommended that the mixture be prepared in advance and tested by the teacher. Under no circumstances should powdered carbon be available in the room when conducting this experiment because of its resemblance to manganese dioxide.

   There are cases on record of potassium chlorate detonating while being ground with mortar and pestle. If the reagent is lumpy, the lumps should be crushed with a large rubber stopper.

   If the sodium peroxide method is employed for preparing oxygen, the students should be warned that it is caustic to the skin and that the residue in the flask is also caustic. Make certain that the sodium peroxide is kept away from paper or other oxidizable material.

   In all gas generating experiments, the apparatus assembly should be checked before use to ensure that the delivery system is open so that explosive pressure will not build up. If the gas is collected over water, the delivery tube should be removed from the pneumatic trough before the generator stops to prevent water retracting into the generator.

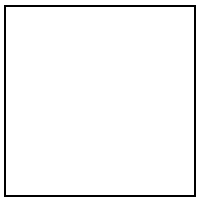


2. **Preparation of hydrogen:** Never ignite hydrogen coming from a generator until it has been tested to ensure that there is no residual air in the generator. This may be done by taking samples of the evolving gas in a small test tube and bringing to a Bunsen burner flame until a non-explosive "no-pop" sample is obtained. As a further precaution, it is suggested that the generator be wrapped in a towel before the gas is ignited. **It is strongly recommended that ignition of evolving hydrogen be done only as a demonstration, not as part of the student experiment.**

In using calcium hydride, the water should be dropped slowly with a dropping funnel with the same care as used in the sodium peroxide generation of oxygen.

3. **Spontaneous combustion:** In using phosphorus dissolved in carbon disulfide to demonstrate spontaneous combustion ignition, prepare only enough solution for the demonstration. **Do not store the prepared solution.**

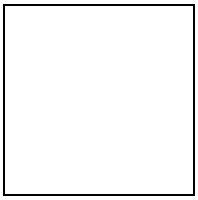
   Students should never be allowed to prepare phosphate. The teacher may demonstrate its preparation with the greatest care. The generator will explode if air gets in. **Spilled or spattered phosphorus may be rendered harmless by treatment with a 2% solution of copper sulfate.** This treatment should be used before attempting to pick up white phosphorus particles from the skin.



4. **Experiments with sulfur:** Carbon disulfide must not be used near a flame, a hot plate, a heating mantle, or even a hot steam line, since its auto-ignition temperature is only a little over 100^{o} C. Watch glasses or evaporating dishes which contain the carbon disulfide-sulfur solution should be placed in the fume hood.

   Sulfur dioxide should not be inhaled. Use the fume hood for experiments involving this gas.

CAUTION



5. **Preparation of halogens: The preparation of chlorine and bromine should be done only as a teacher demonstration, under the fume hood.** The delivery tube of the chlorine generator should be run into a container of sodium thiosulfate solution when the gas is not actually being collected.

   Iodine vapors, like the other halogens, are highly toxic and should be prepared in small quantities only, using a fume hood. Metal subjected to these vapors will quickly oxidize.

   SOME STUDENTS SHOW AN ALLERGIC REACTION TO IODINE VAPORS.

6. **Preparation of nitrogen and nitrogen compounds: The student preparation of nitrogen by heating a mixture of sodium nitrite and ammonium chloride is prohibited since an explosion will occur if the mixture is overheated.**

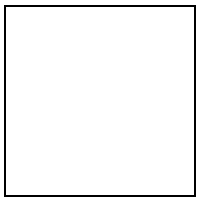
   Students should never prepare nitrous oxide, because of its strong anesthetic properties, and nitrogen tri-iodide, because of its susceptibility to shock detonation.

7. **Preparation of esters:** It is suggested that the alcohol-acid mixture be heated in a water bath, never over an open flame. The risk of spattering the sulfuric acid or igniting the alcohol is too great if heated over the Bunsen burner.

SAFETY

CAUTION

Toxic Vapors



8. **Thermite demonstration:** Before performing a thermite demonstration, the first several rows of seats should be vacated so that there are no students within ten feet of the reaction. Place a bucket of water with the bottom covered with sand under the ignition cup. Be very careful in approaching a mixture that has apparently failed to ignite: the mixture may flare up suddenly. Some teachers find it a refreshing diversion and a reduction of the fire hazard to perform this demonstration outside, building design and weather permitting. The use of a fume hood is highly recommended for this reaction.

9. **Fractional distillation of flammable liquids:** In demonstrating the fractional distillation of gasoline, alcohol, or other flammable liquids, the flask should be heated with a heating mantle or in a sand bath. The receptacle for the collection of distillate should be cooled in an ice bath. Special care should be taken to insure the integrity of the assembly to prevent leakage of flammable vapors.

This procedure is extremely dangerous and not recommended without special equipment.

10. **Use of dilute acids:** Whenever possible it is highly recommended that dilute acid solutions be supplied rather than have students make the dilution. **The use of concentrated sulfuric acid by the students is risky and to be avoided when at all possible.** Calcium chloride or calcium sulfate (Drierite) rather than concentrated sulfuric acid should be used as a drying agent.

11. **Dehydration of sucrose by H_2SO_4:** The students should not handle the spongy lump of carbon formed by the action of concentrated sulfuric acid on sucrose. Also, this reaction is extremely exothermic and caution needs to be taken by the instructor with regard to choice of the reacting vessel.

12. **Metal powders:** Most metal powders react rapidly and in some cases explosively with oxidizing agents, e.g., magnesium, aluminum, iron with potassium chlorate, or the peroxides. A mixture of zinc powder and

sulfur explodes violently on ignition. Metal powders and dusts in general should be treated with respect because of their speed of reaction.

I. Disposal of Wastes

1. **Liquid wastes:** Corrosive or caustic liquids can be disposed of by pouring down the drain while flushing with copious amounts of water. Liquid wastes should never be disposed of in the waste paper baskets. Flammable liquids should never be poured down the sink drain, because the flammable vapors can accumulate in the plumbing and may cause a serious explosion. When performing experiments which result in the accumulation of flammable liquid wastes, a metal can should be provided for collection of wastes. Pouring them into a shallow pan and allowing the material to evaporate in the back of a good, efficient operating fume hood may dispose of small amounts of volatile flammable liquids. Larger amounts of flammable liquids, or any flammable liquid waste that contain appreciable amounts of environmentally hazardous materials will require special disposal procedures, and should be reported to the State Science Supervisor.

2. **Solid wastes:** It is excellent practice to use separate containers for flammable solid wastes and non-flammable wastes, especially broken glassware. The mingling of broken glassware with paper and other trash can present a definite hazard to the custodial help performing collection and disposal.

   Much trouble with stopped up plumbing can be avoided if a small plastic container is provided in each sink for solid waste, or if the sink bottom is covered with rubber mesh. Suitable plastic containers can be made by cutting the top from laundry bleach bottles. Holes can be punched in the bottom of these containers to prevent them from filling with water.

3. **Overage or surplus chemicals:** Overage or surplus chemicals which, because of toxicity, pollution potential, or explosion danger, cannot be disposed of by dissolving, diluting, and flushing down the drain should be reported to the State Science Supervisor. The Supervisor's Office will contact the appropriate disposal agency for action. The practice of obtaining chemicals from surplus agencies or as gifts from students is to be discouraged since the age and condition of these chemicals may not be known.

CHAPTER THREE
PHYSICS/PHYSICAL SCIENCE SAFETY INSTRUCTIONS

While working in the physics laboratory does not involve dangers as obvious as those found in the chemistry laboratory, hazards do exist and are serious enough to warrant special consideration to keep injuries and equipment damage to a minimum.

A. **General Laboratory Precautions**

1. **Supplies:** Those precautions relating to the handling and disposal of chemicals, particularly flammable solvents, radioactive materials, glassware, and cryogenic materials, as previously described, apply here.

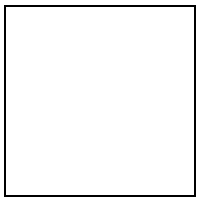
2. **Fire and explosion hazards:** Those precautions relating fire and explosion hazards. Detailed information on these general precautions is provided in Chapter II-C, page 37.

B. **Electricity and Electrical Equipment**

Prior to using any electrical equipment, teachers should carefully read the manufacturer's instructions. Teachers conducting labs or demonstrations with electrical equipment should be familiar with the dangers of electrical shock and its treatment. The best treatment is to avoid the situation through good safety procedures. General guidelines for using electrical equipment in the classroom include the following:

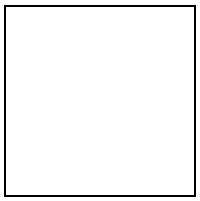
1. **Circuit Breakers and Ground Fault Arrestors:** All circuits used in schools should have proper circuit breakers or fuses. However the purpose of circuit breakers and fuses is to protect equipment, not people. The current needed to cause electrocution is much less than that needed to trip a circuit breaker or blow a fuse. It is recommended that Ground Fault Arrestors be installed in all new circuits and retrofitted to old circuits.

2. **Grounding of electrical equipment:** All electrical equipment having voltages exceeding 50 V should be grounded or of approved "double insulated" design. Grounded appliances are equipped with a three-prong plug and should never be operated with the ground plug removed or inoperative. This type of plug should not be used with a common two-prong receptacle. All receptacles should be grounded in science classrooms. If the appliance is not fitted with a three-prong plug, a separate ground wire with diameter equal to or greater than the power leads should be used unless the appliance is rated as "double insulated". A grounded appliance is not a substitute for adequate safety precautions. Equipment should not be operated in damp or wet locations unless specifically designed and certified for such operation.



3. **Proper Tools:** When working with electrical equipment, only tools with properly insulated handles should be used. Metal article such as rulers, pencils or pens should never be used to examine circuits. Students should remove rings, bracelets and any jewelry that might contact a live circuit when doing electrical work.

4. **Extension cords:** The use of extension cords in the laboratory should be held to a minimum. They should be considered a temporary measure and sufficient receptacles installed to replace them in permanent or frequent applications. When used, they should be of three prong grounded design unless used with "double insulated" equipment. Since grounded extension cords can be used with all equipment, it is recommended that they be the only type used in science labs. Since electrical resistance increases with the length of the cords and because of the dangers of creating a tripping hazard, extension cords should be as short as possible.



5. **Batteries:** When working with batteries students should be advised of the dangers involved. Few students are initially aware of the dangers that can be created by cells in series (high voltage) or in parallel (high current). Teachers should be aware of the number of batteries available and of the potential for unauthorized experimentation. The following cautions should be reviewed with the students as appropriate to the activity.

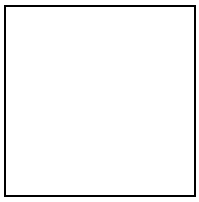
a) Batteries present a shock hazard if connected in series. Experiments should be designed to limit the maximum voltage to less than 50 volts. If this is exceeded, students must be warned of the shock hazard.

b) Short circuits and parallel circuits create a fire hazard due to the high currents present. Some batteries may explode if short circuited.

c) Steel wool can be ignited by accidental short circuits and should never be stored with batteries.

d) Automobile type acid batteries offer several hazards including high current, corrosive electrolyte and an explosion potential when recharging.

6. **Induction coils and Transformers:** Both induction coils and transformers are shock hazards when energized. When using them, students should be informed of the hazards and procedures to follow to prevent shock. Low and high voltage terminals should be marked if possible. Even direct current from a battery can produce dangerous output voltages in transformers or coils when the circuit is opened or closed.



7. **Capacitors:** When capacitors are used to store charge in electrical circuits, they can maintain dangerous voltages for hours or days after electronic equipment is turned off or unplugged. Lyden Jars are capacitors frequently used with static electricity. They can store lethal levels of electricity and should be used only with extreme caution. Voltages in excess of 100,000 V with considerable amperage are possible. The following rules should be reviewed with students as appropriate:

    a) Capacitors are a shock hazard even after electrical equipment has been turned off and unplugged.

    b) All capacitors should be discharged manually with a properly insulated tool or probe.

    c) Bleeding resistors should be installed in student designed power supply circuits to automatically discharge capacitors when the equipment is turned off.

    d) The peak voltage applied to a capacitor should never exceed its rated working voltage.

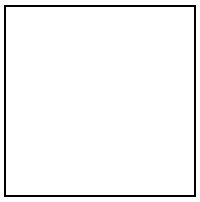
    e) Electrolytic capacitors can explode if connected backwards. Their polarity is marked and must be properly connected. (positive to positive and negative to negative)

    f) Charged capacitors should never be used to shock other students.

8. **Turn off power when working:** If possible, turn off all power when working on electrical equipment. The power leads should be the last connection made when assembling equipment and the first disconnected when disassembling equipment.

9. **Electric Arc:** A face-shield or safety goggles should be used when doing electrical work that may involve an arc.

10. **One hand rule:** Students should be trained to use one hand when working on high voltage circuits as much as possible. They should be cautioned on the danger of having one hand on a grounded circuit or chassis and accidentally contacting a high voltage source with the other. Electrocution is a real possibility in this case.



11. **Touching precaution:** If it is necessary to touch electrical equipment to determine if a motor or transformer is overheating, only the back of the hand should be used to permit contact to be broken. The equipment should be grounded and a voltmeter should be used before the equipment is touched to check for electrical potential.

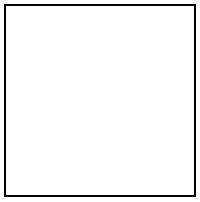
12. **Never be part of the circuit:** Students should be warned that they should never attempt to replace any part of an electrical circuit with their bodies. Appropriate wires or replacement parts should be used.

13. **Maintenance of equipment:** Equipment should not be used if it is defective. It should be repaired or replaced. Homemade equipment should be used only if it is properly inspected and tested. It should meet all of the grounding and safety requirements in this manual.

14. **Maximum load:** The maximum load which should be applied to the school's electrical system should be determined by the teacher and not exceeded. Frequent tripping of circuit breakers indicates circuit overload. Hot plates and other heating devices have particularly high current demands and only a few can be used on the same circuit.

15. **Soldering:** Extreme care should be exercised when soldering electrical connections to avoid burns or breathing of the fumes. It is recommended that soldering be done in a fume hood or well-ventilated area. Warn students about the danger of solder splattering when disconnecting components. Goggles and aprons are mandatory.

C. **Radiation**



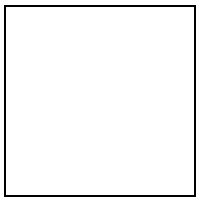
The various types of radiation offer special hazards since they usually cannot be seen or felt but may have long-term effects on students or teachers. Teachers are especially susceptible to the effects of radiation since they may be exposed to low levels in each class but accumulate harmful doses. The teacher should carefully read the manufacturer's manual and be aware of any hazards before using equipment that emits radiation.

If doubts about radiation dosages or equipment standards exist, further advice may be obtained from the Bureau of Environmental Health. Contact the Office of Radiation Control P.O. Box 637, Dover, DE 19903 or phone 736-4731.

1. **Microwave radiation:** Both microwave demonstration equipment and microwave ovens produce this type of radiation. The manufacturer's specifications should be carefully followed. Any microwave equipment lacking the manufacturer's instructions should not be operated unless approved by the Office of Radiation Control.

2. **Infrared light:** Equipment emitting IR radiation should have proper shielding or proper IR adsorbing glasses should be worn. The manufacturer's specifications should be carefully followed.

3. **Visible light:** Sources that emit dangerous levels of visible light include lasers, welding equipment and the sun.



a) Laser performance standards have been issued by the Federal Government and lasers are classified by power output. The manufacturer's cautions should be followed. The helium-neon lasers of class I and II commonly found in schools are believed to offer no hazard to human skin but could cause eye damage at power levels above 1.0 milliwatt. In demonstrations, particular care must be taken so that neither the direct beam nor any mirror-like reflections strike the observer's eye since the beam could be focused onto the retina.

b) If spot-welding, arc welding or gas welding is to be done, it should be done in a shop area with proper eye and general safety protection. Consult your shop or VoTech staff for further details.

c) Direct vision of the sun for even short periods of time can cause eye damage. Mirror-like reflections may also cause injury to the eyes. Sunglasses and exposed photographic film do NOT provide sufficient filtering power to reduce sunlight to safe levels. In fact, they may increase the injury caused by the sun by dilating the pupils of the eye while not blocking sufficient light, particularly in the Ultraviolet range. If experiments are done to observe the sun, they should project an image on white paper using a lens or "camera obscure". Measurements or observations can be made on the paper.

4. **Ultraviolet radiation:** These rays are emitted by mercury light sources, "black lights" and some sterilizing equipment. Proper shielding or goggles certified for ultraviolet protection are required. The teacher should be aware that a wide UV spectrum exists and that protective glasses must be matched to the source.

5. **X-radiation:** These rays may be emitted by high voltage tubes, electron microscopes, cold cathode discharge tubes as well as medical X-ray equipment. The manufacturer's recommendations should be carefully followed and in no case should any of the above equipment be operated without its proper shielding. If there is any doubt about the equipment, the Office of Radiation Control should be contacted.

6. **Ionizing radiation:** Alpha, Beta and Gamma radiations are emitted by radioactive material and particle accelerators. The appropriate sections of Chapter 1 should be reviewed and carefully followed when using ionizing radiation.

D. **Miscellaneous Safety Suggestions**

1. **Vacuum Tubes:** T.V. picture tubes, oscilloscope tubes, cathode ray tubes etc. present a safety hazard due to the partial vacuum in them. If dropped, struck or scratched, the tubes may implode and scatter glass fragments. They are generally manufactured with protective shields to avoid this danger. If it is necessary to work on the equipment without the manufacturer's shield, safety goggles or face shields or a demonstration table shield must be used. To dispose of an inoperable vacuum tube, it should be covered with a heavy cloth and broken by striking from the rear with a hammer. Some tubes may be vented by covering and using side-cutters to remove the glass tip left during manufacture. The coating of fluorescent tubes is toxic and care should be taken to avoid inhaling dust or fumes or coming into direct contact with pieces of the tube.

2. **Steam:** Some experiment such as model steam engines, boiling point measurement or coefficient of expansion determination require the use of steam. The teacher should emphasize the high thermal energy involved. Students should be cautioned to avoid any direct contact with steam and to point outlets away from themselves and other students.

3. **Motor Driven Equipment:** When using equipment that has exposed belts, chains or gears, it is necessary to have the drive system completely enclosed by a shield. Vacuum pumps and centripetal force equipment are two common hazards where the student is likely to be working near the equipment.

4. **Stroboscopic Observations:** If strobe lights are used to "stop" the motion of rotating motors, wheels, etc, the teacher should caution the students to avoid the temptation to touch the rotating object. Serious hand injury may result. A folded piece of paper can be used to "prove" that the object is really rotating.

5. **Model Rockets:** Safety must be stressed when working with model rockets. Details are given in Chapter 6, pg. 84, and in ***Appendix O****, pg. 146.*

6. **Impact Goggles:** If experiments such as projectile motion or circular motion labs involve the possibility of eye injury, impact goggles must be worn by all present. It should be noted that many chemical goggles are NOT certified as impact resistant and it is recommended that goggles used in physics classes be certified for BOTH chemical hazards and impact resistance. Many labs can be redesigned to eliminate eye hazards. For instance, tennis balls or super balls can be used instead of steel balls in projectile experiments.

7. **Laboratory Assistants:** The rules presented in Chapter 2, should be applied to students assisting with physics demonstrations.

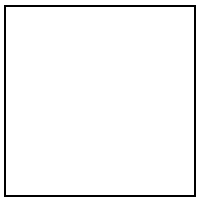
CHAPTER FOUR
EARTH SCIENCE INSTRUCTIONS

The teacher should read and become familiar with the techniques, and procedures in Chapters I and II of this manual.

A. **Eye Protection**

Safety goggles, plastic splash proof, should be worn when the following situations take place:

1. Using hot liquids
2. Heating liquids
3. Using corrosives; e.g., testing for $CaCO_3$
4. Operating power tools
5. Handling of elastic materials under stress; e.g., springs, wire, rubber, etc.
6. Working with hot, molten metals
7. Hammering, chipping, grinding rocks and minerals



B. **Using the Bunsen Burner**

1. Gas burners should be lighted only with a sparker in accordance with instructions.
2. Keep your hand and clothing away from the flame.
3. Turn burner off when not in use.
4. Do not bring any substance into contact with a flame, unless specifically instructed to do so.
5. Use white gauze when heating with a ring stand.
6. Only lab manuals and lab notebooks are permitted in the working area.
7. Treat everything as if it were "hot".

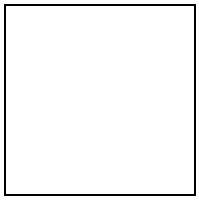
C. **Using Earth Materials**

1. Do not taste minerals or rocks for identification purposes.
2. Use soil testing kits in well-ventilated areas.
3. Use care in smelling odors or fumes from earth materials, use a wafting motion of the hand.
4. The use of ammonium dichromate even under a proper ventilating hood is discouraged.
5. Blow pipes should be sterilized after each use.
6. Avoid electrical equipment on stream tables.
7. Only authorized materials and equipment should be used.

D. **General Instructions**

The following procedures should be followed in the earth science lab:

1. Work areas should be kept clean and tidy
2. Students should always clean, and wipe dry all laboratory equipment
3. Broken class should be removed from the work area as soon as possible.
   never handle broken glass with bare hands, use gloves or a dustpan
4. Do not touch laboratory equipment until directed to do so



E. **Field Trips**

The following safety precautions must be taken to preclude accidents or injury on field trips:

1. Proper clothing and insect repellents should be worn. Follow the instructions given you.

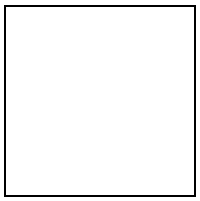
   a. To reduce mite or tick infestation, plant poisoning or scratches, students should wear clothing that covers the legs.

   b. Ankle-high shoes, sneakers or boots should be worn.

   c. Wear clothing that will prevent overexposure to the sun's radiation.

2. Collecting specimens.

   a. Paper, cloth, or plastic bags and plastic vials should be used. Glass is not safe and must be avoided.



3. Buddy system.

WARNING

   a. When taking a field trip involving wading, the buddy system should always be used. Pair off swimmers with non-swimmers. If the water is over knee depth, non-swimmers should wear U.S. Coast Guard approved life jackets.

   b. When in water, caution students of possible slipping on rocks on the bottom of ponds or streams.

4. Supervision.

   a. No more than 10 students per teacher or adult supervisor.

   b. The field leader should not be responsible for students.

5. Equipment for field trip - the following is a partial list of necessary safety equipment:

   a. First aid kit

   b. Proper collecting equipment

   c. Long rope attached to a floating ring (when near water)

   d. Emergency transportation provisions should be made before going on the trip

6. Emergency

   a. Copy of Student Emergency Card or emergency information there on.

   b. The School Nurse Handbook contains the emergency procedure which must be followed in the event of any emergency.

CHAPTER FIVE
BIOLOGY/LIFE SCIENCE INSTRUCTIONS

Safety considerations in the biology laboratory principally concern the use of chemicals or chemically preserved specimens, of glassware, of electrical equipment, of radioactive material, or the handling of living organisms and human body fluids. Safety precautions for the use of chemicals, glassware, and electrical equipment contained in the Chemistry and Physics sections of this manual apply with equal validity to the biology laboratory.

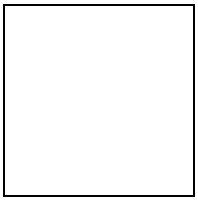
PLEASE READ CHAPTER I AND II THOROUGHLY FOR GENERAL INFORMATION AND PROCEDURES.

A. General Safety Hints

The following is a list of general safety hints pertinent to work in the biology laboratory. Although many may appear obvious and others are covered in detail in other parts of this manual, they are compiled here as a guide for student instruction in laboratory safety.

1. **Eye protection:** The use of anti-splash goggles is required of everyone in the biology/life science room when corrosive chemicals, hot liquids or solids are being used, liquids or solids are being heated in vessels subject to heat fracture, heating or cutting glassware, or when manipulating specimens stored in preservative chemicals. **Face shields and safety glasses are secondary not primary protection.**

ANTI-SPLASH GOGGLES



2. **Do not drink from laboratory equipment. Do not eat or drink in the lab – period!**

3. **Clean up spills:** Spilled chemicals should be cleaned up immediately using the following procedure:

    a. Mercury Clean-Up: The Delaware State Department of Public Health, Division of Environmental Health recommends that in the event of a mercury spill the teacher should quadrant off the are and Environmental Response should be called 739-3694. They will come and clean up the spill. All attempts should be made to avoid aerosolizing the mercury.

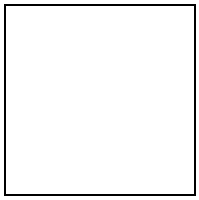
Toxic Vapors

Acute exposure to mercury vapors occurs when the unconfined metal is exposed to high temperatures, e.g., a broken thermometer in a hot oven or a container of hot liquid. In cases of this kind the area should be **immediately** evacuated. Cleanup operations should be undertaken only after temperatures have been reduced and the area thoroughly ventilated.

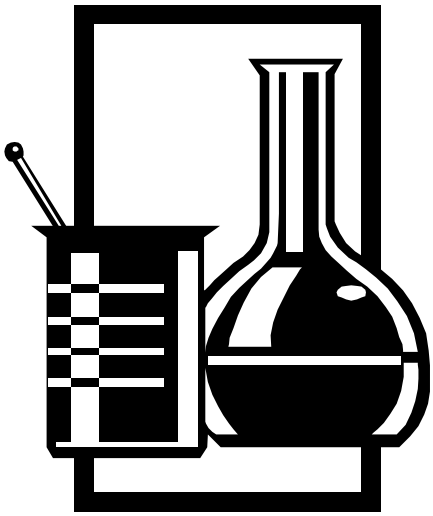
4. **Never pipette by mouth:** Never pipette chemicals or cultures by mouth. Use aspirator bulb or pipette filler.

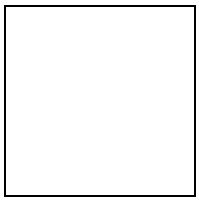
5. **Never point test tubes:** Never point test tubes containing reagents or hot water at anyone while heating. Never look down into such a test tube.

6. **No flammable solvents in refrigerator:** Flammable solvents cannot be stored in the household type refrigerator used in laboratories. Doors of such refrigerators should be conspicuously labeled with this warning



DO NOT MOUTH PIPETTE



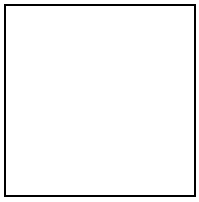


7. **Examine equipment for defects:** Examine tubing, glassware, electrical wiring, and apparatus assemblies periodically for defects.

8. **No flames around flammable solvents:** Make certain that there are no open flames or sparking electrical equipment when flammable vapors are present.

9. **Inspect glassware:** Use only glassware that is free from nicks, scratches, and cracks.

10. **Wash hand:** Hands should be thoroughly washed at the end of each laboratory period. Those teachers using chicks or eggs from any source should instruct their students to wash their hands thoroughly after working with them. The use of disinfectant soap is recommended. Students should be warned to keep their hands away from their face and mouth during laboratory work. These precautions are necessary because of the risk of Salmonella contamination of eggs and chicks.



11. **Gas and electrical precautions:** Make sure all gas outlets are closed and electrical switches are turned off after use. When changing aquarium lamps, cleaning filters, or any type of procedures other than routine feeding, etc., disconnect all aquarium plugs to prevent electrical shock.

12. **Label chemicals:** All chemicals and solutions must be labeled. All dangerous chemicals must be kept in a locked cabinet or storeroom.

13. **Acid into water:** Always pour **acid into water** with constant stirring while making dilutions. Never pour water into acid.

14. **Supervision by professionals:** Any special student projects which involve anesthetic drugs, surgical procedures, pathogenic organisms, toxicological products, carcinogens, or radiation should be undertaken only if under the direct supervision of a professional who is trained and qualified in the special experimental procedures required.

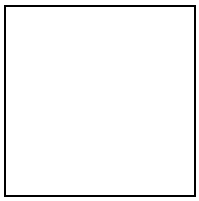
B. **Safe Handling of Equipment**

1. **Bunsen burners:** The students should be thoroughly indoctrinated in the proper use of the Bunsen burner. Bunsen burners, if improperly handled, are dangerous. They should be kept well back from the front of the laboratory bench and secured from tipping. It is suggested that only soft rubber hose be used for Bunsen burner connections. Semi-rigid, woven-cover type connectors aggravate the risk of tipping and are not recommended. Prior to using the Bunsen burner, the hose and hose connections should be checked for possible leaks.

   The spark lighter should be ready before turning on the burner so that it can be lighted promptly before there is a dangerous accumulation of gas. Since there is a constant risk of clothing catching fire, students should be cautioned of the danger of leaning over or reaching over a lighted burner. Hair sprayed with aerosol setting preparations is especially flammable and creates a special hazard when working with Bunsen burners. Loose clothing must not be worn. Matches should not be used to light burners.

   Students should be taught to recognize when the burner "strikes back" (burns at the spud) and warned to shut off the gas immediately, and not to touch the barrel of the burner. Flame spreaders (wing tops) become very hot during operation and should be allowed to cool thoroughly before being removed.

   Lighted burners should never be left unattended; furthermore, it should be required that the student check the gas valve before securing his station. Students should be given instructions that burners must be turned off at the gas jet and not on the burner itself. A master gas valve should be installed in each science room. It is excellent practice for the teacher to keep this valve closed except when laboratory work is in progress.



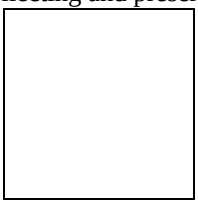
2. **Alcohol lamps: USE IS STRONGLY DISCOURAGED.** Some schools choose to use alcohol lamps at times. Caution is urged when student use is required as there is danger unless special precautions are taken in filling and lighting the lamps. When filling a lamp, no flame should be present in the immediate area. In addition, teachers should refrain from using large open containers to fill the lamps. Small glass bottles or plastic squeeze should be used for such purposes.

CAUTION

3. **Pressure cookers and autoclaves:** Before anyone is allowed to operate a pressure cooker or autoclave, they should be thoroughly familiarized with the operating instructions. The safety valve should always be checked prior to building up pressure. Final pressure should not exceed twenty pounds. The heater should be turned off before removing the clamps and opening the vessel, allowing the pressure to return to normal so that the stopcock can be opened. Use approved eye protection when working with the cooker or the autoclave, under pressure.

4. **Insect killing jars:**

a. Students, either for science projects or for classroom study, often need to be familiar with the proper method of collecting and preserving insects.



b. A safe type of killing jar can be made by using any clean, large, screw-type lid jar (mayonnaise jars are quite acceptable). A tissue is placed in the bottom to absorb the killing liquid. Several liquids can be used to provide the lethal vapors; ethyl acetate, or ethyl alcohol. The killing liquid is added to the tissue in the bottom of the jar -- about six drops is generally satisfactory. A clean tissue is placed on top of the tissue containing the liquid to keep the insects dry. The jar must be labeled DANGER, POISONOUS FUMES, DO NOT BREATHE. Caution students not to breathe the vapors. Jars should be prepared in advance by the teacher.

c. It is a simple task to recharge the jar with lethal fumes by removing the top tissue and adding a few more drops of the killing liquid. A clean tissue is then replaced and the jar is again ready for use.

d. Alternate method of preparing insect killing jars: place one to one and one-half inches of plaster of paris in bottom of glass jar. Use ethyl acetate which will be absorbed by the plaster of paris. Pour off any excess. These jars last ten months.

C. **Safety Suggestions for Specific Experiments**

1. **Dissections:** In performing dissections the students should be instructed to:

   a. Use care when handling all dissection instruments. Remember, scalpels are used to cut flesh and can cut yours if you are not careful!

   b. Always cut down on the specimen to be dissected against a waxed pan or similar holding item.

   c. Always cut away from the body.

   d. Keep the unoccupied hand away from the cutting edge of the dissecting tool.

   e. Take special care to avoid cuts and scratches when cleaning equipment.

   f. At the end of a laboratory period, students must wash their hands thoroughly with soap and scrub under the fingernails.

   g. If a student is cut they should report directly to the school nurse.

   h. **Store dissecting instruments under lock and key** and constantly monitor the inventory.

   i. It is suggested that teachers be aware of the **tetanus status** of their students in the event of a cut or puncture as might be received during a dissection.

   j. Encourage the use of plastic, disposable, gloves for dissections. Inexpensive sources are available. Students with cuts or scratches must be required to wear gloves during dissections.

k. Use only single-edged razor blades with a rigid reinforced back

l. NEVER USE DECAYED OR DECAYING SPECIMEN for dissection. Fresh or preserved specimens are required.

2. **Preserved Specimen** **OSHA**

a. SPECIMEN PRESERVED IN FORMALIN SHOULD NOT BE USED FOR DISSECTIONS SINCE IT IS A SUSPECTED CARCINOGEN. Use only specimen that are preserved in non-toxic shipping and holding fluid.

b. It is strongly recommended that students use gloves and anti-splash goggles for dissections.

c. **Adequate ventilation** in the room is also necessary. The teacher needs to remain alert for students who have problems with nausea, breathing, headache, or dizziness.

d. Even specimens that are stored in non-toxic shipping fluid were most likely originally fixed in formalin (formaldehyde). The possibility of residual formalin necessitates the use of a washing procedure. **Wash all preserved specimen at least one full hour before using in a running flow of water.** Use gloves to handle both the unwashed and washed specimen.

e. Efforts should be made to eliminate the use of materials that contain formalin. Ward's Natural Science Establishment provides specimens that are freeze-dried and can be re-hydrated in a 10% isopropyl solution. In these specimens no other hazardous chemical is present. Another dissection alternative is to use organisms such as frozen squid that are available at local grocery stores.

3. **Bacterial or Viral Cultures**

a. **Organisms that are pathogenic to humans should never be used for class study.** Special care should be taken not to inadvertently introduce pathogens to the classroom. For this reason, random sampling of bathrooms, fountains, floors, etc., is not suggested. Many pathogens are dormant until incubated and given appropriate nutrients. Do not use blood agar plates. Do not attempt to cultivate organisms from a human or animal source.

b. Demonstrate correct aseptic technique to students prior to conducting an investigation. Never transfer liquid media by mouth or mouth suction. Wash the lab surface with a disinfectant before and after handling bacterial cultures.

c. All microbe cultures and any equipment or glassware that is suspected of microbial contamination must be sterilized before they are discarded or washed. Autoclave or steam-sterilize all used cultures, equipment, or glassware at 121 degrees Celsius at 15 psi for at least 15 minutes. A pressure cooker with a release valve is a cost effective alternative to an autoclave. If these devices are not available, flood or immerse these articles in either chlorine laundry bleach or 70% isopropyl alcohol for 30 minutes. While sterilizing cultures, keep them covered and in a fume hood. CAUTION: Alcohol is flammable. Do not allow students to use steam sterilizers.

d. When allowing students to observe cultures in tubes or petri dishes the specimen should be sealed and/or taped shut. It is not recommended that the samples be passed around the room because they may be dropped.

e. Wire inoculating loops are a potential source of aerosol contamination. Require the students to wait for the loop to cool before introducing it into a liquid culture or colony on a plate or slant. **Loops and needles must be flamed both before and after use.** The use of alcohol burners for flaming inoculating loops is not recommended.

f. Viral cultures grown in embryonated eggs can be extremely dangerous. The infected eggs have a concentrated viral population and the shell is a fragile protection. It is strongly suggested that any **viral studies be carried out only when using a ventilated safety cabinet with a fume hood designed to exhaust into a filter and only if an autoclave is available to decontaminate equipment and ultraviolet lighting system to decontaminate working surfaces.**

g. The use of relatively inexpensive pre-sterilized plastic Petri dishes and disposable glass culture tubes eliminates some sterilization and disposal problems and reduces preparation time required for microbiology studies.

h. Never allow students to clean up bacteriological spills. Keep on hand a spill kit containing 500 ml of chlorine type laundry bleach, bio-hazard bags (auto-clavable), forceps, and paper towels. In the event of a bacteriological spill, cover the area with a layer of paper towels. Wet the paper towels with the disinfectant and allow to stand for 20 minutes. While wearing gloves and using forceps, place the residue in the bio-hazard bag. Autoclave the bag and its contents.

i. Consult with the school nurse to screen students who might be receiving immuno-suppressive drug therapy that could lower immune response. Such individuals are extraordinarily sensitive to potential infection from non-pathogenic organisms and should not be permitted to participate in laboratory investigations involving microorganisms unless permitted to do so by a physician. Do not allow students with cuts, abrasions, or open sores to work with microorganisms.

4. **Epithelial Cell Study**

a. Great care should be exercised in securing epithelial cells from the inside of the cheek for study under the microscope. Students should be cautioned against gouging the cheek tissue.

b. Since HIV virus has been isolated in saliva, it and cheek cells, are considered hazardous. Caution students to keep toothpicks separate and not to lay them down where others may touch or use them.

c. Only clean wood splints or the blunt edge of a flat toothpick should be used; pointed instruments, parts of a scalpel, or other instruments, should never be used for this purpose.

d. The splints used to collect the cells should be treated as contaminated waste and placed in a special container and sterilized prior to discarding. Glass slides and coverslips should be collected in a special container and sterilized prior to reuse. Refer to bacterial and viral sterilization procedures in Section 3 (c) on page 64.

5. **Pollen and Mold Spores**

In handling flowers, and other pollen-producing plants and mushrooms as well as spore-producing fungi, care should be taken that pollen or spores are not disseminated throughout the classroom. Many people are allergic to either pollen, mold spores, or to both.

6. **Osmosis Experiments**

a. Great care should be exercised in inserting the thistle tube through the rubber stopper. Do not grasp the thistle tube near the rubber stopper. Wet it beforehand with water, glycerine, or soap solution. For further protection, the tubing could also be wrapped with cloth.

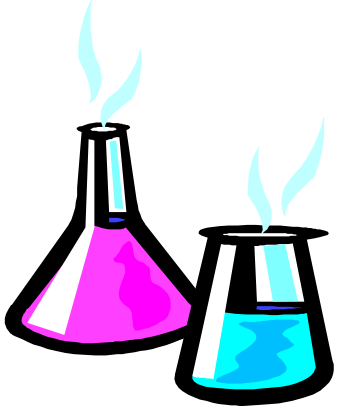
b. Only fresh materials should be used at all times. Do not use decayed or decaying material. Keep the materials in a refrigerator, if used more than one day place in a non-toxic preservative.

7. **Extraction of Chlorophyll and Paper Chromatography**

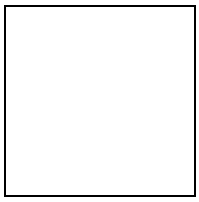
FLAMMABLE vapors

a. Only Pyrex or other hard glass test tubes should be used.

b. Use an electric heater of the immersion type or a water bath heated by an electric hot plate instead of an open flame or a gas heated water bath for heating the alcohol.



c. Keep open flames away from the alcohol and alcohol vapors. If alcohol ignites in a beaker, cover the beaker with a glass plate to extinguish. If burning alcohol runs over the table, use a fire blanket.



d. Some of the solvents used in paper chromatography of chlorophyll pigments are highly flammable and should be kept away from open flame. These solvents give off toxic vapors and should be kept in closed containers and used only under a fume hood.

e. The use of non-toxic water soluble food colors and water soluble marking pen "ink" for paper chromatography is much safer than using the hazardous solvents necessary for extracting and separating plant pigments.

8. **Human Blood Sampling** (Check local regulations)

a. With the concern for the transmission of the Human Immuno-deficiency Virus (HIV) which causes Acquired Immuno-deficiency Syndrome (AIDS), it is recommended that human blood not be used in the laboratory for any procedures including blood typing and microscopic analysis. Although it is indeed difficult to contract AIDS when carefully following blood handling procedures, there is always a chance of transmission through carelessness, student pranks with lancets, exposure to the virus while cleaning slides, etc. The message should be conveyed to students that the disease is incredibly hazardous and that the classroom is one arena where precaution is stressed.

b. Blood typing can be covered by using videos or by using simulation labs such as the one described in The American Biology Teacher, April 1989, in the article "A Simulation of the Blood Type Test" by John D. Sharpe and Deborah L. Smailes.

c. **The use of disposable lancets is mandated for this activity.** Each lancet should be used only for one person and then carefully and deliberately discarded, that is, all lancets should be accounted for and placed in an appropriate disposal container.

d. The surface of the finger from which blood is withdrawn must be rubbed with sterile absorbent cotton dipped in 70 percent alcohol before removing blood. The purchase of pre-packaged, sterile alcohol pads is recommended. Use a fresh piece of sterile absorbent cotton dipped in 70 percent alcohol after removing blood.

9. **Histology**

a. The histologic preparation of tissue involves securing a tissue sample, slicing the tissue into sections, staining and mounting it on a slide and label preparation. The use of dehydration chemicals and the microtome in these procedures poses special safety considerations.

b. The dehydrating chemicals include a series of alcohols and xylene. These are volatile substances and a fume hood should be used to prevent breathing these chemicals and to reduce fire hazards.

c. The microtome is an extremely sharp metal or glass instrument capable of slicing tissues to very exact thickness. Since the automatic or semi-automatic instruments can easily amputate a finger, great care and supervision are needed when using these tools.

10. **Taxidermy**

a. Road killed animals should never be used by students in the classroom. It would be impossible for the teacher to know if the animal was killed because disease had affected its health, thus making the road accident more likely.

b. Only borax based drying and preserving agents should be used on hides and skins. Arsenic compounds, which are used by professional scientists, are not appropriate for use by middle and high school students.

c. Plastic gloves should be worn and care should be taken not to cut the hands with sharp dissecting instruments. These procedures are necessary to reduce the risk of infection from diseased animals.

11. **Tissue Culture**

a. Plant growth substances (hormones)

1. Some plant growth substances are toxic. Although they are normally used in very low concentrations in experiments and media, technicians and teachers should always handle solids or concentrated stock solutions with care. Appropriate precautions should therefore be taken to avoid the formation and inhalation of dust or aerosols. It is recommended that plastic gloves are worn when appropriate. Spills should be cleaned up promptly, removing any solid material first, then washing the area with plenty of water.

D. **Dangerous Chemicals and Radioisotopes**

1. **Dangerous chemicals:** The labels on all chemicals should be carefully read and double checked before use, with special attention being paid to specific precautions of danger. The following chemicals commonly used in biology laboratories are worthy of individual comment:

a. **Carbon tetrachloride:** Carbon tetrachloride is both a highly toxic compound and a probable carcinogen, and should be replaced with safer materials. Ethyl acetate is recommended as an insect killer in place of carbon tetrachloride. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

Toxic Vapors

b. **Millon's reagent:** Used in protein identification. Contains mercury and as such is toxic. Should be purchased already prepared. Biuret reagent is recommended instead of Millon's reagent. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

c. **Ninhydrin:** This chemical presents a health hazard in vapor form. Care should be exercised not to inhale vapor, especially when dispensed from an aerosol can. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

d. **Phenol:** This is a toxic and corrosive chemical which will cause severe skin damage. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

CAUSTIC

CAUTION

WARNING

OSHA

suspected Carcinogen

e. **Colchicine:** The skin and especially the eyes should not be exposed to this substance because of its toxic and mutagenic nature. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

f. **Carnoy's solution:** Used in root tip cell squash preparation. This solution contains acid, mercury, and chloroform, and is both highly toxic and flammable. In addition, chloroform is suspected of being a carcinogen. **THE USE OF THIS CHEMICAL IS DISCOURAGED.**

g. **Formaldehyde:** Formaldehyde has been reported to be carcinogenic in animals. In addition, its vapors are toxic and irritating. Adequate ventilation is necessary. Preserved specimens should be rinsed in fresh water before use. Specimens can be removed from formalin solution with tongs or tweezers. Rubber gloves and anti-splash goggles should be worn.

Avoid storing hydrochloric acid anywhere in the vicinity of formaldehyde or specimens preserved in formaldehyde, because the very potent carcinogen, bis (chloromethyl) ether, is formed as hydrochloric acid and formaldehyde react in air.

IT IS STRONGLY RECOMMENDED THAT THE USE OF THIS SUBSTANCE BE DISCONTINUED. Other, non-toxic, preservatives are available.

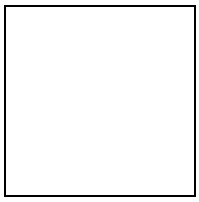
h. **Benzene:** Benzene is a suspected carcinogen, and should be replaced with other solvents such as toluene or cyclohexane. **THE USE OF THIS SUBSTANCE IS STRONGLY DISCOURAGED.**

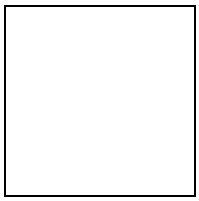
i. **Chloroform:** Chloroform is a suspected carcinogen. **IT'S USE IS STRONGLY DISCOURAGED.**

j. **Fehling's solution and Biuret test solution:** These solutions are caustic and require caution, especially when hot.

k. **PTC Paper:** Phenylthiocarbamide is used as a commercial rodent killer. It has been used in genetics units to study tasting and nontasting traits. This practice should be discontinued. Students should NEVER taste this paper.

l. **Ether:** Ether vapors are narcotic and highly explosive. Adequate ventilation is absolutely essential. Special precautions required in the storage and handling of ether are described in the Chemistry Section. Carbon dioxide and other commercially available substances may be used as a substitute in anesthetizing Fruit Flies. As ether ages it forms explosive peroxides. Discard supplies of ether every 3-6 months and purchase minimum quantities. **THE USE OF THIS SUBSTANCE IS DISCOURAGED.**



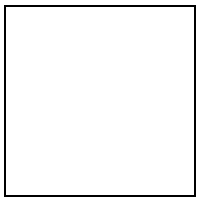


2. **Radioisotopes:** The kinds and amounts of radioisotopes that may be obtained are regulated by law. These materials should be treated with the highest respect. The instructions contained in Chapter I, pages 9-15, on the procurement, handling, and disposal of radioisotopes will be strictly followed in biology tracer experiments and investigations.

E. **Live Animals**

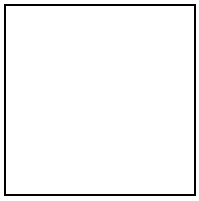
1. **Permission:** One preventive measure practiced by many schools is a policy which requires permission of the principal before any warm-blooded animals (including birds) can be kept in a classroom, and that once this is done, the animals cannot be kept there for more than fourteen days. This should be supplemented with the requirement that all wild animals should be held in isolation outside the classroom for at least a week before being brought in. All animals should be purchased from a reputable supply house and the presence of wild animals in the classroom should be avoided.

2. **Wild animals:** Potential danger exists with animals brought in by students who find birds, raccoons, squirrels, opossums, mice and others that have been struck by a car or are otherwise too weak to escape a child's enthusiasm. Students should be discouraged from handling wild animals. Animal weaknesses may be due to an undetected illness. Animal diseases may include ringworm, rabies, rabbit fever, and a host of others that can be carried by vectors parasitizing the weakened animals. Fleas may carry worms which can be inhaled or swallowed by students. These may result in fatalities not associated with the prior handling of animals, including dogs and cats. Ticks and mites can fall into the clothing of a student and later attach themselves behind the student's ear or to other creases and folds of the body. Students should be discouraged from handling dead or wild birds and mammals. These animals should not be brought into the classroom for study.



3. **Hazards caused by improper feeding and watering:** If mice, rabbits, gerbils, and guinea pigs, common animals found in laboratories, are not fed properly or have been deprived of water, as may happen over a weekend, they may scratch or bite the student handling them. Finding some of the remains of one of the animals is an indication of water deprivation and is a threatening possibility. Extreme care must be taken in working with such animals in the immediate future, including watering them. Any student bitten by any animal should be attended to in accordance with recommended procedure as stated in School Nurse Handbook immediately, with a report filed as to the source of the wound. The animal should NOT BE DESTROYED, but should be kept especially safe until examined by authorities.

4. **Disinfect cage:** After an animal has been kept in a cage, the cage should be thoroughly cleaned, using strong detergents and germicides. If possible, the cage should be boiled or scrubbed with boiling water. It is quite possible that the first animal may leave behind an infectious organism which the newly introduced animal can transmit to the teacher or students.



5. **Danger signs:**

   a. Unusual odor emanating from the cage.

   b. Animal is sluggish, unresponsive.

   c. Constant or unusual bickering or fighting between inmates. (Not to be confused with peck order behavior).

d. Loss of appetite.

e. Hair, eyes or skin change color with an unhealthy pallor.

f. Unusual discharges from body openings.

g. Fellow inmates dead or body remnants in cage.

h. Frequent sneezing.

6. **Student's role:** There should be no question about a student's role in caring for the animals in a laboratory. A specific routine should be posted with emphasis on scrubbing the hands after handling the cage or animals. Providing proper care and regularly feeding and providing fresh water will lessen the chance of having sick animals. This will considerably help to control diseases.

Before a student is allowed to work with animals, there should be instruction in the proper methods of handling and carrying. Leather gloves should be worn when working with live animals.

WARNING

7. **Don't treat laboratory animals as pets:** A laboratory animal is NOT A PET. If it is treated as a pet, then it serves little purpose as a laboratory animal and can create a psychological situation that is unwarranted. If the animals have been used as laboratory objects, they are not used to being handled often and may bite or scratch unintentionally.

Before a vertebrate is used in any type or experiment, policy and regulations should be checked out at the school, county and state level.

Any animal that has been part of an experiment, whether it be one relating to behavior or a response to some chemical agent, usually undergoes a change which will alter its normal behavior. This is especially true of old or introduced wild animals. It is unwise to:

* Handle nursing females.

* Try to "cure" an animal brought in by a student.

* Mend a suspected "broken bone" in a wild animal.

* Dissect an animal found injured along a highway.

* Pet and cuddle wild or laboratory animals.

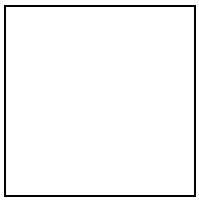
8. **Marine animal, reptile, and insect hazards:** With the increasing interest in marine biology, many students have been bringing in a variety of fish, sea urchins, mollusks, etc., to class. Although these animals ordinarily do not attack the collector directly, each should be handled with care. An octopus can inflict a sharp wound. Spines of fishes and urchins can cause very painful infections due to the foreign proteins carried into the body during penetration. Even living mollusks can inflict a dangerous wound. Only incomplete records prevent knowing how many people have suffered from wounds acquired while handling marine organisms.

This includes allergic responses to such things as seemingly harmless egg cases of whelks and the clusters of algae that may hide many marine worms. The symptoms are usually identified by itching, swelling of the hands and a slight headache.

allergy
CAUTION

The following is a partial list of organisms known to cause harmful reactions when handled carelessly.

Ants
Bedbugs
Bees
Black Widow Spider
Blister Beetles
Brown Recluse Spider
Centipedes
Chiggers
Clams
Copperhead Snake
Coral Snake
Cottonmouth Snake
Fleas
Gnats
Ioa Caterpillar
Jelly Fish
Millipede
Mosquitoes
Mussels*
Netting Caterpillar
(Slug Caterpillar)
Oysters*
Pussmoth
(Saddleback
Caterpillar)
Potato Beetles
Rattlesnake
Ticks (Dermacenter
and Ixodidae)
Wasps
Yellow Jackets



Fishes known to cause poisoning. This usually depends on where fish has been caught and its diet*.

Barracuda
Butterfly fish
Goat fish
Moon fish
Moray eel
Parrot fish
Perch
Pompano
Porcupine fish
Puffers
Sea Bass
Snapper
Sting Rays
Surgeon fish
Triggerfish
Wrasse

*When living in polluted water or feeding on certain dinoflagellates.

9. **NABT GUIDELINES FOR THE USE OF LIVE ANIMALS:**

The following guidelines were developed by the National Association of Biology Teachers and revised in January 1990.

Living things are the subject of biology, and their direct study is an appropriate and necessary part of biology teaching. Textbook instruction alone cannot provide students with a basic understanding of life and life processes. The National Association of Biology Teachers recognizes the importance of research in understanding life processes and providing information on health, disease, medical care and agriculture.

The abuse of any living organism for experimentation or any other purpose is intolerable in any segment of society. Because biology deals specifically with living things, professional biology educators must be especially cognizant of their responsibility to prevent the inhumane treatment of living organisms in the name of science and research. This responsibility should extend beyond the confines of the teacher's classroom to the rest of the school and community.

The National Association of Biology Teachers believes that students learn the value of living things, and the values of science, by the events they witness in the classroom. The care and concern for animals should be a paramount consideration when live animals are used in the classroom. Such teaching activities should develop in students and teachers a sense of respect and pleasure in studying the wonders of living things. NABT is committed to providing sound biological education and promoting humane attitudes toward animals. These guidelines should be followed when live animals are used in the classroom:

a. Biological experimentation should be consistent with a respect for life and all living things. Humane treatment and care of animals should be an integral part of any lesson that includes living animals.

b. Exercises and experiments with living things should be within the capabilities of the students involved. The biology teacher should be guided by the following conditions:

   1) The lab activity should not cause the loss of an animal's life. Bacteria, fungi, protozoans and invertebrates should be used in activities that may require use of harmful substances or loss of an organism's life. These activities should be clearly supported by an educational rationale and should not be used when alternatives are available.

   2) A student's refusal to participate in an activity (e.g., dissection or experiments involving live animals, particularly vertebrates) should be recognized and accommodated with alternative methods of learning. The teacher should work with the student to develop an alternative for obtaining the required knowledge or experience. The alternative activity should require the student to invest a comparable amount of time and effort.

c. Vertebrate animals can be used as experimental organisms in the following situations:

   1) Observations of normal living patterns of wild animals in their natural habitat or in zoological parks, gardens or aquaria.

   2) Observations of normal living functions such as feeding, growth, reproduction, activity cycles, etc.

3) Observations of biological phenomenon among and between species such as communication, reproductive and life strategies behavior, interrelationships of organisms, etc.

d. If live vertebrates are to be kept in the classroom the teacher should be aware of the following responsibilities:

1) The school, under the biology teacher's leadership, should develop a plan on the procurement and ultimate disposition of animals. Animals should not be captured from or released into the wild without the approval of both a responsible wildlife expert and a public health official. Domestic animals and "classroom pets" should be purchased from licensed animal suppliers. They should be healthy and free of diseases that can be transmitted to humans or to other animals.

2) Animals should be provided with sufficient space for normal behavior and postural requirements. Their environment should be free from undue stress such as noise, overcrowding and disturbance caused by students.

3) Appropriate care - including nutritious food, fresh water, clean housing and adequate temperature and lighting for the species - should be provided daily, including weekends, holidays and long school vacations.

4) Teachers should be aware of any student allergies to animals.

5) Students and teachers should immediately report to the school health nurse all scratches, bites and other injuries, including allergies or illnesses.

6) There should always be supervised care by a teacher competent in caring for animals.

e. Animal studies should always be carried out under the direct supervision of a biology teacher competent in animal care procedures. It is the responsibility of the teacher to ensure that the student has the necessary comprehension for the study. Students and teachers should comply with the following:

1) Students should not be allowed to perform surgery on living vertebrate animals. Hence, procedures requiring the administration of anesthesia and euthanasia should not be done in the classroom.

2) Experimental procedures on vertebrates should not use pathogenic microorganisms, ionizing radiation, carcinogens, drugs or chemicals at toxic levels, drugs known to produce adverse or teratogenic effects, pain causing drugs, alcohol in any form, electric shock, exercise until exhaustion, or other distressing stimuli. No experimental procedures should be attempted that would subject vertebrate animals to pain or distinct discomfort, or interfere with their health in any way.

3) Behavioral studies should use only positive reinforcement techniques.

4) Egg embryos subjected to experimental manipulation should be destroyed 72 hours before normal hatching time.

5) Exceptional original research in the biological or medical sciences involving live vertebrate animals should be carried out under the direct supervision of an animal scientist, e.g., an animal physiologist, or a veterinary or medical researcher, in an appropriate research facility. The research plan should be developed and approved by the animal scientist and reviewed by a humane society professional staff person prior to the start of the research. All professional standards of conduct should be applied as well as humane care and treatment, and concern for the safety of the animals involved in the project.

6) Students should not be allowed to take animals home to carry out experimental studies.

f. Science fair projects and displays should comply with the following:

1) The use of live animals in science fair projects shall be in accordance with the above guidelines. In addition, no live vertebrate animals shall be used in displays for science fair exhibitions.

2) No animal or animal products from recognized and endangered species should be kept and displayed.

It is recommended that life science and biology teachers obtain a copy of NABT's Monograph IV, The Responsible Use of Animals in Biology Classrooms Including Alternatives to Dissection, 1990. This 146 page publication contains information on the procurement and maintenance of animals, accidents involving animals, disposal of dead animals, animal diseases, lessons that provide alternatives to dissection, ethical considerations, and a list of sources for teaching materials.

Additional information on the use of live animals has been developed by The National Academy of Science, National Research Council, Institute of Laboratory Animal Research, International Science and Engineering Fair and the Intel Science Search.

10. **NABT Policy Statement on Animals in Biology Classrooms**

The following policy statement was approved by the National Association of Biology Teachers' Board of Directors, October 1995.

Policy Statement

The Use of Animals in Biology Education

(Approved by NABT Board of Directors, October, 1995)

The National Association of Biology Teachers (NABT) believes that the study of organisms, including nonhuman animals, is essential to the understating of life on Earth. NABT recommends the prudent and responsible use of animals in the life science classroom. NABT believes that biology teachers should foster a respect for life. Biology teachers also should teach about the interrelationship and interdependency of all things.

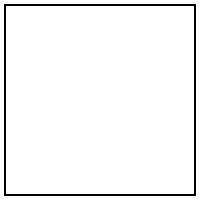
Classroom experiences that involve nonhuman animals range from observation to dissection. NABT supports these experiences so long as they are conducted within the long established guidelines of proper care and use of animals, as developed by the scientific and educational community.

As with any instructional activity, the use of nonhuman animals in the biology classroom must have sound educational objectives. Any use of animals, whether for observation or dissection, must convey substantive knowledge of biology. NABT believes that biology teachers are in the best position to make this determination for their students.

NABT acknowledges that no alternative can substitute for the actual experience of dissection or other use of animals and urges teachers to be aware of the limitations of alternatives. When the teacher determines that the most effective means to meet the objectives of the class do not require dissection, NABT accepts the use of alternatives to dissection including models and the various forms of multimedia. The Association encourages teachers to be sensitive to substantive student objections to dissection and to consider providing appropriate lessons for those students where necessary.

To implement this policy, NABT endorses and adopts the "Principles and Guidelines for the Use of Animals in Precollege Education" of the Institute of Laboratory Animals Resources (National Research Council). See ***Appendix K**, pg. 132.*

F. **Poisonous Plants**



Poison ivy, poison oak and poison sumac are well-advertised outdoor dangers. But growing around them, in woods, fields, backyards, and even in the home, are some 700 other species of plants known to cause death or illness.

Each year, according to the U.S. Public Health Service, about 1,200 children chew or swallow these potentially poisonous plants. Many are made violently sick: some die. Yet in most cases the children's parents don't even know that the plants are dangerous. Many of these plants grow in millions of backyards.

1. **Common rules:** Since **ALL** plants have not been thoroughly researched for their toxicity, a few common rules are:

   a. Never eat unknown berries, seeds, fruits, mushrooms, or other plant parts.

   b. Never rub any sap or fruit juice into or on the skin or open wound.

   c. Never inhale or expose your skin or eyes to the smoke of any burning plant or plant parts.

   d. Never pick any strange wild flowers or cultivated plants unknown to you.

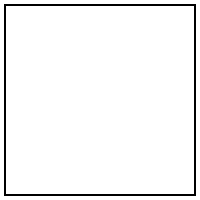
   e. Never eat food after handling plants without first scrubbing your hands.

The reason for these "NEVER" precautions is that **any part of a plant can be relatively toxic.**

toxic CAUTION toxic

2. **Insecticide contamination:** Since the parents of many students have gardens and use some dangerous insecticides, instructions should be given in the danger during handling or use. Students should be instructed that when working with plants that have been sprayed by insecticide they must take the same precautions that they would when working with any hazardous chemical substance.

3. **Signs of plant poisoning:** Teachers should become suspicious and act very quickly if they notice any of their students exhibiting any of the following signs of plant poisoning--constriction of pupils, increase in nasal and salivary secretions, sweating, gastrointestinal disturbance, tightness in the chest, muscle tremor, blueness around the lips and under the fingernails, or indications of convulsions. First Aid measures may have to be taken and the **POISON CONTROL CENTER, (302) 655-3389**, should be contacted immediately. This Center is open 24 hours a day.



4. **Specific poisonous plants:** ***Appendix D***, pages 106-109, contains a list of poisonous plants that could pose a threat to the safety of the student and teacher alike. This list is far from complete and any plants peculiar to your area should be added. The list reads somewhat like a garden catalog. **Flowering garden plants such as the daffodil, larkspur, iris, lily-of-the-valley, foxglove, wisteria, laurel, rhododendron, and azalea are poisonous if ingested.** Common trees, including the oaks, cherries, and black locust also present hazards. All are potential dangers, especially to young children with their natural urge to taste the unknown.

a. **A child may die from eating a few mistletoe berries. The berries of the yew may cause death if eaten because of the poisonous seeds they contain. The foliage of this common ornamental tree is also toxic.** Death is sudden, without warning symptoms.

b. Numerous wild mushrooms are also highly toxic and can cause severe gastric upset or even death if eaten. The mushrooms of the genus **Amanita** are particularly deadly, and are responsible for the majority of mushroom related deaths.

FATAL

c. For years, **poinsettia plants** were the subject of holiday warnings, but the traditional Christmas plant is no longer considered poisonous. Poinsettia isn't completely harmless, however. Ingestion can cause stomach irritation, and the sap can irritate the skin.

d. The National Safety Council points out that it's easy to be fooled by plants, because one part may be edible, another poisonous. **The twigs of cherry trees, on which any youngster might munch, release cyanide. Peach tree leaves contain hydrocyanic acid, one of the most dangerous poisons known.** Five children recently became ill after sipping "tea" brewed with peach leaves.

e. **Rhubarb** is another dangerous garden plant, but only in part. Its stalk, of course, is not toxic, but its leaves, which some have suggested could be eaten like spinach, can be fatal.

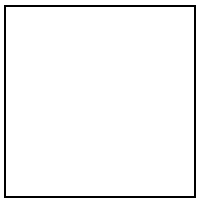
WARNING

f. The plant variously called **thorn apple, stinkweed, and jimson weed** deserves a place on the top ten list of outdoor dangers. First, because it grows almost everywhere; second, because **all its parts are poisonous.** Responsible for more poisonings than any other plant, it grows from 2 to 5 feet tall, has large leaves and funnel-shaped flowers resembling morning glories.

WARNING

g. If any plants on the list of poisonous plants are used or displayed in the laboratory, the teacher should inform his or her students about the dangers of these plants.

WARNING

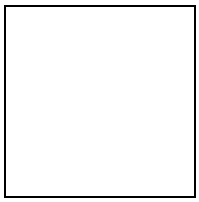


FATAL

CHAPTER SIX
EXTRACURRICULAR ACTIVITIES

The teacher can and should exercise direct control over student science activity in the classroom. However, many worthwhile and desirable science activities are indulged in by students outside the classroom and should be encouraged. Safety consciousness instilled as part of the science instruction program should be such as to influence these outside activities, even though, in some cases, no direct supervision or control is possible.

A. Field Trips



In addition to the administrative regulations governing students' field trips to places of interest in the local area, certain safety precautions must be taken to preclude accident or injury.

1. **Responsibility:** It should be kept in mind that field trips as a school activity are under school sponsorship and the school's responsibility for student safety is not abrogated. Government agencies and private industrial or research facilities usually assume no legal liability for the safety of visitors on their premises.

2. **Field trip permission forms:** Prior to departure on a field trip, the teacher should issue "Field Trip Permission Forms" to each participating student. These forms must be signed by the parent or guardian and returned prior to the trip. These permission slips, as the name implies, give parental approval for the student to make the trip, but in no way diminish the teacher's responsibility for safeguarding the students under his care.

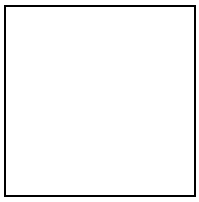
3. **Emergency Cards:** Important information regarding a student's state of health, medical problems, medication, allergies, phone numbers, etc., can be found on the Emergency Cards filed with the nurse. A teacher should have this information available when going on a field trip, as well as a copy of approved emergency procedures, available in the School Nurse Handbook.

4. **Transportation:** Transportation will normally be furnished by school buses. If none are available, commercial buses may be used. There must be an adult, teacher or parent, in charge of the students in each bus. **Using private automobiles for field trips is discouraged because the owner of the automobile is legally liable in case of accident.** Use of seat belts in private vehicles is required by State law. The fact that the automobile is being used for a field trip does not transfer liability to the Board of Education. If, however, it is decided to use private automobiles, an adult should be in charge of each car, and the permission form should specify that private automobiles are being used.

5. **Trips to wilderness areas:** On biology or geology field trips to wilderness or undeveloped areas, the following special precautions should be taken:

a. **First aid:** The teacher in charge should be trained in First Aid and equipped with a First Aid kit. CPR training is also recommended.

b. **Difficult terrain:** Students should be cautioned when required to walk or climb on marshy terrain, or rock or shale strewn slopes.

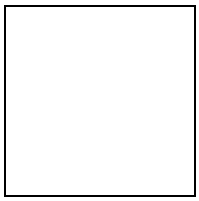


c. **Clothing:** Students should be required to wear stout shoes and clothing suited to the weather and terrain.

d. **Ticks:** If the trip is taken during tick season, the clothing should be tick-proofed as much as possible (buttoned collar, wrist and ankle bindings). Head coverings should also be worn. Proper insect repellents should be used at all times. Students need to inspect themselves for ticks before retiring.

INSTRUCTORS SHOULD BECOME FAMILIAR WITH THE SYMPTOMS OF ROCKY MOUNTAIN SPOTTED FEVER.

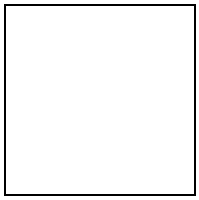
CAUTION



e. **Poisonous plants:** Students should be thoroughly indoctrinated in the recognition of poison ivy, poison sumac, and poison oak. After field trips where exposure to poison ivy, etc., is probable, immediately on return the students should lather the exposed parts of the body with strong laundry soap such as Fels Naphtha. The lather should be allowed to dry, washed off, and the treatment repeated several times.

INSTRUCT STUDENTS NEVER TO EAT ANY BERRIES OR LEAVES OF PLANTS. MANY PLANTS ARE HIGHLY POISONOUS AND INGESTION CAN BE FATAL.

f. **Poisonous snakes:** Students should be taught how to recognize and avoid poisonous snakes of the types indigenous to this area, water moccasins and copperheads.



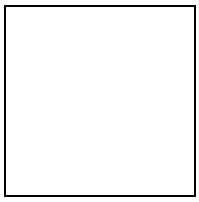
g. **Rendezvous point:** Special precautions should be taken to familiarize students with the general area. Prior arrangements should be made for rendezvous in case students are separated from the group. Set up a "buddy system."

B. **Home Laboratories**

The teacher should discourage ALL unsupervised experimentation, and under no circumstances assign or give extra credit for home labs.

Although the teacher cannot, obviously, exercise direct control over experimentation conducted by students in home laboratories, he/she should make every effort to impress upon the students that safety procedures and techniques necessary in the school laboratories are even more important at home, since such experimentation is usually undertaken without supervision.

1. **Dangerous household chemicals:** Ordinarily, home chemistry sets for young people contain comparatively harmless chemicals. The manuals accompanying these sets usually give complete directions for numerous experiments using only the materials provided, and as long as directions are followed, no danger is likely. However, some youngsters want to pursue, chemistry beyond the provided instructions. Many common household chemicals can be dangerous in combination. Household ammonia, bleaching and dye preparations, lye, preparations for cleaning clogged drains, plant sprays, rat and insect poisons, disinfectants, chemicals in matches and fireworks, turpentine, paint removers, and some garden fertilizers can be mixed to produce hazardous products.



2. **Dangerous mail order chemicals:** For as little as a dollar and postage, and without the knowledge of his parents, a youngster can obtain instructions on how to make everything from tear gas to TNT and thermite. For a few cents more he can obtain the necessary ingredients to make them. The National Fire Protection Association has this to say of this deplorable situation:

> "The mail order selling of explosive formulas, chemicals, and kits to teenagers in the name of science is a vicious racket. It feeds on the innate curiosity of teenagers, but instead of gaining them knowledge, in too many cases it costs them hands, fingers, and eyes."

3. **The teacher's role:** The teacher should continually impress on the students, the dangers involved in manipulating chemicals without thorough knowledge of their reactivity. The importance of using minimum quantities of unfamiliar ingredients should be continually stressed. The danger is in direct proportion to the quantity. Good techniques call for using the smallest quantity to get the desired result. Habitual care in the handling of chemicals should be instilled in the students, and they must be made aware of the possible hazards of not taking all precautions. For demonstrations of such violent reactions as the thermite reaction as long as the teacher takes adequate precautions to insure no danger to persons or property. Demonstrations of the fire hazard of flammable liquids and commonly used aerosol sprays such as insect bombs and hair sprays can also be effectively used.

C. **Model Rocketry**

Due to the hazards involved in the operation of model rockets and the amount of popularity it is gaining, it is important that the following rules be understood and observed.

1. **Rocket specifications:**

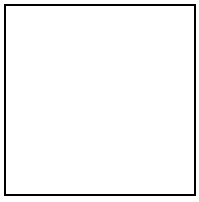
   a. No more than **113 grams (4 ounces) of propellant** materials shall be contained in a single model rocket engine at lift off. The total weight of the rocket will be no more than **454g** (16 oz.)

   b. Model rockets shall contain means of retarding descent to the ground so that the structure shall not be substantially damaged and no hazard shall be created to persons or property on the ground.

   c. Design and construction shall include suitable means which will provide stabilizing and restoring forces necessary to maintain a substantially true and predictable flight path.

   d. A model rocket shall no contain any type of explosive or pyrotechnic warhead.

   e. Under no circumstances will animals of any kind be carried by the rockets in flight.



2. **Rocket engines specifications:** Model rocket engines shall comply with the following requirements prior to launch, operating and flight.

   a. Rocket engines shall be a solid propellant reaction engine produced by a commercial manufacturer. It shall have all of the propelling ingredients preloaded into the casing in such a manner that they cannot be easily removed. These cannot be tampered with.

   b. Rocket engine must be so constructed that, should it rupture its casing, the casing shall not fragment.

   c. Rocket engine must be so designed and constructed as to be incapable of spontaneous ignition in air, in water, as a result of physical shocks, jarring, impacts or motion under conditions that would reasonably be expected to occur during shipment, storage and use or when subjected to a temperature of 80 degrees Celsius (176 degrees Fahrenheit) or less.

   d. A model rocket engine shall contain no more than 113 grams (4 ounces) of propellant materials, and shall produce less than 80 Newton-seconds (17.92 pounds-seconds) of total impulse with thrust duration not less than 0.050 seconds.

3. **Authorized locations for operation:** Model rockets may be launched only upon compliance with the following conditions:

   a. Notification of The Bureau of Fire Prevention and inspection of the launch site by the bureau.

   b. There shall be a ground area whose shortest dimension is no less than one-fourth (1/4) the anticipated maximum altitude of the rocket(s) to be flown.

   c. Flight areas shall be located in areas that will not create a hazard to persons and property in the vicinity of the area.

   d. Flight areas shall not contain or be located adjacent to high voltage lines, major highways, multi-story building or other similar obstacles.

   e. The launching location shall be no closer than 25 feet to the boundaries of the flight area.

4. **Launching:** The following conditions must be met during the launching of any model rocket.

   a. A device or mechanism shall be used which provides a suitable deflector to prevent the exhaust jet from impinging directly on the ground or launch surface and shall restrict the horizontal motion of the model unit until sufficient flight stability shall have been attained for a reasonably safe, predictable flight.

   b. Launching or ignition shall be conducted by remote electrical means fully under the control of the person launching the model.

   c. A launching angle of more than 60 degrees from the horizontal shall be used.

d. At least one adult person competent, in the opinion of the authority having jurisdiction to supervise the safe operation model rockets shall inspect each model rocket before flight and shall supervise the launching of each model rocket.

e. A short countdown shall be given prior to each launch to notify all persons in the immediate vicinity that a launching is imminent before a model rocket may be ignited and launched.

f. Surface winds at the launch site shall be less than 20 miles per hour and visibility shall be greater than 2,000 feet.

g. A model rocket shall not be fired so as to create a hazard to aircraft.

h. A model rocket shall not be used as a weapon against ground or air targets.

i. Model rockets may be launched only during daylight hours except for valid educational scientific experiments.

j. All personnel conducting, assisting or observing the launching shall remain at least 10 feet from models containing less than 25 grams of propellant and less than 20 Newton-seconds total impulse and at least 20 feet from models exceeding these limits during the countdown and launching.

k. No rocket may be launched unless its construction is completed at least 24 hours before launch and all glue is completely dry.

l. All additional requirements set forth in the Federal Aviation Regulations, Part 101, "Moored Balloons, Kits and Unmanned Rockets", must be followed. These regulations may be obtained by writing:

Federal Aviation Agency
Publishing and Graphic Division, HQ 428
Washington, DC 20533

5. **Permission to Launch**

a. No launch may be launched without prior approval/notification of the following:

(1) Principal
(2) State Fire Marshall
(3) City and County authorities where applicable
(4) Local airport or military facility

b. Notification containing the following must be given to each of the above at least 5 school days before the launch.

(1) Location of the launch.
(2) Date and time of intended launch.
(3) Name of adult in charge of launch.
(4) Name of school.
(5) Number of rockets to be launched and number of times.

D. **Science Fairs**

SAFETY

The safety regulations applicable to exhibits in Delaware Science Fairs should also be enforced for local school Science Fairs. It is excellent practice to require students to comply with these regulations in pursuing any special project activity even if the project is not to be entered in the Science Fair. The Science Fair Safety Regulations are quoted in their entirety on the following pages:

1. **General Regulations**

a. All electrical apparatus must be constructed according to standard electric safety laws. If in doubt, consult the National Electrical Code and Fire Code of the State of Delaware. Your library or industrial arts teacher probably has these books.

b. All exhibits that require house current for either operation or illumination must be designed for operation with alternating current at 110-120 volts. The maximum load shall not exceed 500 watts.

c. Ordinary doorbell push buttons must **not** be used to control 110-120 volt apparatus. Use 110-120 volt toggle or push button type switches, mounted on suitable panels or switchboxes. Open knife switches will **not** be allowed on 110-120 or 220-volt apparatus.

d. All wiring, switches, and metal parts that carry 110-120 volt current, or currents of higher voltages, such as radio and electronic apparatus, must be located out of reach or shielded from observers by plate glass or plexiglass. This rule is most essential to prevent serious electrical shock.

e. All electrical joints must be properly made with solder and plastic electric tape or solderless wire nuts.

f. Nails, tacks, and uninsulated staples must **not** be used for fastening wires. Use porcelain and other suitable types of insulators.

g. All wire connections and contact points used to carry electricity must be properly and thoroughly insulated for the voltage in use.

h. All electrical apparatus except single lamps and older laboratory instruments, which uses 110-120 volt current must be provided with a suitable cord, including grounding wire, no longer than six feet, and having a durable attachment plug of the three pronged grounded type.

i. Storage batteries must be protected to prevent short-circuiting, and also spilling of the acid.

j. All fan blades and other dangerous moving parts must be properly shielded.

k. Fire resistant materials shall be used.

l. Exhibits producing high temperatures must be properly insulated and ventilated. Open flames are not permitted.

m. Dangerous chemicals, such as poisons, insecticides, radioactive or corrosive substances and explosives, are prohibited. Simulation with a safe material such as clear or colored water, flour, sugar, table salt, etc., is effective but safe.

n. No medicines or narcotics shall be exhibited in such a way as to be accessible to the public.

o. All sharp objects such as knives, and hypodermic needles shall be firmly secured to the exhibit.

2. **Use and Care of Living Organisms**

a. A qualified adult supervisor must assume primary responsibility for the purpose and technique of any experiment involving virus, bacteria, fungi, and seed plants. Insects, spiders, and other animals that might be dangerous to the exhibitor or the viewing public, are the responsibility of the teacher of educator sponsoring the Science Fair.

b. Any display of pathogenic organisms should be sealed in break-resistant clear plastic containers and properly marked with danger or warning signs attached to the container.

c. Use pictures or simulated models if there is any danger of infecting the exhibitor, the public, or the judges.

d. No live vertebrate animals shall be exhibited.

e. Exhibits utilizing data derived from using live animals must conform with the following "Regulations for Experiments with Animals".

3. **Regulations for Experiments with Animals**

a. The basic aims of experiments involving animals are to achieve an understanding of life processes and to further man's knowledge. The development of the scientific method can be enhanced when teachers and science fair judges insist that experiments involving animals have clearly defined objectives requiring the use of animals to demonstrate a biological principle of answer scientific propositions. Such experiments **must** be conducted with a respect for life and an appreciation of humane considerations that must be afforded all animals.

b. Protista and other invertebrates are preferable for most experiments involving animals. Their wide variety and the feasibility of using larger numbers than is usually possible with vertebrates makes them especially suitable.

c. To provide for humane treatment of animals, a qualified adult supervisor who has had training in the proper care of laboratory animals **must** assume primary responsibility for the conditions of any experiment that involves living vertebrates. If the school faculty includes no one with training in the proper care of laboratory animals, the services of such a person on a consulting basis **must** be obtained.

d. **No experiment may be undertaken that involves anesthetic drugs, organisms pathogenic for man or other vertebrates, ionizing radiation, carcinogens, or surgical procedures other than venipuncture or hypodermic injection, unless these procedures are performed under the immediate supervision of a biomedical scientist experienced in the field under investigation.**

"Immediate supervision" involves the following: (a) The student must submit a protocol to the supervising scientist for approval prior to the commencement of the project. (b) The supervising scientist must be in the same locality as the student for the duration of the experiment work (except for short trips). This means that a project started in one city (such as scientist's laboratory during the summer) may not be continued in another city unless another supervisor is obtained prior to continuation of the experimental work. (c) The supervising scientist must be present for at least some of the experimental work, and make sure that the student is properly trained in the procedure involved.

"Biomedical scientist" means a person with any of the following degrees: Ph.D., M.D., D.V.M., or D.D.S.

e. The comfort of the animal used in any experiment shall be a prime concern. No experiment using live animals shall be attempted unless the animals shall have been obtained from a reliable source and the following conditions can be assured: appropriate, comfortable quarters; adequate food and water; humane treatment and gentle handling. Proper quarters and care must be provided at all times, including weekends and vacation periods. An experiment in nutritional deficiency may proceed only to the point where symptoms of the deficiency appear. Appropriate measures shall then be taken to correct the deficiency, if such action is feasible, or the animal(s) shall be killed by a humane method.

f. Students shall not be permitted to participate in science fairs held under the auspices of the schools unless their qualified adult supervisors have submitted certification in writing that the above rules have been observed.

4. **Protocol certificate:** The following certificate should be completed by the student's supervisor and submitted to the school principal before a project involving animals or other living organisms is started.

PROTOCOL CERTIFICATE

I, _____, do hereby certify that I have received and approved the attached Protocol; that if the student is not trained in the necessary procedures, I will ensure his training; that I will provide advice and on the spot supervision during the project; and that I am a qualified biomedical scientist actively engaged in the field under supervision.

Name_____ Signature_____
(Type or Print)

Title_____Institution_____
(Type or Print)

Address_____ Phone_____
(Type or Print)

ATTESTED BY:

Name of Sponsoring Teacher_____
(Type or Print)

Signature of Sponsoring Teacher_____

Name of Principal_____
(Type or Print)

Signature of Principal_____

School_____

Address_____

4. **Supervisor's certificate:** The following certificate should be completed by the student's supervisor and submitted to the principal after a project involving live animals has been completed.

SUPERVISOR'S CERTIFICATE

I, _____, do hereby certify that I personally have supervised and have accepted primary responsibility for the conditions of the experiment(s) undertaken by the undersigned student and am satisfied that the "Guiding Principles for the Use of Animals by Secondary Students and Science Club Members" have been fully met.

I further certify that I have been trained in the proper care and handling of the laboratory animals.

Name_____ Signature_____
(Type or Print)

Title_____ Institution_____

Address_____ Phone_____

Student's Name_____
(Type or Print)

Project Title_____

ATTESTED BY:
Names of Sponsoring Teacher_____
(Type or Print)

Signature of Sponsoring Teacher_____

Name of Principal_____
(Type or Print)

Signature of Principal_____

School_____

Address_____

CERTIFICATION
Delaware's Right-to-Know Law

I, _____, certify that Mr./Mrs./Ms.

_____has given me instruction on my rights and responsibilities under the Delaware Hazardous Materials Communications Act also know as the "Right-to-Know" law. After receiving instruction I was given a test on the material.

My score on that test was:_____

_____ Date:_____
(student's signature)

_____ Date:_____
(teacher's signature)

NOTE: The materials in any Appendix are for your use. Photocopy them for student distribution, or other uses.

A P P E N D I X A

LABORATORY SAFETY INSTRUCTIONS FOR STUDENTS

General

Every precaution is taken to make the laboratory a safe place to work. However, because of the serious consequences of mistakes or carelessness, safety can only be assured by complete cooperation and compliance with instructions.

Follow the instructions for performing each experiment carefully. Never go beyond the scope of the instructions. If your initiative should suggest trying some phase not covered by the instructions, consult the teacher before attempting it.

The laboratory is the workroom of the scientist - a place of serious business which involves many potential dangers. It is not a playroom. Absolutely no horseplay, skylarking, or practical jokes will be tolerated in the laboratory. The consequences of such tricks as squirting another student with a wash bottle can sometimes be disastrous. Instinctive recoil from the surprise of a prank of this sort can cause damaging spills or fire hazards.

Efficiency is directly dependent upon good order and cleanliness. Cleanliness and the avoidance of clutter makes experimentation much safer as well as more pleasant. Students should periodically clean and set their station in order during an experiment and wipe up all spills immediately. At the end of the laboratory period, glassware and equipment should be cleaned and replaced in its proper storage. After working with liquids, the table top should be sponged down and wiped dry with paper toweling.

Special purpose reagents, not provided at the individual stations, should be used at the supply table and not carried through the laboratory to individual stations.

If the laboratory is equipped with stools, they should be used only when authorized by the teacher. When used, all four legs should be placed firmly on the floor, never tilted. DO NOT SIT ON THE LAB TABLES.

Minor spills on the floor should be wiped up with a sponge. Should extensive spills occur, the teacher should be notified so that he can have them mopped up, or neutralized.

If glassware or equipment is broken during an experiment, the teacher should be notified. Replacements should be obtained and the floor and/or table top cleared of broken glass. Never use cracked or chipped glassware.

Chemicals spilled on the hands or person should be flushed off immediately with plenty of water. If there is any skin irritation as a result, the teacher should be notified and action taken in accordance with the Health Manual.

In the event of chemicals being splashed in the eyes, the eyes should be flushed immediately with copious amounts of water, using the eye bath fountain or flushing hose for this purpose. The flushing should be continued for at least 15 minutes. If contact lenses are worn, they should be removed immediately, before flushing with water. In this, as in all other cases of accident, the teacher should be promptly notified and action taken as indicated in the School Nurse's Handbook.

Know the location of the eye bath fountain, the flushing hose, and the deluge shower. The shower is very effective in quenching clothing fires as well as in washing off extensive spills on the face or body.

Should any chemicals be spilled on any clothing, especially tight fitting clothing such as socks, hosiery, shells, sweaters, etc., the article of clothing should be removed promptly. Some organic chemicals which cause little or no irritation on bare skin can cause severe dermatitis if clothing dampened by them is in contact with the skin for prolonged periods.

In the event of a fire, verbal alarm should be given and the area immediately evacuated. Students are not to attempt to extinguish any fire except on person or clothing.

Sensible clothes should be worn in the laboratory. It is inadvisable to wear frilly blouses or shirts, or excessively loose fitting clothing. The wearing of sandals is also discouraged. Hair sprayed with aerosol setting preparations presents a special fire hazard around Bunsen burners. In this regard, students should be aware of the extreme flammability of the spray from some aerosol containers. They should never use them in the presence of an ignition source, such as an open flame, or electrical spark. Keep this in mind in your outside activities as well as in school.

Some wigs and falls are more flammable than natural hair. Special care is in order around Bunsen burners when these are worn. It is NECESSARY that long, free flowing hair be bound in a pony tail with a rubber band during laboratory work involving the use of the Bunsen burner. Very curly or high, straight, stand-up styles with dressing, spray, or mousse are extremely flammable as well and should be covered. Hair Care Products cause hair to be more flammable.

SPECIFIC STUDENT PRECAUTIONS
(Discuss these points with students in detail, adding personal points)

***Chemistry**

1. Wash the hands after each lab period.
2. Never eat or drink from laboratory glassware.
3. Never taste any chemical – unless specifically instructed to do so by your teacher.
4. Check Bunsen burner hose for security and leaks before lighting burner.
5. Have spark-lighter handy before turning on the Bunsen burner.
6. Check gas valves before leaving stations to insure they are "OFF".
7. When diluting acids, pour **acid slowly into water** with constant stirring. **Never pour water into acid!**
8. Never point a test tube at yourself or another person, especially when heating. Never look down into a test tube.
9. Smell the contents of a test tube, when necessary, by wafting some of the escaping gas toward your nose with a cupped hand.
10. Test the temperature of questionable beakers, ring stands, wire gauze, crucibles or other pieces of apparatus that have been heated by holding the back of the hand close before grasping them. Hot and cold metal and glassware look exactly the same.
11. Flush the exterior of reagent bottles with water frequently.
12. Always wear protective goggles unless specifically told by the teacher that they are not necessary.
13. Wear aprons in the chemistry laboratory, as instructed.
14. When pouring liquids, especially caustic or corrosive ones, use a stirring rod to avoid drips and spills.
15. **Never pipette by mouth**
16. Read the label twice before using contents of a reagent bottle.
17. In cutting glass tubing, score with the file, wrap in a towel, grasp the tubing firmly in both hands with the thumbs opposite the scratch, and bend the ends toward you. Fire polish the ends of all glass tubing before using in an assembly.
18. Do not attempt to remove ground glass stoppers which have become stuck. Ask the teacher for assistance.
19. Cracked or broken glassware should never be used. Ask for a replacement.
20. Follow the instructions for the disposal of wastes prescribed in the experiment, or by your instructor. Ask if unsure.

21. Use beaker tongs to handle hot beakers, not towels, or crucible tongs.

22. Glass stoppers of reagent bottles should not be laid on the bench top but held between the index and middle finger while pouring. This practice will prevent the accidental interchange of stoppers between reagent bottles and prevent contamination of the bench top.

23. Never pour reagents back into stock bottles. The amount needed should be estimated and any excess discarded in an appropriate container provided by the instructor.

24. When inserting glass tubing, thermometers, thistle tubes, etc., in stoppers, be sure the hole is large enough, lubricate both the glass and stopper with water, glycerine, or silicone grease, and insert by holding with a towel, using a gentle rotary motion. Keep the hand holding the stopper out of the line of the tubing being inserted.

25. If glass tubing or thermometers are stuck in a rubber stopper, do not attempt to remove them. Ask assistance from the teacher.

* **PHYSICAL SCIENCE TEACHERS:** Should use both Chemistry and Physics student precautions as needed.

SPECIFIC STUDENT PRECAUTIONS
(Discuss these points with students, adding personal points)

* **Physics**

1. Batteries should never be intentionally shorted. Severe burns can be caused by the heat generated in a bare copper wire placed directly across the battery terminals. If a mercury type dry cell is shorted, an explosion can result.

2. When working with large vacuum tubes, or equipment containing them, use special care and attention. Such tubes, when they break, implode violently sending glass flying great distances.

3. When working with ultraviolet or infrared light, use the protective glasses provided by the teacher, and comply with all safety precautions issued.

4. Induction coils and transformers produce exceedingly high voltages. Make sure you understand their operation before use, and have properly identified the low and high voltage outlets.

5. Capacitors and Lyden jars store electrical charge. A person can receive a dangerous and sometimes fatal shock or serious burn from them even though the equipment in which they are installed is turned off or disconnected. Before working with a capacitor, it should be discharged by shorting with an insulated tool. Never exceed the designed capacity of any capacitor. Do not reverse polarity of electrolytic type capacitors. Explosion could result in either case.

6. Electrical circuits and capacitors should **never be used to deliberately shock anyone.** Susceptibility to shock and possible resulting injury is unpredictable because of the many physical and physiological variables.

7. Turn off all power when setting up circuits or repairing electrical equipment.

8. When working on a circuit, remember that the power leads are the last to connect when assembling, and the first to disconnect when disassembling.

9. When working with electrical equipment, use only those tools which have properly insulated handles.

10. Don't trust circuit breakers, fuses, etc. Treat every electrical circuit as if it were energized.

11. Never use such metal articles as metal rulers, metal pencils or pens, nor wear rings, metal watchbands, bracelets, etc. when doing electrical work.

12. Develop the habit of using only one hand when doing electrical work. If both hands must be used, stand on a rubber mat or other type of insulating material.

13. When disconnecting a piece of electrical equipment, pull the plug and not the wire.

14. Use caution in handling electrical equipment which has been in use and has been disconnected. The equipment may still be hot enough to produce a serious burn. Electrical capacitors may hold charge for hours after the equipment is turned off.

15. Never connect, disconnect, or operate a piece of electrical equipment with wet hands or while standing on a wet floor.

16. In experiments involving the generation of live steam, carefully check the assembly for leaks, kinks, and blockages. Make sure that the steam outlet is not pointed toward anyone.

LABORATORY SAFETY RULES

1. **FOLLOW ALL INSTRUCTIONS**

Study all instructions carefully before beginning a laboratory activity. The instructions are for your success and safety. If you wish to try something not included in the instructions, consult your teacher before attempting it.

2. **REPORT ACCIDENTS IMMEDIATELY**

Quickly report to your instructor. Remain calm. Your teacher will give you further instructions.

3. **NO HORSEPLAY**

The laboratory is a place of serious business which involves many potential dangers. It is not a playroom. Absolutely no fooling around will be tolerated. The consequences of someone's practical joke could be disastrous.

4. **KNOW YOUR SAFETY EQUIPMENT**

Become familiar with the location of safety equipment. These may include the following:

a. **Goggles:** To protect eyes from any damage.

b. **First Aid Kit:** For minor medical treatment.

c. **Eyewash Station:** For flushing the eyes in case of chemical splashing. **Remove contact lenses prior to flushing.**

d. **Safety Shower:** For quenching clothing fires as well as extensive spills on the face or body.

e. **Fire Extinguisher:** For fires not on a person.

f. **Main Gas and Water Cut Off Valves:** Emergency ONLY.

g. **Fire Alarm:** If fire becomes out of control.

h. **Fire Exit:** Pathway from a specific room.

5. **WEAR SAFETY GOGGLES**

Eye protection will be required for many lab activities. You will be informed by your teacher if eye protection is not required for a particular lab activity. Eye protection devices must be of the type specified for the particular activity.

6. **STAY OUT OF RESTRICTED AREAS**

Certain areas present special hazards to students. These areas are designated for your safety and should be entered only with teacher permission.

7. **KEEP WORK AREA CLEAR**

Avoid unnecessary hazards in your lab area by placing coats, textbooks and other personal belongings in a designated area away from the lab working area. Keep aisles free of all obstructions such as

chairs, trash cans, books, etc. Use only laboratory equipment needed to complete an experiment and keep all other equipment not in use in its proper storage area.

8. **CLEAN ALL SPILLS**

Minor solid and liquid spills should be wiped with a sponge, cloth, paper towel, etc. Large liquid spills should be mopped up with a mop. If a large solid spill occurs, use a dust pan and broom and dispose of contents in a proper container. Inform your instructor. If hazardous materials are spilled, consult your teacher for special instructions.

9. **DISPOSE OF BROKEN GLASSWARE**

Broken glass should be cleaned up promptly using a dust pan and brush. A separate waste container is provided for broken glass. Notify your teacher and obtain replacement for broken item.

10. **DON'T TAMPER WITH GAS**

Tampering with gas valves when they are not in use may cause the valves to become clogged or loose allowing gas to leak into a cabinet and/or the classroom.

11. **WEAR APPROPRIATE CLOTHING**

Clothing which dangles from the body can be easily grabbed by rotating equipment, dipped into some solution containing a harmful chemical, cause an unwanted spill or catch on fire. Clothing may be damaged and bodily injury may result.

12. **SECURE LONG HAIR**

Hair will easily scorch and burn. Hair sprayed with flammable aerosol setting preparations presents an extreme fire hazard around Bunsen burners. Hair should be bound firmly to the head so that it cannot be caught, dipped into beakers, swung through flame or otherwise obstruct the carrying out of the laboratory exercise. A net or scarf may be necessary for bushy, curly hair.

13. **NO EATING OR DRINKING**

To avoid the risk of food contamination, no eating or drinking is permitted in the lab, and hands should be washed thoroughly after each investigation. Never taste any chemical unless directed to do so.

LABORATORY SAFETY RULES STUDENT PLEDGE

I have received, read, understand and agree to follow the science Laboratory Safety Rules.

_____ _____

Student Signature Date

_____ _____

Parent Signature Date

TEACHER NOTE: Keep on file for a given school year.

A P P E N D I X B

CHEMICAL INVENTORY FORM

SAFETY CODE ALERT:

Color_____ No_____

Chemical Name	Amount Location	Purchase Date	Discard Date_____

(A) Potential Hazards: _____

_____

_____

(B) Notes for Safe Disposal: _____

_____

_____

(C) Notes for Storage: _____

(1) Do not store near: _____

_____

_____

(2) Do not exceed this inventory amount: _____

_____

_____

A P P E N D I X C

FIRE HAZARD PROPERTIES OF CERTAIN FLAMMABLE LIQUIDS

	Flashpoint	Boiling Point	Ignition Temp.	Explosive Limits (% by volume)	
	°C.	°C.	°C.	Lower	Upper
Acetaldehyde	-27.2	21	185	4	57
Acetic acid, Glacial	40	118.7	426.7	4	-----
Acetic anhydride	49.4	140	315.6	-----	-----
Acetone	-17.8	56.5	537.8	2.55	12.8
Acetyl Chloride	4.4	50.2	-----	-----	-----
Allyl Alcohol	21	96.7	378	3	18
Amyl acetate, n	25	148	398.9	-----	-----
Aniline	75.6	184	537.8	-----	-----
Benzaldehyde	64.5	180	191.7	-----	-----
Benzoyl (benzene)	-11.1	70.1	537.8	1.5	8.0
Benzyl chloride	60	170.6	-----	1.1	-----
Butyl acetate, n-	22.2	120.7	421.1	1.7	15
Butyl alcohol, n-	37.8	110.7	343.3	1.7	-----
Carbon disulphide	-30	40.6	100	1.0	50
Cellosolve, methyl	40	130.5	230.8	2.6	15.7
Chlorobenzene mono-	29.4	130.2	-----	1.8	9.6
Cyclohexane	-17	80	268	1.31	8.35
Ethanol	12.8	78.5	371.1	3.5	19
Ether	-45	34.6	180	1.85	36.5
Ethyl acetate	4.4	70.7	426.7	2.2	11.5
Ethyl alcohol	12.8	78.5	371.1	3.5	19
Ethylene dichloride	13.3	80.4	412.8	6.2	15.9
Ethyl formate	-20	50.4	-----	3.5	16.5
Ethyl nitrate	10	80.8	-----	3.8	-----
Ethyl nitrite	-35	10.7	90	3.01	50
Formaldehyde (30-40 per-cent solution)	54.4	----	430	-----	-----
Gasoline	-42.8	60-200	257.2	1.3	6.0
Heptane (n)	-3	98	233	1	6
Hexane (n)	-22	69	247	1.25	6.9

APPENDIX C (cont.)

	Flashpoint	Boiling Point	Ignition Temp.	Explosive Limits (% by volume)	
	°C.	°C.	°C.	Lower	Upper
Kerosene	37.8	-----	254.4	-----	-----
Methyl acetate	-10	60	454.4	4.1	13.9
Methyl alcohol	11.1	64.6	426.7	6.0	36.5
Methylcello-solve	40	124.3	230.8	2.6	15.7
Methyl ethyl ketone	1	80	516	1.81	11.5
Nitrobenzene	88	211	496	1.8	-----
Petroleum ether	0 or less	40-70	246	1.1	4.8
Propyl alcohol, n-	11.7	90.7	398.9	2.5	-----
Propyl alcohol (iso)	11.7	83	456	2.5	-----
Propylene dichloride	10	96	557	3.4	14.5
Pyridine	20	110.5	482.2	1.8	12.5
Toluidine	87	200	482.2	-----	-----
Toluol (toluene)	4.4	110.1	552.2	1.27	7.0
Turpentine	35	149	240	0.8	-----
Xylol (xylene)	17.2	140.4	482.2	1.0	5.3

SOURCE: Chemical and Biological Safety Guide, Public Health Service, National Institutes of Health, U.S. Department of Health, Education, and Welfare, by permission.

A P P E N D I X D

POISONOUS PLANTS

House Plants

Plant	Comment	Toxic Part
Castor bean	**Fatal.** One or two seeds are near the lethal dose for adults.	Seeds
Daffodil	Nausea, vomiting, diarrhea. May be fatal.	Bulbs
Dieffenbachia (dumb cain); Elephant Ear, Philodendron	Intense burning and irritation of the mouth and tongue, caused by needle like crystals of calcium oxalate. Death can occur if base of tongue swells enough to block the air passage of the throat.	All parts
Elephant Ear	Same as for dieffenbachia.	All parts
Hyacinth	Nausea, vomiting, diarrhea. May be fatal.	Bulbs
Mistletoe	**Fatal.** Both children and adults have died from eating the berries.	Berries
Narcissus	Nausea, vomiting, diarrhea. May be fatal.	Bulbs
Poinsettia	One leaf can be fatal to a child.	Leaves
Oleander	Extremely poisonous. Affects the heart, produces severe digestive upset and has caused death.	All parts
Posary Pea	**Fatal.** A single pea seed has caused death.	Seeds

Flower Garden Plants

Autumn Crocus	Vomiting and nervous excitement.	Bulbs
Bleeding Heart	Poisonous in large amounts. Has proved fatal to cattle.	Foliage, Roots
Buttercup	Irritant juices may severely injure the digestive system.	All parts
Dutchman's Breeches	Similar to bleeding heart.	Foliage, Roots
Death Camas	Can be fatal by ingestion.	Bulbs, Flower

Plant	Comment	Toxic Part
Foxglove	One of the sources of the drug digitalis, used to stimulate the heart. In large amounts, the active principals cause dangerously irregular heartbeat and pulse, digestive upset, and mental confusion. May be fatal.	Leaves Flower
Iris	Severe, but not usually serious digestive upset.	Rhizomes (roots)
Larkspur	Digestive upset, nervous excitement, depression. May be fatal.	Young Plant Seeds
Lily-of-the Valley	Irregular heartbeat and pulse, usually accompanied by digestive upset and mental confusion.	Leaves Flowers Fruit
Monkshood	Digestive upset and nervous excitement.	Leaves, Roots Flower
Star-of-Bethlehem	Vomiting and nervous excitement.	Bulbs
	Vegetable Garden Plants	
Potato	Large quantities can be fatal.	Green/spoiled Vines, sprouts Or tubors.
Rhubarb	Large amounts of raw or cooked leaves can cause convulsions, coma, followed rapidly by death.	Leaves
	Ornamental Plants	
Azaleas	**Fatal.** Produces nausea and vomiting, depression, difficult breathing, prostration, and coma.	All Parts
Daphne	**Fatal.** A few berries can kill a child.	Berries
Golden Chain	Severe vomiting, excitement, staggering, convulsions and coma. May be fatal.	Bean-like seed
Jasmine	**Fatal.** Digestive disturbance, nervous excitement, or respiratory failure.	Berries, leaves Flowers
Lantana Camara	**Fatal.** Affects lungs, kidneys, heart and nervous system.	Green Berries

Plant	Comment	Toxic Part
Laurels	**Fatal.** Produces nausea and vomiting, depression, difficult breathing, prostration, and coma.	All Parts
Rhododendron	**Fatal.** Produces nausea and vomiting, depression, difficult breathing, prostration, and coma.	All Parts
Wisteria	Mild to severe digestive upset. Many children are poisoned by this plant.	Seeds Pods
Yew	**Fatal.** Foliage more toxic than berries. Death is usually sudden without warning symptoms.	Foliage Berries
	Plants in Swamp or Moist Areas	
Water Hemlock	**Fatal.** Violent and painful convulsions. A number of people have died from hemlock.	All Parts
	Trees and Shrubs	
Apple	**Fatal.** Contains a compound that releases cyanide when eaten. Gasping, excitement, and prostration are common symptoms.	All parts, but fruit
Buckeye	Produces digestive and nervous upset and death in children.	Sprouts, Nuts
Cherries, Wild and Cultivated	**Fatal.** Contains a compound that releases cyanide when eaten. Gasping, excitement, and prostration are common symptoms.	Twigs Foliage Pits
Elderberry	Children have been poisoned by using pieces of the pithy stems for blowguns. Nausea and digestive upset.	Shoots, Roots Leaves, Berries, Bark
Hemlock	**Fatal** Violent and painful convulsions. A number of people have died from hemlock.	All Parts
Holly	Nausea, vomiting, diarrhea, stupor.	Berries
Locust, Black	Children have suffered nausea, weakness and depression after chewing the bark and seeds.	Bark, Sprouts, Seeds
Peach	**Fatal.** Contains a compound that releases cyanide when eaten. Gasping, excitement,	All parts, but fruit

Plant	Comment	Toxic Part
Plum	**Fatal**. Contains a compound that releases cyanide when eaten. Gasping, excitement, And prostration are common symptoms.	All parts, but fruit
Poison Sumac	Poisonous by contact. Painful inflammation of the skin with blisters, lasting for days.	All parts
Oaks	Affects kidneys gradually. Symptoms appear Only after several days or weeks. Takes a large amount for poisoning. Children should not be allowed to chew on acorns.	Foliage
	Plants in Wooded Areas	
Jack-in-the-Pulpit	Contains small needle like crystals of calcium oxalate that cause intense irritation and burning of the mouth and tongue.	All parts, especially roots
Mayapple	Contains at least 16 active toxic principals, Primarily in the roots. Children often eat the apples with no ill effects, but several apples may cause diarrhea.	Roots Foliage
Moonseed	Blue, purple color, resembling wild grapes. Contains a single seed. (True wild grapes contain several seeds.) May be fatal.	Berries
Poison Ivy	Poisonous by contact. Painful inflammation o of the skin, lasting for days.	All parts
	Plants in Fields	
Buttercup	Irritant juices may severely injure the digestive system.	All parts
Jimson Weed (Thorn Apple) (Stink Weed)	Abnormal thirst, distorted sight, delirium, incoherence and comma. Common cause of poisoning. Has proven fatal.	All parts
Nightshade	**Fatal.** Intense digestive disturbances and nervous symptoms.	All parts, especially the unripe berries
Poison Hemlock	**Fatal.** Resembles a large wild carrot. Used in ancient Greece to kill condemned prisoners.	All parts
Death Cap (Amanita phalloides)	**Fatal.** Contains the hemolytic toxin, phallin. Symptoms delayed for several hours. Cramps, convulsions, then death in two to four days.	All parts
Destroying	**Fatal.** Similar to death cap mushroom.	All parts
Fly Amanita	**Fatal.** Contains the toxic alkaloid muscarine. Symptoms include diarrhea, visual disturbance, cold sweating and stupor.	All parts

A P P E N D I X E

DELAWARE STUDENT AND STAFF ACCIDENT REPORT FORM

DEPARTMENT OF EDUCATION
TOWNSEND BUILDING
DOVER, DE

Instruction: This form is to be completed on each injury that results in one-half or more days' absence from school or requires a doctor's attention or both. Submit all completed reports to the designated office in school district. It is recommended that a duplicated copy of this report be prepared for the school's file.

Name of Injured (last, first, middle)	**School District**	**School**
Home address:	**Date Occurred**	**Time/Date Accident Reported**
	Grade	**(M)** ____ **(F)** ____ **Sex**

NATURE OF ACCIDENT – Check All Appropriate Areas
(To be Completed by Nurse or Other Designated Personnel)

____	1 Abrasion	____	6 Concussion	____	11 Fracture
____	2 Bite	____	7 Cut	____	12 Laceration
____	3 Bruise	____	8 Dental	____	13 Puncture
____	4 Burn	____	9 Dislocation	____	14 Sprain/Strain
____	5 Chemical Burn	____	10 Foreign Body in Eye	____	15 Other

PART OF BODY (Indicate L or R for left or right when applicable)

1- Ankle	7- Eye	13-Hip	19-Nose
2- Arm	8- Face	14-Knee	20-Shoulder
3- Back	9- Finger	15-Leg	21-Stomach
4- Chest	10- Foot	16-Lip	22-Tooth
5- Collar Bone	11- Hand	17-Mouth	23-Wrist
6- Elbow	12- Head	18-Neck	24-Other

Area

1- Building	4-Intramural	6- Shops
2- Grounds	5-Physical Education	7- Labs
3- Interscholastic		

CHECK APPROPRIATE CATEGORY

LOCATION

1- Auditorium	6-Lavatories	10 – Stairs Inside
2-Cafeteria	7-Lockers	11-Stairs and Walks Outside
3-Classroom	8-Science	12-Voc. and Ind. Arts
4-Corridor	9-Shower and Dressing Room	13 - Other
5-Home Ec.		

ACTIVITIES

1-Apparatus	6- Football	11-Softball
2- Ball	7-Free Play	12-Swimming
3-Baseball	8-Gymnastics	13-Track & Field
4-Basketball	9-Running	14-Volleyball
5-Field Hockey	10-Soccer	15-Wrestling
		16-Other

TO & FROM SCHOOL

_____ 1-Bicycle (only) _____ 3-Motor Vehicle/Bicycle _____ 5-School Bus

_____ 2-Motor Vehicle _____ 4-Motor Vehicle Pedestrian _____ 6-Streets & Walks

_____ 7-Other

Immediate Action Taken: First Aid _____ Home _____ Physician _____

Was Parent or Anyone Notified? Yes _____ No _____ When _____ _____
Date Time

By Whom? _____ How _____

Has the student returned to school? Yes ____ No ____ Total number of days lost from school ____

Adult present at scene of accident: _____ _____
Name Title

Description of Accident: _____

_____

_____

_____

Corrective action taken or recommended _____

Principal's Signature _____ Date _____

Staff Members's Signature _____ Date _____

Nurse's Signature _____ Date _____

A P P E N D I X F

SCIENCE SAFETY INSPECTION CHECKLISTS

The safety checklists in this appendix were adapted from
Science Safety: Making the Connection, Council of State Science Supervisors, 2000

GENERAL SCIENCE-SAFETY CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate choice for each item on the checklist:

S = Satisfactory (item meets guideline, no action needed)
U = Unsatisfactory (item does Not meet guideline, corrective action required)
NA = Not applicable (item does not apply for this room or activity)

The following general science-safety recommendations are followed:

1.	Have appropriate protective equipment, e.g., American National Standards Institute (ANSI) Z87 or Z87.1 coded goggles, chemical aprons, non-allergenic gloves, dust masks, eyewash, shower(s), ABC fire extinguisher, sand bucket(s), fire blanket(s), in easily accessible locations. (General rule is accessibility within 15 seconds or 30 steps from any location in the room.) Make certain that instructor and students wear adequate protective equipment, including especially safety goggles and aprons, when experiments involving hazardous chemicals or procedures are conducted.	**S**	**U**	**NA**
2.	Notify supervisors immediately of hazardous or potentially hazardous conditions, such as lack of Ground-Fault Interrupters (GFIs) near sinks, inadequate ventilation, or potential hazards, e.g., study halls scheduled in laboratories or tile floors waxed with non-skid wax.	**S**	**U**	**NA**
3.	Check the fume hood regularly for efficiency and never uses the hood as a storage area. Ensure that the hood is vented properly through the roof.	**S**	**U**	**NA**
4.	Use only equipment in good condition (not broken) and efficient working order.	**S**	**U**	**NA**
5.	Have a goggle sanitation plan for goggles used by multiple classes per day.	**S**	**U**	**NA**
6.	Have separate disposal container for broken glassware and flammables.	**S**	**U**	**NA**
7.	Discuss and post emergency/escape and notification plans/numbers in each room/laboratory. Clearly mark fire exits, and keep exits (preferably two from laboratories) unobstructed.	**S**	**U**	**NA**
8.	Have and enforce a safety contract with students and parents.	**S**	**U**	**NA**
9.	Identify medical and allergy problems for each student to foresee potential hazards.	**S**	**U**	**NA**
10.	Model, post, and enforce all safety procedures. Display safety posters.	**S**	**U**	**NA**

11.	Keep laboratory uncluttered and locked when not in use or when teacher is not present.	**S**	**U**	**NA**
12.	Know district and state policies concerning administering first-aid and have an adequately stocked first-aid kit accessible at all times.	**S**	**U**	**NA**
13.	Know and follow district and state policies/guidelines for use of hazardous chemicals, live animals, and animal and plant specimens in the classroom/laboratory.	**S**	**U**	**NA**
14.	Report all injuries, including animal scratches, bites, and allergic reactions, immediately to appropriate supervisor.	**S**	**U**	**NA**
15.	Keep records on safety training and laboratory incidents.	**S**	**U**	**NA**
16.	Provide the number of accessible lab stations having sufficient workspace (60 square feet or 5.6 square meters) workspace per student; 5 foot or 1.5 meters wide aisles and low lab table sections for wheelchair accessibility that can be supervised by the number of qualified teachers/aides present (maximum 24:1).	**S**	**U**	**NA**
17.	Have master cut-off switches/valve within each laboratory (preferably in one secure location); know how to use them; and keep water, gas, and electricity turned off when not in use.	**S**	**U**	**NA**
18.	Maintain up-to-date chemical and equipment inventories, including Material Safety Data Sheet (MSDS) files.	**S**	**U**	**NA**
19.	Label equipment and chemicals adequately with respect to hazards and other needed information.	**S**	**U**	**NA**
20.	Post the National Fire Protection Association (NFPA) “diamond” at all chemical storeroom entrances denoting the most hazardous chemical in each category within. Regularly send an update copy of the inventory to the local fire department.	**S**	**U**	**NA**
21.	Organize chemical storerooms properly. Arrange chemicals by National Institute for Occupational Safety and Health (NIOSH)/Occupational Safety and Health Administration (OSHA) compatibility classes, with special storage available for oxidizers, non-flammable compressed gases, acids, and flammables.	**S**	**U**	**NA**
22.	Store chemicals in appropriate places e.g., below eye level, large containers no higher then 2 feet (.6 meters) above floor, acids in corrosives cabinets, and solvents in OSHA/NFPA approved flammables cabinets-with acids physically separated from bases and oxidizers physically separated from organics within secure, limited access adequately ventilated storerooms	**S**	**U**	**NA**
23.	Provide in a readily accessible location appropriate materials and procedures for clean-up of hazardous spills and accidents, e.g. aspirator or kit for mercury spills, vermiculite and baking soda for acids, and% Clorox bleach solution or 5 % Lysol solution for body fluid, and appropriate procedures for disposal of chemo- and bio-hazardous materials.	**S**	**U**	**NA**
24.	Prohibit the use of pathogens or any procedures or materials in any school; laboratory above Bio-safety Level 1 as outlined by Centers of Disease Control/National Institutes of Health protocols.	**S**	**U**	**NA**
25.	Keep live animals and students adequately protected from one another.	**S**	**U**	**NA**

CHEMICAL PURCHASING, LABELING, STORAGE AND DISPOSAL CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate choice for each item on the checklist:

S = Satisfactory (item meets guideline, no action needed)
U = Unsatisfactory (item does Not meet guideline, corrective action required)
NA = Not applicable (item does not apply for this room or activity)

The following purchasing, labeling, storage, and disposal recommendations are as follows:

A. Purchasing

These factors are considered before purchasing

1.	Will the amounts be used within 1-2 years.	**S**	**U**	**NA**
2.	The chemical can be stored properly.	**S**	**U**	**NA**
3.	The chemical can be safely disposed of.	**S**	**U**	**NA**
4.	The facility has proper personal protective equipment.	**S**	**U**	**NA**
5.	Facility personnel are aware of any hazards associated with this product.	**S**	**U**	**NA**
6.	Facility personnel are properly trained in the use, and handling of the materials.	**S**	**U**	**NA**
7.	The budget allows for disposal of the chemical or by-products.	**S**	**U**	**NA**

B. Labeling Chemicals

The following minimum essentials information is included on chemical labels:

1.	Chemical manufacturer of supplies (including address and telephone number).	**S**	**U**	**NA**
2.	Chemical name and/or trade name of the product (same as MSDS when applicable)	**S**	**U**	**NA**
3.	Date received or date placed in the container.	**S**	**U**	**NA**
4.	Precautions to be observed in handling or mixing the chemicals	**S**	**U**	**NA**
5.	Appropriate the hazard symbol National Fire Protection Association (NFPA) rating	**S**	**U**	**NA**

C. Chemical Storage

Chemicals are stored according to the following minimum storage requirements:

1.	Separate storage area from the classroom area. Appropriate warning symbols mark storage areas.	**S**	**U**	**NA**
2.	Storage area is properly ventilated.	**S**	**U**	**NA**
3.	Appropriate fire extinguisher(s) or extinguishing system is provided.	**S**	**U**	**NA**
4.	Fire door or adequate exits are provided.	**S**	**U**	**NA**
5.	Storage shelves are securely attached to wall (each shelf with a front one-inch or 2.5 centimeter lip to prevent bottles from slipping off shelves.	**S**	**U**	**NA**
6.	Inorganic chemicals are separated from organic chemicals.	**S**	**U**	**NA**
7.	A reputable guide, e.g., National Institute for Occupational Safety and Health Administration, is to help properly separate incompatible chemical families.	**S**	**U**	**NA**
8.	Chemicals are not stored past the manufacturer's suggested shelf life.	**S**	**U**	**NA**
9.	Flammables and corrosives are stored separately in appropriate cabinets.	**S**	**U**	**NA**
10.	A Material Data Sheet (MSDS) should be kept on file and be easily accessible for ALL chemicals. MSDS sheets should be referred for proper storage and for appropriate personal protection equipment (PPE). Refer to your school district and state policies for local storage requirements and mandates.	**S**	**U**	**NA**

D. Disposal

The Environmental Protection Agency (EPA) and the American Chemical Society (ACS) list the following possible disposal methods:

Sanitary landfills, hazardous waste landfills, sewer system (regulations differ for different locations), thermal treatments (incineration), recycling or reuse, chemical, physical, or biological treatments, including neutralization, oxidation, precipitation, and solidification.

1.	Materials are disposed of following appropriate MSDS sheet instruction or local, state or federal regulations.	**S**	**U**	**NA**

CHEMICAL HYGIENE CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate choice for each of the items on the checklist:

S = Satisfactory (item meets guideline, no action needed)
U = Unsatisfactory (item does not meet guideline, corrective action required)
NA = Not applicable (item does not apply to this room or activity)

The school's chemical hygiene plan for science laboratories includes:

1.	Development of a statement that includes clearly defined responsibilities of the superintendent, principles, department chairs, classroom teachers, and parents.	**S**	**U**	**NA**
2.	Inclusion of a laboratory safety program as part of the curriculum and instruction.	**S**	**U**	**NA**
3.	Regular training for all staff on safety policies, record keeping, and other procedures.	**S**	**U**	**NA**
4.	Evaluation of laboratory facilities and procurement of equipment needed	**S**	**U**	**NA**
5.	Development and enforcement of a plan for monitoring safety equipment and storage areas.	**S**	**U**	**NA**
6.	Preparation and storage of safety records, i.e., inventories, Materials Safety Data Sheet (MSDS), accident/incident reports, hazard notification reports.	**S**	**U**	**NA**
7.	Identification of hazardous chemicals and minimizing exposure to teachers and students, e.g., computerized/written inventory.	**S**	**U**	**NA**
8.	Development of safety policies and procedures for procurement, distribution, storage, and disposal of chemicals, e.g., using MSDS file.	**S**	**U**	**NA**
9.	Development of a written emergency plan and practiced procedures for spills or accidents involving chemicals.	**S**	**U**	**NA**
10.	Implementation of a plan for posting signs and labels.	**S**	**U**	**NA**

ANIMAL AND PLANT CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate choice for each of the items on the checklist:

S = Satisfactory (item meets guidelines, no action needed)
U = Unsatisfactory (item does not meet guidelines, corrective action required)
NA = Not applicable (item does not apply for this room activity)

The following precautions are taken when using animals for plants in the laboratory:

A. Animals

1.	Teachers inquire about student allergies associated with animals.	**S**	**U**	**NA**
2.	Teachers allow students to handle/touch animals only after proper directions and demonstrations have been given.	**S**	**U**	**NA**
3.	Students use gloves while handling vertebrates and appropriate invertebrates and wash hands afterwards.	**S**	**U**	**NA**
4.	Teachers report to the principal and school nurse immediately and animal bites or scratches.	**S**	**U**	**NA**
5.	A veterinarian evaluates all animals that die unexpectedly.	**S**	**U**	**NA**
6.	Fecal matter is never disposed of in sinks or with commonly used equipment.	**S**	**U**	**NA**
7.	Wild animals are never used. Classroom animals are for reputable suppliers.	**S**	**U**	**NA**
8.	Poisonous animals are never in the classroom.	**S**	**U**	**NA**
9.	Students are never allowed to tease animals or touch animals to their mouths.	**S**	**U**	**NA**

B. Plants

1.	Teachers inquire beforehand about student allergies associated with plants.	**S**	**U**	**NA**
2.	Poisonous or allergy-causing plants are never used in the classroom.	**S**	**U**	**NA**
3.	Plant that might contain allergy- causing oils, e.g., poison ivy are never burned.	**S**	**U**	**NA**
4.	A clear distinction is made between edible and non-edible plants.	**S**	**U**	**NA**
5.	Plants are never tasted without clear direction from the teacher.	**S**	**U**	**NA**
6.	Students use gloves while handling plants and wash hands afterwards.	**S**	**U**	**NA**

SCIENCE LABORATORY PROTECTIVE EQUIPMENT CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate choice for each of the items on the checklist:

S = Satisfactory (item meets guideline (no action needed)
U = Unsatisfactory (item does not meet guideline (corrective action required)
NA = Not Applicable (item does not apply for this room or activity)

The following protective equipment is kept/provided in a laboratory for teachers and students to use:

1.	Master shut off valves/switches should be located within each laboratory, preferably in one secure location accessible only to the instructor. Water, gas, and electricity should be turned off when not in use.	**S**	**U**	**NA**
2.	Adequate numbers of tri-class ABS fire extinguishers should be strategically placed within 30 steps or 15 seconds of any location in the room. These should be checked and certified as fully charged and in working order at least every sic months.	**S**	**U**	**NA**
3.	Multiple faucet-type portable eyewash stations should be strategically placed with 30 steps for 15 seconds from any location in the room. Eye wash stations should forearm or foot-operated for hand-free operation. Flow rate of potable water at 1.5 gallon/minute at pressure below 25 p.s.i is recommended if a standard eyewash station is installed.	**S**	**U**	**NA**
4.	Forearm or foot-operated face/body sprayers, with adequate flexible hoses and water pressure, should strategically placed within 30 steps or 15 seconds from any location in the room. If a standard plumbed safety shower unit is used, it should provide potable water at a flow rate of 30-60 gallons/minute at a pressure of 20-50 p.s.i.	**S**	**U**	**NA**
5.	An appropriate fume hood, vented through the roof to at least 8 feet above the roof line, should have a face velocity of 60-100 feet/minute of air through the hood. The hood should not be within 10 feet of an exit or on a main aisle.	**S**	**U**	**NA**
6.	All electrical outlets within 5 feet of sinks and serving delicate electrical equipment should be fitted with Ground Fault interrupters (GFI). Where thunderstorm activity is a regular meteorological phenomenon, it is essential that outlets be equipped with GFI's. Outlets should be capped when not in use and placed along walls or counters at intervals of 6-8 feet.	**S**	**U**	**NA**

7.	Retardant-treated wool fire blankets, free of friable asbestos, should be prominently labeled and strategically placed within 30 steps or 15 seconds of any location in the room.	**S**	**U**	**NA**
8.	A bucket of dry, organics-free sand should be available foe alkali metals fires.	**S**	**U**	**NA**
9.	American National Standards Institute (ANSI) coded Z87 or Z87.1 approved safety goggles should be provided for each student when there is a danger of chemical projectile hazard. Specially marked, non-vented goggles should be available for contact lens wearers.	**S**	**U**	**NA**
10.	Sanitizing and/or sterilizing equipment or materials, e.g., ultraviolet cabinets or alcohol swabs, should be available and used between classes to clean safety goggles.	**S**	**U**	**NA**
11.	Non-absorbent, chemical-resistant aprons should be provided for each student during laboratory activities where there is danger of spilling or splattering of chemicals or hot liquids.	**S**	**U**	**NA**
12.	Heavy-gauge metal storage cans with an internal flame arrester (heat sump) should be used for storage and dispensing of flammable chemicals by teacher only.	**S**	**U**	**NA**
13.	Separate corrosives (primarily for acids) and Occupational Safety and Health Administration/National Fire Protection Association (OSHA/NFPA) approved flammable cabinets (primarily for alcohols and solvents) should be secured in the storeroom.	**S**	**U**	**NA**
14.	A container should be provided and clearly marked for the disposal of broken glass only.	**S**	**U**	**NA**
15.	Container of diatomaceous earth should be kept available for general chemical spills. Vinegar and sodium hydrogen carbonate are needed for neutralization of bases and acids respectively. An aspirator and a mercury spill kit should be available for mercury spills. Disinfectants and 10% Clorox bleach solution should be used to sterilize equipment and wash down counter tops.	**S**	**U**	**NA**
16.	An adequately stocked first-aid kit for teachers use should be easily accessible in an emergency.	**S**	**U**	**NA**
17.	Safety posters should be prominently displayed in room.	**S**	**U**	**NA**
18.	Emergency procedures and telephone numbers should be prominently posted in the room.	**S**	**U**	**NA**

SCIENCE LABORATORY PHYSICAL LAYOUT/SPECIFICATION CHECKLIST

School_____ **Date**_____

Room Number(s)_____ **Teacher**_____

Type of Activity_____ **Evaluator**_____

Directions: Circle the appropriate fro each of the items on the checklist

S = Satisfactory (item meets guideline (no action needed)
U = Unsatisfactory (item does not meet guideline corrective action needed)
NA = Not Applicable (item does not apply for room or activity)

Laboratories comply with the following physical layout/specifications:

1.	The room should not be overcrowded, with 45-60 square feet of working space/student, depending upon the type of activity to be performed. It should be designed for no more than 24 students/teacher.	**S**	**U**	**NA**
2.	There should be no less the 6 linear feet (1.8 meters) of workspace per student in the classroom/laboratory.	**S**	**U**	**NA**
3.	In order to meet Americans with Disabilities Act (ADA) requirements for handicapped and disabled students, there should be an additional 20 square feet for working space per student.	**S**	**U**	**NA**
4.	Approximately 15 square feet per computer station, 10 square feet, for a T.V. with VCR or laser disc player, and 12 square feet for a projector should be added to total lab area to accommodate minimum technological equipment.	**S**	**U**	**NA**
5.	The room should have no blind spots where students cannot be observed and supervised.	**S**	**U**	**NA**
6.	General light should be between 538.2-1076.4 lumens per square meter with diffuse lighting preferred.	**S**	**U**	**NA**
7.	Aisle width should be adequate (4-5 feet to accommodate handicapped students and equipment needs.	**S**	**U**	**NA**
8.	The room should have two exits, both opening outward and at least 5 feet wide to accommodate handicapped students and facilities equipment carts and emergency exits. Doors should have reinforced glass viewing windows or peepholes.	**S**	**U**	**NA**

9.	During labs, air in the room should be regularly recycled and mixed with outside air at a rate of 4-12 complete laboratory air changes per hour, depending on the chemical used.	**S**	**U**	**NA**
10.	The exhaust ventilation system should be separate from that of the chemical fume hood and should meet the American National Standards Institutes (ANSI) Z9.5 Standard.	**S**	**U**	**NA**
11.	For high school labs where chemicals of low to moderate toxicity are used, at least one functioning exhaust hood (portable or permanent) that meets American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHREA)110 testing standard, with a face velocity of approximately 80-120 linear feet/minute (24.4-36.6 meters/minute), should be provided. Exhaust should be vented to the outside through the roof or outside wall. A common through-the-wall hood may serve the laboratory and preparation room. Exhaust hood(s) should be located away (10 feet or 3.1 meters) from entrances/exits, windows, intake ducts and high traffic areas.	**S**	**U**	**NA**
12.	There should be a telephone or intercom for notifying the office and other emergencies.	**S**	**U**	**NA**
13.	Tile floors should be covered with a nonskid wax.	**S**	**U**	**NA**
14.	There should be lockable storage for certain items. Emergency/master shut-off controls fro water, gas. And electricity should be in a securable location near the teacher station.	**S**	**U**	**NA**
15.	There should be sufficient electrical outlets located at intervals of 6-8 feet that make extension cords unnecessary. They should be capped when not in use. Those outlets within 5 feet of water should be equipped with Ground Fault Interrupters. (GFI'S)	**S**	**U**	**NA**
16.	Goose-neck faucets should be used on sinks to allow attachment of portable eye-washes and shower hoses.	**S**	**U**	**NA**
17.	Lab surfaces should be made of material unaffected by acids, alkalis, solvents, and temperate heat.	**S**	**U**	**NA**

A P P E N D I X G

USE OF LASERS IN CLASSROOMS

The Bureau of Radiological Health and others have suggested the following guidelines for the safe use of lasers.

1. **Avoid direct viewing of the beam.** Direct propagation of the laser beam from the laser into the eye of an observer should be avoided at all times since a serious retinal burn and even blindness could result. Eye protection devices that are "certified-for-use-with-laser" should be worn whenever a laser is producing radiation outside the visible region of the spectrum. As a general practice, do not place any portion of the body in the beam. This practice becomes increasingly important as the output power of the laser device increases. Good work practices developed early will assist the individual in working safely later with higher output units.

2. **Remove unnecessary objects from the path of the beam.** Objects with mirror-like finishes reflect laser beams. Viewing the reflected beams should also be avoided. Demonstration equipment, such as support rods and bench surfaces, should be painted or treated to produce a dull, non-reflective surface. All optical components should be rigidly fixed with respect to their position to the laser.

3. **Block the beam when it is needed.** Add a shutter or cap which can be operated to allow the beam to radiate ONLY when necessary for measurements or observations.

4. **Terminate laser beams.** All radiation beams from a laser should be terminated by non-reflective, absorbing material to prevent unnecessary propagation beyond the work area. Such targets should be fixed rigidly to prevent accidental displacement of terminating materials.

5. **Prepare and test demonstrations without others present.** Demonstrations should be prepared and tested by the instructor without others present. The possibility of an unexpected reflection should always be considered.

6. **Deflect beam in a vertical plane.** Complex experiments or demonstrations involving reflection or refraction should be conducted with the beam deflection angles contained in a vertical plane. The laser display system should be contained in a box, open on the side(s), but closed on the ends, top and bottom. The height of the laser beam axis should be established at a level below or above the eye level height of the instructor or observers.

7. **Affix expanding lens rigidly to laser.** When the laser is used to illuminate large surfaces, such as in the viewing of holograms, beam-expanding lenses should be rigidly fixed to the laser.

8. **Equip laser with a key switch.** The laser should be equipped with a key switch in the primary power circuit, rather than the more commonly used toggle-type switch. Key switches are available from electronic supply stores for approximately $2.00.

9. **Do not leave an operable laser accessible and unattended.** Render the laser inoperable when not in authorized use.

10. **Reduce optical power.** The optical power used should be reduced to the minimum necessary to accomplish the classroom objective. Neutral density filters or colored plastic can be used effectively to reduce radiated optical power.

11. **Instruction manual.** Keep available the instruction manual and any safety advice or information for the laser device that is being used.

12. **Post sign when laser is in use.** Post a sign on the entrance to the area whenever a laser is in use -- "CAUTION, LASER IN USE -- Do not enter without permission of the instructor."

A P P E N D I X H

EYE PROTECTION LAW

Title 14

Delaware Code

EYE PROTECTION DEVICES

#8301. **Definitions**

As used in this sub-chapter –
Eye protection areas" means vocational or industrial arts shops, science or other school laboratories, or school or institutional facilities in which activities take place involving:

i. Hot molten metals;

ii. Milling, sawing, turning, shaping, cutting, grinding, or stamping of any solid materials;

iii. Heat treatment, tampering of kiln firing of any metal or other materials;

iv. Gas or electric arc welding;

v. Repair or servicing of any vehicle or mechanical equipment;

vi. Corrosive or explosive materials;

vii. Custodial or other service activity potentially hazardous to the eye;
or

viii. Any other activity or operation involving mechanical or manual work in any area that is potentially hazardous to the eye.

#8302. **Eye protection devices required in schools**

"Every person shall wear eye protection devices when entering, participating in, observing or performing any function in connection with, any course or activity taking place in eye protection areas of any school, college, university or other public or private educational institution in this State. Persons covered in this section include, without limitation, any student or teacher in, staff member or other employee of, or visitor to, any of the foregoing educational institutions."

#8303. **Eye protection device standards**

"Eye protection devices, which shall include safety spectacles, plastic face shields or goggles, shall comply with the American Standards Association Safety Code for Head, Eye, and Respiratory Protection."

#8304. **Instruction for compliance**

"The State Department of Public Instruction shall prepare and circulate to each public or private educational institution in this State a manual containing instructions and recommendations for the guidance of such institution in implementing the eye safety provisions of this sub-chapter."

#4109. **Fire extinguishers and fire drills; duties of School Boards**

(a) Every public school shall be equipped with an adequate number of fire extinguishers and shall hold a fire drill at least once every month while the school is in session.

(b) Each Board of Education shall see that the requirements of subsection (a) of this section are complied with in the schools under their respective jurisdictions.

#6801. **Good Samaritan Act**

Any person, who in good faith gratuitously renders emergency care at the scene of an accident or emergency to a victim thereof, shall not be liable for any civil damages for any personal injury resulting from an act or omission by the person rendering the emergency care or as a result of any act or failure to act to provide or arrange for further medical treatment or care for the injured person, except acts or omissions amounting to gross negligence or willful or wanton misconduct. The exemptions from civil liability provided by this chapter shall not apply to the administering of such care where the same is rendered for remuneration or with the expectation of remuneration, or is rendered by any person or agent of a principal who was at the scene of the accident or emergency because he or his principal was soliciting business or performing or seeking to perform emergency care services for remuneration. (16 Del. C. 1953, #6801; 58 Del. Laws, c. 105; 59 Del. Laws, c. 361, #1.)

A P P E N D I X I

EYE PROTECTION ACTIVITY AREAS

The following table indicates the recommended eye protection devices for various activity areas and the related hazards.

OPERATION OR ACTIVITY AREA	EYE HAZARDS	EYE PROTECTION DEVICES
Auto Mechanics		
Welding, electric arc	Welding flashes, flying sparks	Welding helmet
Gas, welding, cutting, and burning		
Cleaning overhead	Hot metal splatters	Welding goggles
Grinding and other work		
	Flying dusts, splashes	Chemical goggles
	Flying chips, dusts, splashes	Safety spectacles with full side shield Chemical goggles Face shield**
Administration	The same eye protection devises as prescribed for students in various areas of activity are required for administrative personnel	
Chipping		
Cold chisel, drill press, grinding, metal sanding, milling, pressure greasing, shaping, machine spray painting, steam cleaning	Flying chips, dusts, splashes	Safety spectacles with full side shields Chemical goggles Face shield**
Commercial Art		
Spray painting and other work	Sprays	Safety spectacles with full side shields
Commercial Food		
Cooking	Flying hot greases	Safety spectacles with full side shields
Ceramics		
Kiln inspection during firing and unloading, potters wheel, spraying glaze	Air bubble explosion, flying clay, clay particles, fluids	Safety spectacles with full side shields Face shield**
Cooper Enameling		
Enameling, kiln firing	Air bubble explosions, flying dust particles, enamel chips	Safety spectacles with full side shields Face shield**

****Must be worn over primary protective device.**

OPERATION OR ACTIVITY AREA	EYE HAZARDS	EYE PROTECTION DEVICES
Electric Shop Grinding and other work	Flying borings, chips, dusts	Safety spectacles with full side shields
Electricity/Electronics Drilling, hand and machine boring, metal lathe turning, hand and machine punching, soldering, spring winding, tube handling, wire stripping	Flying metals and wood chips, glass, wire spring, splattering solder	Safety spectacles with full side shields
Foundry Work Chipping and filing castings, sand packing a flask Heating and pouring metal	Flying chips, sand, parting compounds Splashing and sputtering molten metals	Safety spectacles with full side shields Face shield**
General Metals (Sheet, Art, and Bench Metal) Annealing, bending and shaping metals, butting, chiseling metals, drill press, etching, metal spinning, pickling of metals, riveting, sawing metals, snipping metals, soldering, tinning a copper	Flying chips, chunks, projectiles, lubricants, lint, buffing compounds, sparks, abrasives, rivets, sputtering solder, flux, splashing acids, fluids	Safety spectacles with full side shields
Graphic Arts Darkroom chemicals, knives for cutting silk screen, offset press, wire stitcher	Chemical splashes, flying metals, improper handling of knives	Safety spectacles with full side shields
Home Economics Cooking	Flying hot greases	Safety spectacles with full side shields
Instruction	The same eye protection devices as prescribed for students in various areas of activity are required for institutional personnel	
Jewelry Work Silver soldering, chasing, forging, bending, casting, sawing and pickling	Sputtering metals, flux, flying chips, wire ends, broken saw blades, acid splashes	Safety spectacles with full side shields Chemical Goggles
Lasers	SEE *APPENDIX G*	
Leather Carving Carving, stamping	Flying chips	Safety spectacles

****Must be work over primary protective device.**

OPERATION OR ACTIVITY AREA	EYE HAZARDS	EYE PROTECTION DEVICES
Leather Carving		
Carving, stamping	Flying chips	Safety spectacles
Mosaic Tile Work		
Cutting tile	Flying chips	Safety spectacles
Machine Shop		
Cylindrical grinder, surface grinder, grinders, lathe milling, machine, shaper, and other work	Flying chips, dusts, shavings, splashes	Safety spectacles with full side shields Chemical Goggles Face shield**
Bench grinder, chipping, filing and scraping drill press, lathe milling machine, power hacksaw, shaper, surface grinder	Flying abrasive chips, cuttings, cutter teeth, broken cutters, piece being machined, sparks, splashing, cutting, fluids	Safety spectacles with full side shields Chemical goggles Face shield**
Metallurgy Lab		
Lead pot, heat treating and salt bath furnaces	Flying hot metals, hot molten, molten splashes	Chemical goggles Face shield**
Grinders, polishing, tensile tester, and other work	Flying dusts and particles, splashes	Safety spectacles with full side shields Chemical goggles Face shield**
Maintenance and Custodial	Flying objects, splashes of corrosive liquids, dusts	Chemical goggles
Plastics Area		
Buffing machine, carving, drill press, extruding heat, forming, portable drills, snaring, sawing, shaping machine	Flying broken drills, plastic chips, compound plastic dusts, splattering, broken parts	Safety spectacles with full side shields
Plumbing, Pipefitting, Welding		
Welding, electric arc	Welding flashes, sparks	Welding hood
Gas welding, cutting and burning Pressure testing	Hot metal splatters	Welding goggles
Grinding and other work	Flying metal splashes	Chemical goggles Face shield**
	Flying dusts	Safety spectacles with full side shields Chemical goggles Face shield**

****Must be work over primary protective device.**

OPERATION OR ACTIVITY AREA	EYE HAZARDS	EYE PROTECTION DEVICES
Printing		
Melting lead and other work	Ink splatter, flying dusts, solvents	Safety spectacles with full side shields
Radio and Television		
Buffing, grinding, soldering and other work	Flying chips, dusts, flux, loose wires	Safety spectacles with full side shields
Science Laboratories		
(Life, physical, earth science areas and science activities, K – 12)	Chemical storage or handling	Safety spectacles with full side shields
	Any activity or operation that is potentially dangerous to the eye	Chemical goggles Face shield**
Visitors	Visitors must wear eye protection devices as required for the activity in the area visited	
Welding		
Welding, electric arc	Welding, flashes, flying sparks, flux, sputtering welds, air bubble explosions	Welding helmet
Gas welding, cutting and burning	Flying sparks, metal, flux	Welding goggles
Chipping welds	Flying chips, slag	Face shield**
Other work	Flying chips, sparks	Safety spectacles with full side shields
Wire Work		
Shaping and forming	Moving unprotected ends	Safety spectacles with full side shields

****Must be worn over primary protective device.**

A P P E N D I X J

EYE SAFETY AND ECLIPSES

As with any eclipse of the sun, there are dangers in viewing it with the naked eye. It is possible to become blinded by viewing such an event. There are safe ways to view an eclipse. The following tips come from NASA RP 1344.

The sun can be viewed safely with the naked eye only during the few brief seconds or minutes of a *total* solar eclipse. Partial and annular solar eclipses are *never* safe to watch without taking special precautions. Even when 99% of the Sun's surface is obscured during the partial phases, the remaining photospheric crescent is intensely bright and cannot be viewed safely without eye protection [Chou, 1981; Marsh, 1982]. ***Do not attempt to observe the partial or annular phases of any eclipse with the naked eye. Failure to use appropriate filtration may result in permanent eye damage or blindness!***

Generally, the same equipment, techniques and precautions used to observe the Sun outside of the eclipse are required [Pasachoff & Covington, 1998; Pasachoff & Menzel, 1992; Sherrod, 1981]. There are several safe methods that may be used to watch the partial phases. The safest of these is projection, in which a pinhole or small opening is used to cast the image of the sun on a screen placed a half-meter or more beyond the opening. Projected images of the Sun may even be seen on the ground in the small openings created by interlacing fingers, or in the dappled sunlight beneath a leafy tree. Binoculars can also be used to project a magnified image of the Sun on a white card, but you must avoid the temptation of using these instruments for direct viewing.

Direct viewing of the sun should only be done using filters specifically designed for this purpose. Such filters usually have a thin layer of aluminum, chromium or silver deposited on their surfaces that attenuates both the visible and the infrared energy. Experienced amateur and professional astronomers may use one or two layers of completely exposed and fully developed black-and-white film, provided the film contains a silver emulsion. Since developed color films lack silver, they are unsafe for use in solar viewing. A widely available alternative for safe eclipse viewing is a number 14 welder's glass. However, only mylar or glass filters specifically designed for the purpose should be used with telescopes or binoculars.

Unsafe filters include color film, some non-silver black and white film, smoked glass, photographic neutral density filters and polarizing filters. Solar filters designed to thread into eyepieces and often sold with inexpensive telescopes are also dangerous. They should not be used for viewing the Sun at any time since they often crack from overheating. Do not experiment with other filters unless you are certain that they are safe. Damage to the eyes comes predominantly from invisible infrared wavelengths. The fact that the Sun appears dark in a filter or that you feel no discomfort does not guarantee that your eyes are safe. Avoid all unnecessary risks. Your local planetarium or amateur astronomy club is a good source for additional information.

A P P E N D I X K

INSTITUTE OF LABORATORY ANIMAL RESOURCES
COMMISSION ON LIFE SCIENCES
NATIONAL RESEARCH COUNCIL
NATIONAL ACADEMY OF SCIENCES
NATIONAL ACADEMY OF ENGINEERING

A. Principles and Guidelines for the Use of Animals

The humane study of animals in pre-college education can provide important learning experiences in science and ethics and should be encouraged. Maintaining classroom pets in preschool and grade school can teach respect for other species, as well as proper animal husbandry practices. Introduction of secondary school students to animal studies in closely supervised settings can reinforce those early lessons and teach the principles of humane care and use of animals in scientific inquiry. The National Research Council recommends compliance with the following principles whenever animals are used in pre-college education or in science fair projects.

Principle 1.

Observational and natural history studies that are not intrusive (that is, do not interfere with an animal's health or well-being or cause it discomfort) are encouraged for all classes or organisms. When an intrusive study of a living organism is deemed appropriate, consideration should be given first to using plants (including lower plants such as yeast and fungi) and invertebrates with no nervous systems or with primitive ones (including protozoa, planaria, and insects). Intrusive studies of invertebrates with advanced nervous systems (such as octopi) and vertebrates should be used only when lower invertebrates are not suitable and only under the conditions stated below in Principle 10.

Principle 2.

Supervision shall be provided by individuals who are knowledgeable about and experienced with the health, husbandry, care, and handling of the animal species used and who understand applicable laws, regulations and policies.

Principle 3.

Appropriate care for animals must be provided daily, including weekends, holidays, and other times when school is not in session. This care must include:

a. nutritious food and clean, fresh water;
b. clean housing with space and enrichment suitable for normal species behaviors; and
c. temperature and lighting appropriate for the species.

Principle 4.

Animals should be healthy and free of diseases that can be transmitted to humans or to other animals. Veterinary care must be provided as needed.

Principle 5.

Students and teachers should report immediately to the school health authority all scratches, bites, and other injuries; allergies; or illnesses.

Principle 6.

Prior to obtaining animals for educational purposes, it is imperative that the school develop a plan for their procurement and ultimate disposition. Animals must not be captured from or released into the wild without the approval of the responsible wildlife and public health officials. When euthanasia is necessary, it should be performed in accordance with the most recent recommendations of the American Veterinary Medical Association's Panel Report on Euthanasia (Journal of the American Veterinary Medical Association, 188[3]: 252-268, 1986, et seq.). It should be performed only by someone trained in the appropriate technique.

Principle 7.

Students shall not conduct experimental procedures on animals that:

b. are likely to cause pain or discomfort or interfere with an animal's health or well-being.
c. induce nutritional deficiencies or toxicities; or
d. expose animals to microorganisms, ionizing radiation, cancer producing agents, or any other harmful drugs or chemicals capable of causing disease, injury, or birth defects in humans or animals. In general, procedures that cause pain in humans are considered to cause pain in other vertebrates.

Principle 8.

Experiments on avian embryos that might result in abnormal chicks or in chicks that might experience pain or discomfort shall be terminated 72 hours prior to the expected date of hatching. The eggs shall be destroyed to prevent inadvertent hatching.

Principle 9.

Behavioral conditioning studies shall not involve aversive stimuli. In studies using positive reinforcement, animals should not be deprived of water; food deprivation intervals should be appropriate for the species but should not continue longer than 24 hours.

Principle 10.

A plan for conducting an experiment with living animals must be prepared in writing and approved prior to initiating the experiment or to obtaining the animals. Proper experimental design of projects and concern for animal welfare are important learning experiences and contribute to respect for and appropriate care of animals. The plan shall be reviewed by a committee composed of individuals who have the knowledge to understand and evaluate it and who have the authority to approve or disapprove it. The written plan should include the following:

a. a statement of the specific hypotheses or principles to be tested, illustrated, or taught;

b. a summary of what is known about the subject under study, including references;

c. a justification for the use of the species selected and consideration of why a lower vertebrate or invertebrate cannot by used; and

d. a detailed description of the methods and procedures to be used, including experimental design; data analysis; and all aspects of animal procurement, care, housing, use and disposal.

Exceptions: Exceptions to principles 7 - 10 may be granted under special circumstances by a panel appointed by the school principal or his or her designee. This panel should consist of at least three individuals including a science teacher, a teacher of a non-science subject, and a scientist or veterinarian who has expertise in the subject matter involved. At least one panel member should not be affiliated with the school or science fair, and none should be a member of the student's family. In situations where an appropriate scientist is not available to assist the student, the Institute of Laboratory Animal Resources (ILAR) might be able to provide referrals.

B. **Individuals Who Have Personal Beliefs Opposed to Dissection**

1. The teacher must be sensitive to the views of students regarding dissection, with an awareness of students' rights to their beliefs.

2. Should a science teacher feel that an alternative to dissection would be a better solution for a given student, it is important to select as meaningful an alternative as possible.

Science Service: International Science and Engineering Fair

Rules:

The booklet contains the rules for participation in the International Science and Engineering Fair (ISEF). The directors of all regional fairs which will be affiliated and participating in the ISEF must conduct the regional fair according to these rules. Copies of the booklet are available from:

Science Service,
1719 N Street, N.W.,
Washington, DC 20036

Permission to reprint with credit is granted. Rules may be updated yearly.

Before beginning any experimental work with vertebrate animals or humans, carefully read the rules in order to ensure compliance by the student experimenter. The following areas are the most critical in terms of compliance:

1. The use, misuse, and sacrifice of animals.

2. The use of toxic substances by the high school experimenter.

3. Nutritional deficiency experiments.

4. The use of humans in any way. Failure to comply with the rules regardless of the institutional rules will result in disqualification of the student from participation in competition in all ISEF affiliated fairs.

Recommendations:

The educational value of the selected student research topics should be the primary consideration of both the teachers and the fair directors. Science Service is proud to be associated in this important activity which provides incentives for the development of talent in scientific and technological fields among creative young people. We urge an increase in the efforts of all persons involved to extend and expand the influence and effectiveness of science and engineering fairs and we offer our continued assistance and counsel to help assure success. The development of the scientific method can be enhanced when teachers or supervisors insist that research has clearly defined objectives. Research should demonstrate scientific principles or answer propositions. It is suggested that this be completed before the student begins any research. A paper describing the research, notebooks, computer programs, or other relevant written materials are encouraged and may be displayed.

A P P E N D I X L

SCIENCE LABORATORY SAFETY GUIDELINES FOR SUBSTITUTE TEACHERS

Guidelines should be developed at each school to insure the safety of students in science labs when substitute teachers are employed. The following memo illustrates guidelines that are being used in at least one school in Delaware. Similar guidelines should be developed on a school-by-school basis in order to account for difference in physical facilities and local safety regulations.

MEMO TO: Science Staff

FROM: Principal

RE: SCIENCE SAFETY AND SUBSTITUTE TEACHERS

The following guidelines will be in effect for substitute teachers who are working in all science areas:

SCIENCE LABORATORY SAFETY GUIDELINES FOR SUBSTITUTE TEACHERS:

The following guidelines should be followed in order to insure the safety of students in science labs when substitute teachers are employed:

EARTH SCIENCE **No labs.**

BIOLOGY **No labs.**

CHEMISTRY **No labs.**

PHYSICS **No labs.**

1. It is the responsibility of the teacher to insure that lesson plans left for substitutes conform to these guidelines.

2. Substitute teachers with previous training, experience, or educational background in science safety may be exempted from these guidelines. It is, however, the responsibility of the Principal to insure that the substitute meets acceptable criteria for knowledge of safety procedures.

3. Substitute teachers who will be teaching in a particular class for extended period of time should receive safety instruction so that the normal laboratory instructional program can continue.

A copy of these guidelines should be included in the substitute teacher folder of all science teachers.

A P P E N D I X M

DELAWARE EMERGENCY TREATMENT DATA CARD

Student's Name_____ Birth Date_____School District_____
Last Name First Name Middle Initial
School_____Grade_____Homeroom or Teacher_____
Home Address_____Development_____HomePhone_____
Mother/Guardian's Name_____Father/Guardian's Name_____
Mother's Place of Employment Phone_____Ext._____
Father's Place of Employment Phone_____Ext._____
If parents/guardians cannot be reached, call:
1._____
Name Address Phone
2._____
Name Address Phone
Family Physician_____Phone_____ Family Dentist Phone_____
Indicate student's serious medical
problems_____
Student is allergic to: ( ) Penicillin ( ) Aspirin ( ) Other_____
Medical Insurance: Medicaid No._____Blue Cross/Blue Shield_____
Certificate No. Group No. Type
Other Insurance: _____
(Please turn card over for parent/guardian signature.) (over)

SCHOOL EMERGENCY PROCEDURES

Your schools have adopted the following procedures in caring for your child when he/she becomes sick or injured at school:

In case of emergency and/or need of medical or hospital care:

1. The school will call the home. If there is no answer,
2. The school will call the father's, mother's or guardian's place of employment. If there is no answer,
3. The school will call the other telephone number(s) listed and the physician.
4. If none of the above answer, the school will call an ambulance, if necessary, to transport the child to a local medical facility.
5. Based upon the medical judgment of the attending physician, the child may be admitted to a local medical facility.
6. The school will continue to call the parents, guardians or physician until one is reached. If I cannot be reached and the school authorities have followed the procedures described, I agree to assume all expenses for moving and medically treating this student. I also hereby consent to any treatment, surgery, diagnostic procedures or the administration of anesthesia which may be carried out based on the medical judgment of the attending physician.

Parent/Guardian Signature_____Date_____

A P P E N D I X N

LIST OF EXTREMELY HAZARDOUS SUBSTANCES AND THEIR THRESHOLD PLANNING QUANTITIES

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
75.86.5	Acetone Cyanohydrin		10 1000
1752.30.3	Acetone Thiosemicarbazide	e	1 1000/10000
107.02.8	Acrolein		1 500
79.06.1	Acrylamide	d,l	5000 1000/10000
107.13.1	Acrylonitrile	d,l	100 10000
814.68.6	Acrylyl Chloride	e,h	1 100
111.69.3	Adiponitrile	e,l	1 1000
116.06.3	Aldicarb	c	1 100/10000
309.00.2	Aldrin	d	1 500/10000
107.18.6	Allyl Alcohol		100 1000
107.11.9	Allylamine	e	1 500
20859.73.8	Aluminum Phosphide	b	100 500
54.62.6	Aminopterin	e	1 500/10000
78.53.5	Amiton	e	1 500
3734.97.2	Amiton Oxalate	e	1 100/10000
7664.41.7	Ammonia	l	100 500
300.62.9	Amphetamine	e	1 1000
62.53.3	Aniline	d,l	5000 1000
88.05.1	Aniline, 2,4,6-trimethyl-	e	1 500
7783.70.2	Antimony Pentafluoride	e	1 500
1397.94.0	Antimycin A	c,e	1 1000/10000
86.88.4	ANTU		100 500/10000
1303.28.2	Arsenic Pentoxide	d	5000 100/10000
1327.53.3	Arsenous Oxide	d,h	5000 100/10000
7784.34.1	Arsenous Trichloride	d	5000 500
7784.42.1	Arsine	e	1 100
2642.71.9	Azinphos-Ethyl	e	1 100/10000
86.50.0	Azinphos-Methyl		1 10/10000
98.87.3	Benzal Chloride	d	5000 500
98.16.8	Benzenamine, 3-(Trifluoromethyl)-	e	1 500
100.14.1	Benzene, 1-(Chloromethyl)-4-Nitro	e	1 500/10000
98.05.5	Benzenearsonic Acid	e	1 10/10000
3615.21.2	Benzimidazole, 4,5-Dichloro-2-(Trifluoromethyl)-	e,g	1 500/10000
98.07.7	Benzotrichloride	d	1 100
100.44.7	Benzyl Chloride	d	100 500
140.29. 4	Benzyl Cyanide	e,h	1 500
15271.41.7	Bicyclo[2,2,1] Heptane-2-Carbonitrile, 5-Chloro-6-	e	1 500/10000
15271.41.7	((((Methylamino)Carbonyl)Oxy)Imino)-, (1s-(1-alpha,		
15271.41.7	2-beta, 4-alpha, 5-alpha, 6E))-		
534.07.6	Bis (Chloromethyl) Ketone	e	1 10/10000
4044.65.9	Bitoscanate	e	1 500/10000
10294.34.5	Boron Trichloride	e	1 500
7637.07.2	Boron Trifluoride	e	1 500
353.42.4	Boron Trifluoride with Methyl Ether (1:1)	e	1 1000
28772.56.7	Bromadiolone	e	1 100/10000

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
7726.95.6	Bromine	e,l	1 500
1306.19.0	Cadmium Oxide	e	1 100/10000
2223.93.0	Cadmium Stearate	c,e	1 1000/10000
7778.44.1	Calcium Arsenate	d	1000 500/10000
8001.35.2	Camphechlor	d	1 500/10000
56.25.7	Cantharidin	e	1 100/10000
51.83.2	Carbachol Chloride	e	1 500/10000
26419.73.8	Carbamic Acid, Methyl-, O-((		
	(2,4-Dimethyl-1,3	e	1 100/10000
26419.73.8	Dithiolan-2-Yl) Methylene)Amino)-		
1563.66.2	Carbofuran		10 10/10000
75.15.0	Carbon Disulfide	l	100 10000
786.19.6	Carbophenothion	e	1 500
57.74.9	Chlordane	d	1 1000
470.90.6	Chlorfenvinfos	e	1 500
7782.50.5	Chlorine		10 100
24934.91.6	Chlormephos	e	1 500
999.81.5	Chlormequat Chloride	e,h	1 100/10000
79.11.8	Chloroacetic Acid	e	1 100/10000
107.07.3	Chloroethanol	e	1 500
627.11.2	Chloroethyl Chloroformate	e	1 1000
67.66.3	Chloroform	d,l	5000 100 00
542.88.1	Chloromethyl Ether	d,h	1 100
107.30.2	Chloromethyl Methyl Ether	c,d	1 100
3691.35.8	Chlorophacinone	e	1 100/10000
1982.47.4	Chloroxuron	e	1 500/10000
21923.23.9	Chlorthiophos	e,h	1 500
10025.73.7	Chromic Chloride	e	1 1/1000
62207.76.5	Cobalt, ((2,2-(1,2-Ethanediylbis		
	(Nitrilomethylidyne)	e	1 100/1000
	Bis(6-Fluorophenolato))(2-)-N,N,O,O)-		
10210.68.1	Cobalt Carbonyl	e,h	1 10/10000
64.86.8	Colchicine	e,h	1 10/10000
56.72.4	Coumaphos		10 100/10000
5836.29.3	Coumatetralyl	e	1 500/10000
95.48.7	Cresol, o-	d	10001000/10000
535.89.7	Crimidine	e	1 100/10000
4170.30.3	Crotonaldehyde		100 1000
123.73.9	Crotonaldehyde, (E)-		100 1000
506.68.3	Cyanogen Bromide		1000 500/10000
506.78.5	Cyanogen Iodide	e	1 1000/10000
2636.26.2	Cyanophos	e	1 1000
675.14.9	Cyanuric Fluoride	e	1 100
66.81.9	Cycloheximide	e	1 100/10000
108.91.8	Cyclohexylamine	e,l	1 10000
17702.41.9	Decaborane(14)	e	1 500/10000
8065.48.3	Demeton	e	1 500
919.86.8	Demeton-S-Methyl	e	1 500
10311.84.9	Dialifor	e	1 100/10000
19287.45.7	Diborane	e	1 100
111.44.4	Dichloroethyl Ether	d	1 10000
149.74.6	Dichloromethylphenylsilane	e	1 1000

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
62.73.7	Dichlorvos		10 1000
141.66.2	Dicrotophos	e	1 100
1464.62.6	Diepoxybutane	d	1 500
814.49.3	Diethyl Chlorophosphate	e,h	1 500
1642.54.2	Diethylcarbamazine Citrate	e	1 100/10000
71.63.6	Digitoxin	c,e	1 100/10000
2238.07.5	Diglycidyl Ether	e	1 1000
20830.75.5	Digoxin	e,h	1 10/10000
115.26.4	Dimefox	e	1 500
60.51.5	Dimethoate		10 500/10000
2524.03.0	Dimethyl Phosphorochloridothioate	e	1 500
77.78.1	Dimethyl Sulfate	d	1 500
75.18.3	Dimethyl Sulfide	e	1 100
75.78.5	Dimethyldichlorosilane	e,h	1 500
57.14.7	Dimethylhydrazine	e	1 1000
99.98.9	Dimethyl-p-Phenylenediamine	e	1 10/10000
644.64.4	Dimetilan		1 500/10000
534.52.1	Dinitrocresol		10 10/10000
88.85.7	Dinoseb		1000100/10000
1420.07.1	Dinoterb	e	1 500/10000
78.34.2	Dioxathion	e	1 500
82.66.6	Diphacinone	e	1 10/10000
152.16.9	Diphosphoramide, Octamethyl-		100 100
298.04.4	Disulfoton		1 500
514.73.8	Dithiazanine Iodide	e	1 500/10000
541.53.7	Dithiobiuret		100 100/10000
316.42.7	Emetine, Dihydrochloride	e,h	1 1/10000
115.29.7	Endosulfan		1 10/10000
2778.04.3	Endothion	e	1 500/10000
72.20.8	Endrin		1 500/10000
106.89.8	Epichlorohydrin	d,l	1000 1000
2104.64.5	EPN	e	1 100/10000
50.14.6	Ergocalciferol	c,e	1 1000/10000
379.79.3	Ergotamine Tartrate	e	1 500/10000
1622.32.8	Ethanesulfonyl Chloride, 2-Chloro-	e	1 500
10140.87.1	Ethanol, 1,2,Dichloro-, Acetate	e	1 1000
563.12.2	Ethion		10 1000
13194.48.4	Ethoprophos	e	1 1000
538.07.8	Ethylbis(2-Chloroethyl)Amine	e,h	1 500
371.62.0	Ethylene Fluorohydrin	c,e,h	1 10
75.21.8	Ethylene Oxide	d,l	1 1000
107.15.3	Ethylenediamine		5000 10000
151.56.4	Ethyleneimine	d	1 5000
542.90.5	Ethylthiocyanate	e	1 10000
22224.92.6	Fenamiphos	e	1 10/10000
122.14.5	Fenitrothion	e	1 500
115.90.2	Fensulfothion	e,h	1 500
4301.50.2	Fluenetil	e	1 100/10000
7782.41.4	Fluorine	k	10 500
640.19.7	Fluoroacetamide	j	100 100/10000
144.49.0	Fluoroacetic Acid	e	1 10/10000
359.06.8	Fluoroacetyl Chloride	c,e	1 10
51.21.8	Fluorouracil	e	1 500/10000

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
944.22.9	Fonofos	e	1 500
500.00.0	Formaldehyde	d,l	1000 500
107.16.4	Formaldehyde Cyanohydrin	e,h	1 1000
23422.53.9	Formetanate Hydrochloride	e,h	1 500/10000
2540.82.1	Formothion	e	1 100
17702.57.7	Formparanate	e	1 100/10000
21548.32.3	Fosthietan	e	1 500
3878.19.1	Fuberidazole	e	1 100/10000
110.00.9	Furan		100 500
13450.90.3	Gallium Trichloride	e	1 500/10000
77.47.4	Hexachlorocyclopentadiene	d,h	1 100
4835.11.4	Hexamethylenediamine, N,N-Dibutyl-	e	1 500
302.01.2	Hydrazine	d	1 1000
74.90.8	Hydrocyanic Acid		10 100
7647.01.0	Hydrogen Chloride (gas only)	e,l	1 500
7664.39.3	Hydrogen Fluoride		100 100
7722.84.1	Hydrogen Peroxide (conc > 52%)	e,l	1 1000
7783.07.5	Hydrogen Selenide	e	1 10
7783.06.4	Hydrogen Sulfide	l	100 500
123.31.9	Hydroquinone	e	1 500/10000
13463.40.6	Iron, Pentacarbonyl-	e	1 100
297.78.9	Isobenzan	e	1 100/10000
78.82.0	Isobutyronitrile	e,h	1 1000
102.36.3	Isocyanic Acid, 3,4,-Dichlorophenyl Ester	e	1 500/10000
465.73.6	Isodrin	1	100/10000
55.91.4	Isofluorphate	c	100 100
4098.71.9	Isophorone Diisocyante	b,e	1 100
108.23.6	Isopropyl Chloroformate	e	1 1000
625.55.8	Isopropyl Formate	e	1 500
119.38.0	Isopropylmethylpyrazolyl Dimethylcarbamate	e	1 500
78.97.7	Lactonitrile	e	1 1000
21609.90.5	Leptophos	e	1 500/10000
541.25.3	Lewisite	c,e,h	1 10
58.89.9	Lindane	d	1 1000/10000
7580.67.8	Lithium Hydride	b,e	1 100
109.77.3	Malononitrile		100500/10000
12108.13.3	Manganese, Tricarbonyl Methylcyclopentadienyl	e,h	1 100
51.75.2	Mechlorethamine	c,e	1 10
950.10.7	Mephosfolan	e	1 500
1600.27.7	Mercuric Acetate	e	1 500/10000
7487.94.7	Mercuric Chloride	e	1 500/10000
21908.53.2	Mercuric Oxide	e	1 500/10000
10476.95.6	Methacrolein Diacetate	e	1 1000
760.93.0	Methacrylic Anhydride	e	1 500
126.98.7	Methacrylonitrile	h	1 500
920.46.7	Methacryloyl Chloride	e	1 100
30674.80.7	Methacryloyloxyethyl Isocyanate	e,h	1 100
10265.92.6	Methamidophos	e	1 100/100005
58.25.8	Methanesulfonyl Fluoride	e	1 1000
950.37.8	Methidathion	e	1 500/10000
2032.65.7	Methiocarb		10 500/10000
16752.77.5	Methomyl	h	100 500/10000

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
151.38.2	Methoxyethylmercuric Acetate	e	1 500/10000
90.63.7	Methyl 2-Chloroacrylate	e	1 500
74.83.9	Methyl Bromide	l	1000 1000
79.22.1	Methyl Chloroformate	d,h	1000 500
624.92.0	Methyl Disulfide	e	1 100
60.34.4	Methyl Hydrazine		10 500
624.83.9	Methyl Isocyanate	f	1 5005
56.61.6	Methyl Isothiocyanate	b,e	1 500
74.93.1	Methyl Mercaptan		100 500
3735.23.7	Methyl Phenkapton	e	1 500
676.97.1	Methyl Phosphonic Dichloride	b,e	1 100
556.64.9	Methyl Thiocyanate	e	1 10000
78.94.4	Methyl Vinyl Ketone	e	1 10
502.39.6	Methylmercuric Dicyanamide	e	1 500/10000
75.79.6	Methyltrichlorosilane	e,h	1 500
1129.41.5	Metolcarb	e	1 100/10000
7786.34.7	Mevinphos		10 500
315.18.4	Mexacarbate		1000 500/10000
50.07.7	Mitomycin C	d	1 500/10000
6923.22.4	Monocrotophos	e	1 10/10000
2763.96.4	Muscimol	e,h	1000 10000
505.60.2	Mustard Gas	e,h	1 500
13463.39.3	Nickel Carbonyl	d	1
154.11.5	Nicotine	c	100 100
65.30.5	Nicotine Sulfate	e	1 100/10000
7697.37.2	Nitric Acid		1000 1000
10102.43.9	Nitric Oxide	c	10 100
98.95.3	Nitrobenzene	l	1000 10000
1122.60.7	Nitrocyclohexane	e	1 500
10102.44.0	Nitrogen Dioxide		10 100
62.75.9	Nitrosodimethylamine	d,h	1 1000
991.42.43	Norbormide	e	1 100/10000
0	Organorhodium Complex (PMN.82.147)	e	1 10/10000
630.60.4	Ouabain	c,e	1 100/10000
23135.22.0	Oxamyl	e	1 100/10000
78.71.7	Oxetane, 3,3 -Bis(Chloromethyl)-	e	1 500
2497.07.6	Oxydisulfoton	e,h	1 500
10028.15.6	Ozone	e	1 100
1910.42.5	Paraquat	e	1 10/10000
2074.50.2	Paraquat Methosulfate	e	1 10/10000
56.38.2	Parathion	c,d	1 1000
298.00.0	Parathion-Methyl	c	100100/10000
12002.03.8	Paris Green	d	100500/10000
19624.22.7	Pentaborane	e	1 500
2570.26.5	Pentadecylamine	e	1 100/10000
79.21.0	Peracetic Acid	e	1 500
594.42.3	Perchloromethylmercaptan		100 500
108.95.2	Phenol		1000 500/10000
97.18.7	Phenol, 2,2 -Thiobis(4,6 -Dichloro)-	e	1 100/10000
4418.66.0	Phenol, 2,2 -Thiobis(4-Chloro-6-Methyl)-	e	1 100/10000
64.00.6	Phenol, 3 - (1-Methylethyl)-, Methylcarbamate	e	1 500/10000
58.36.6	Phenoxarsine, 10,10 - Oxydi-	e	1 500/10000
96.28.6	Phenyl Dichloroarsine	d,h	1 500

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
59.88.1	Phenylhydrazine Hydrochloride	e	1 1000/10000
62.38.4	Phenylmercury Acetate		100 500/10000
2097.19.0	Phenylsilatrane	e,h	1 100/10000
103.85.5	Phenylthiourea		100 100/10000
298.02.2	Phorate		10 10
4104.14.7	Phosacetim	e	1 100/10000
947.02.4	Phosfolan	e	1 100/10000
75.44.5	Phosgene	l	10 10
732.11.6	Phosmet	e	1 10/10000
13171.21.6	Phosphamidon	e	1 100
7803.51.2	Phosphine		100 500
2703.13.1	Phosphonothioic Acid,Methyl-O-Ethyl, O-(4-(Methylthio Phenyl) Ester	e	1 500
50782.69.9	Phosphonothioic Acid, Methyl-S(2-(Bis (1-Methylethyl) Amino)Ethyl)	e	1 100
2665.30.7	Phosphonothioic Acid, Methyl-O-(4-Nitrophenyl) O-Phenyl Ester	e	1 500
3254.63.5	Phosphoric Acid, Dimethyl 4-(Methylthio) Phenyl Ester	e	1 500
2587.90.8	Phosphorothioic Acid, O,O-Dimethyl-S-(2-Methylthio) Ethyl Ester	c,e,g	1 500
7723.14.0	Phosphorus	b,h	1 100
10025.87.3	Phosphorus Oxychloride	d	1000 500
10026.13.8	Phosphorus Pentachloride	b,e	1 500
1314.56.63	Phosphorus Pentoxide	b,e	1 10
7719.12.2	Phosphorus Trichloride		1000 1000
57.47.6	Physostigmine	e	1 100/10000
57.64.7	Physostigmine, Salicylate (1:1)	e	1 100/10000
124.87.8	Picrotoxin	e	1 500/10000
110.89.4	Piperidine	e	1 1000
5281.13.0	Piprotal	e	1 100/10000
23505.41.1	Pirimifos-Ethyl	e	1 100
10124.50.2	Potassium Arsenite	d	1000 500/10000
151.50.8	Potassium Cyanide	b	10 100
506.61. 6	Potassium Silver Cyanide	b	1 500
2631.37.0	Promecarb	e,h	1 500/10000
106.96.7	Propargyl Bromide	e	1 10
57.57.8	Propiolactone, Beta-	e	1 500
107.12.0	Propionitrile		10 500
542.76.7	Propionitrile, 3-Chloro-		1000 1000
70.69.9	Propiophenone, 4-Amino-	e,g	1 100/10000
109.61.5	Propyl Chloroformate	e	1 500
75.56.9	Propylene Oxide	l	100 10000
75.55.8	Propyleneimine	d	1 10000
2275.18.5	Prothoate	e	1 100/10000
129.00.0	Pyrene	c	50001000/10000
140.76.1	Pyridine, 2-Methyl-5-Vinyl-	e	1 500
504.15.5	Pyridine, 4-Amino-	h	1000500/10000
1124.33.0	Pyridine, 4-Nitro-, 1-Oxide	e	1 500/10000

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
53558.25.1	Pyriminil	e,h	1 100/10000
14167.18.1	Salcomine	e	1 500/10000
107.44.8	Sarin	e,h	1 10
7783.00.8	Selenious Acid		10 1000/10000
7791.23.3	Selenium Oxychloride	e	1 500
563.41.7	Semicarbazide Hydrochloride	e	1 1000/10000
3037.72.7	Silane, (4-Aminobutyl)Diethoxymethyl-	e	1 1000
7631.89.2	Sodium Arsenate	d	1001000/10000
7784.46.5	Sodium Arsenite	d	10500/10000
26628.22.78	Sodium Azide (NaN3)	b	1000 500
124.65.2	Sodium Cacodylate	e	1 100/10000
143.33.9	Sodium Cyanide (NaCN)	b	10 100
62.74.8	Sodium Fluorophenate		10 10/10000
131.52.2	Sodium Pentachlorphenate	e	1 100/10000
13410.01.0	Sodium Selenate	e	1 100/10000
10102.18.8	Sodium Selenite	h	100100/10000
10102.20.2	Sodium Tellurite	e	1 500/10000
900.95.8	Stannane, Acetoxytriphenyl-	e,g	1 500/10000
57.24.9	Strychnine	c	10 100/10000
60.41.3	Strychnine, Sulfate	e	1 100/10000
3689.24.5	Sulfotep		100 500
3569.57.1	Sulfoxide, 2-Chloropropyl Octyl	e	1 500
7446.09.5	Sulfur Dioxide	e,l	1 500
7783.60.0	Sulfur Tetrafluoride	e	1 100
7446.11.9	Sulfur Trioxide	b,e	1 100
7664.93.9	Sulfuric Acid		1000 10000
77.81.6	Tabun	c,e,h	1 10
13494.80.9	Tellurium	e	1 500/10000
7783.80.4	Tellurium Hexafluoride	e,k	1 100
107.49.3	TEPP		10 100
13071.79.9	Terbufos	e,h	1 100
78.00.2	Tetraethyllead	c,d	10 100
597.64.8	Tetraethyltin	c,e	1 100
75.74.1	Tetramethyllead	c,e,l	1 100
509.14.8	Tetranitromethane		10 500
10031.59.1	Thallium Sulfate	j	100 100/10000
6233.73.9	Thallous Carbonate	c,h	100 100/10000
7791.12.0	Thallous Chloride	c,h	100 100/10000
2757.18.8	Thallous Malonate	c,e,h	1 100/10000
7446.18.6	Thallous Sulfate		100 100/10000
2231.57.4	Thiocarbazide	e	1 1000/10000
39196.18.4	Thiofanox		100 100/10000
297.9702	Thionazin		100 500
108.98.5	Thiophenol		100 500
79.1936	Thiosemicarbazide		100 100/10000
5344.82.1	Thiourea, (2-Chlorophynyl)-		100 100/10000
614.78.8	Thiourea, (2-Methylphynyl)-	e	1 500/10000
7550.45.0	Titanium Tetrachloride	e	1 100
584.84.9	Toluene 2,4-Diisocyanate		100 500
91.08.7	Toluene 2,6-Diisocyanate		100 100
110.57.6	Trans-1,4-Dichlorobutene	e	1 500
1031.47.6	Triamiphos	e	1 500/10000
24017.47.8	Triazofos	e	1 500
76.02.8	Trichloroacetyl Chloride	e	1 500

CAS #	Chemical Name (in alpha order)	Notes	RQ TPQ
115.21.9	Trichloroethylsilane	e,h	1 500
327.98.0	Trichloronate	e,k	1 500
98.13.5	Trichlorophenylsilane	e,h	1 500
1558.25.4	Trichloro(Chloromethyl)Silane	e	1 100
27137.85.5	Trichloro(Dichlorophenyl)Silane	e	1 500
998.30.1	Triethoxysilane	e	1 500
75.77.4	Trimethylchlorosilane	e	1 1000
824.11.3	Trimethylpropane Phosphite	e,h	1 100/10000
1066.45.1	Trimethyltin Chloride	e	1 500/10000
639.58.7	Triphenyltin Chloride	e	1 500/10000
555.77.1	Tris(2-Chloroethyl)Amine	e,h	1 100
2001.95.8	Valinomycin	c,e	1 1000/10000
1314.62.4	Vanadium Pentoxide		1000 100/10000
108.05.4	Vinyl Acetate Monomer	d,l	5000 1000
81.81.2	Warfarin		100 500/10000
129.06.6	Warfarin Sodium	e,h	1 100/10000
28347.13.9	Xylylene Dichloride	e	1 100/10000
58270.08.9	Zinc, Dichloro(4,4-Dimethyl-5((((Methylamino)Carbonyl)Oxy)Imino)Pentanenitrile)-,(T-4)-	e	1 100/10000
1314.84.7	Zinc Phosphide	b	100 500

***** NOTES *****

RQ Reportable Quantity (in pounds)

TPQ Threshold Planning Quantity (in pounds)

a* Only the statutory or final RQ is shown. For more information, see 40CFR Table 302.4

b This material is a reactive solid. The TPQ does not default to 10,000 pounds for non-powder, non-molten, non-solution form.

c The calculated TPQ changed after technical review as described in the technical support document.

d Indicates the RQ is subject to change when the assessment of potential carcinogenicity and/or other toxicity is completed.

e Statutory reportable quantity for purposes of notification under SARA sect 304(a)(2)

f The statutory 1 pound reportable quantity for methylisocyanate may be adjusted in a future rule-making action.

g New chemicals added that were not part of the original list of 402 substances.

h Revised TPQ based on new or re-evaluated toxicity data.

j TPQ is revised to its calculated value and does not change due to technical review as in proposed rule.

k The TPQ was revised after proposal due to calculation error.

l Chemicals on the original list that do not meet the toxicity criteria but because of their high production volume and recognized toxicity are considered chemicals of concern ("Other Chemicals")

A P P E N D I X O

MODEL ROCKETRY STUDENT SAFETY PLEDGE
MODEL ROCKETRY SAFETY CODE

1. **Materials**. My model rocket will be made of lightweight materials such as paper, wood, rubber, and plastic suitable for the power used and the performance of my model rocket. I will not use any metal for the nose cone, body or fins of a model rocket.
2. **Motors**. I will use only commercially made, NAR-certified model rocket motors in the manner recommended by the manufacturer. I will not alter the model rocket motor, its parts, or its ingredients in any way.
3. **Recovery**. I will always use a recovery system in my model rocket that will return it safely to the ground so it may be flown again. I will use only flame-resistant recovery wadding if wadding is required by the design of my model rocket.
4. **Weight and Power Limits**. My model rocket will weigh no more than 1,500 grams (53 ounces) at lift-off and its rocket motors will produce no more than 320 Newton-seconds (71.9 pounds-second) of total impulse. My model rocket will weigh no more than the motor manufacturer's recommended maximum lift-off weight for the motors used, or I will use motors recommended by the manufacturer for my model rocket.
5. **Stability**. I will check the stability of my model rocket before its first flight, except when launching a model rocket of already proven stability.
6. **Payloads**. My model rocket will never carry live animals (except insects) or a payload that is intended to be flammable, explosive, or harmful.
7. **Launch Site**. I will launch my model rocket outdoors in a cleared area, free of tall trees, power lines, buildings, and dry brush and grass. My launch area will be at least as large as that recommended in the accompanying table.
8. **Launcher**. I will launch my model rocket from a stable launch device that provides rigid guidance until the model rocket has reached a speed adequate to ensure a safe flight path. To prevent accidental eye injury, I will always place the launcher so the end of the rod is above eye level or I will cap the end of the rod when approaching it. I will cap or dissemble my launch rod when not in use and I will never store it in an upright position. My launcher will have a jet deflector device to prevent the motor exhaust from hitting the ground directly. I will always clear the area around my launch device of brown grass, dry weeds, or other easy-to-burn materials.
9. **Ignition System**. The system I use to launch my model rocket will be remotely controlled and electrically operated. It will contain a launching switch that will return to "off" when released. The system will contain a removable safety interlock in series with the launch switch. All persons will remain at least 15 feet from the model rocket when I am igniting model rocket motors totaling 30 Newton-seconds or less of total impulse and at least 30 feet from the model rocket when I am igniting model rocket motors totaling more than 30 Newton-seconds or total impulse. I will use only electrical igniters recommended by the motor manufacturer that will ignite model rocket motors within one second of actuation of the launching switch.
10. **Launch Safety**. I will ensure that people in the launch area are aware of the pending model rocket launch and can see the model rocket's lift-off before I begin my audible five-second countdown. I will not launch my model rocket so its flight path will carry it against a target. If my model rocket suffers a misfire, I will not allow anyone to approach it or the launcher until I have made certain that the safety interlock has been removed or that the battery has been disconnected from the ignition system. I will wait one minute after a misfire before allowing anyone to approach the launcher.
11. **Flying Conditions**. I will launch my model rocket only when the wind is less than 20 miles per hour. I will not launch my model rocket so it flies into clouds, near aircraft in flight, or in a manner that is hazardous to people or property.
12. **Pre-Launch Test**. When conducting research activities with unproven model rocket designs or methods I will, when possible, determine the reliability of my model rocket by pre-launch tests. I will conduct the launching of an unproven design in complete isolation from persons not participating in the actual launching.

13. **Launch Angle**. My launch device will be pointed within 30 degrees of vertical. I will never use model rocket motors to propel any device horizontally.
14. **Recovery Hazards**. If a model rocket becomes entangled in a power line or other dangerous place, I will not attempt to retrieve it.

LAUNCH SITE DIMENSIONS

Installed Total Impulse (N-sec)	Equivalent Motor Type	Minimum Site Dimensions (ft)
0.00	1/4A, 1/2A	50
1.26—2.50	A	100
2.51—5.00	B	200
5.01—10.00	C	400
10.01—20.00	D	500
20.01— 40.00	E	1,000
40.01— 80.00	F	1,000
80.01—160.00	G	1,000
160.01—320.00	Two G's	1,500

I promise to faithfully follow the rules of safe conduct as established in the above code.

_____ _____

Student Signature Date

_____ _____

Parent Signature Date

This Model Rocketry Safety Code was Approved by the National Association of Rocketry, July 1999.

A P P E N D I X P

NATIONAL FIRE PROTECTION ASSOCIATION HAZARD CODING SYSTEM

Identification of Health Hazard Color Code: BLUE Type of Possible Injury	Identification of Flammability Color Code: RED Susceptibility of Materials to Burning	Identification of Reactivity Stability Color: YELLOW Susceptibility to Release of Energy
SIGNAL 4		
Materials which on very exposure could cause death or major residual injury even though prompt medical treatment were given.	Materials which will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in are and which will burn readily.	Materials which in themselves are readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.
SIGNAL 3		
Materials which on short exposure could cause serious temporary or residual injury even though prompt medical treatment were given.	Liquids and solids that can be ignited under almost all ambient, temperature conditions.	Materials which in themselves are capable of detonation or explosive reaction but require a strong initiating source or which must be heated under confinement before initiation or which react explosively with water.
SIGNAL 2		
Materials which on intense themselves or continued exposure could and cause temporary incapacitation or possible residual injury unless prompt medical treatment is given.	Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur.	Materials which in themselves are normally unstable and readily undergo violent chemical change but do not detonate. Also materials which may react violently with water or which may form potentially explosive mixtures with water.
SIGNAL 1		
Materials which on exposure would cause irritation but only minor residual injury even if no treatment is given.	Materials that must be preheated before ignition can occur.	Materials which in themselves are normally stable, but which can become unstable at elevated temperatures and pressures or which may react with some release of energy but not violently.

Identification of Health Hazard	Identification of Flammability	Identification of Reactivity Stability
Color Code:	Color Code:	Color:
BLUE	RED	YELLOW
Type of Possible Injury	Susceptibility of Materials to Burning	Susceptibility to Release of Energy

SIGNAL 0

Materials Which on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	Materials that will not burn.	Materials which in themselves are normally stable, even under fire exposure conditions and which are not reactive with water.

A P P E N D I X Q

STEPS TO REORGANIZE YOUR SCHOOL'S CHEMICAL STORAGE AREA

1. INVENTORY chemicals - include shelf life or date to be discarded.

2. PROJECT needs for no more than a 2 year period and remove the rest for later disposal. Check the remaining chemicals to be sure they are not out dated.

3. Reorganize the chemicals retained into compatible storage families, as suggested on the next page. DO NOT use an alphabetical system of organization.

4. Acids should be stored separately in a dedicated storage cabinet. Store ACETIC ACID with the inorganic acids, but keep it ISOLATED from nitric acid.

5. Store flammables in a separate and dedicated flammable cabinet.

6. Use a locked cabinet for severe poison storage.

7. Do note store chemicals on the floor or above eye level.

8. Anti-roll-off lips should be on all shelve edges and shelving and supports must be constructed of wood not metal.

A P P E N D I X R

SUGGESTED SHELF STORAGE PATTERN FOR CHEMICALS

INORGANIC	**INORGANIC**	**ORGANIC**	**ORGANIC**
Sulfur, phosphorus, phosphorous pentoxide	arsenates, cyanides cyanales (keep away from water)	alcohols, glycols, phenols, amines, imines inides	cresols
INORGANIC	**INORGANIC**	**ORGANIC**	**ORGANIC**
Halides, sulfates, sulfites, phosphates, thiosulfate	metals and hydrides (keep away from water)	hydrocarbons, peroxides, azides, esters, aldehydes hydroperoxides acetates,	
INORGANIC	**INORGANIC**	**ORGANIC**	**ORGANIC**
	Sulfides, Selenides, ethylene nitrides	Ethers, ketones, anhydrides, phosphides, carbides, peracids oxide halogenated hydrocarbons	acids, ketenes,
INORGANIC	**INORGANIC**	**ORGANIC**	**ORGANIC**
amides, nitrates (not $NH_4(NO_3)$* nitrates, azides		epoxy compounds, isocyanates	
INORGANIC	**INORGANIC**	**ORGANIC**	**ORGANIC**
Hydroxides* oxides, carbonates silicates, carbon	Borates, chromates, manganates, permanganates	Sulfides, polysulfides	

***Isolate ammonium nitrate and hydroxide.** **Store in flammable cabinet if flammable**

*****NITRATES and other OXIDIZERS can be stored in a separate cabinet.**

Note: ORGANIC and INORGANIC chemicals should be stored in separate rooms or as far apart as possible.

APPENDIX S

EFFECTS OF ELECTRIC SHOCK

Electric shock is a jarring, shaking sensation resulting from contact with electric circuits or with lightning. The victim usually feels that he has received a sudden blow; if the voltage and the resulting current are sufficiently powerful, he may become unconscious. Severe burns may appear on the skin at the place of contact, and the victim's hand muscles may contract so that he is unable to let go of the wire causing the shock.

Body resistance varies from 1,000 to 500,000 ohms for unbroken, dry skin. Resistance is lowered by moisture and high voltage, and is highest with dry skin and low voltage. Breaks, cuts, or burns may lower body resistance. A current of 1 mA (one thousandth of an ampere) will cause a sensation of shock. Current as low as 5 mA can be dangerous. If the palm of your hand make contact with the conductor, a current of about 12 mA will cause the hand muscles to contract, freezing your body to the conductor. Such a shock may or may not cause serious injury, depending on the contact time and your physical condition, particularly the condition of your heart. A current of only 25 mA ha been known to be fatal; 100 mA is usually fatal.

Because of the physiological and chemical nature of the human body, five times more direct current than alternating current is needed to freeze the body o an electric conductor. One of the most dangerous AC frequencies is 60 Hz (cycles per second.) Unfortunately, this is the frequency normally used in residential, commercial, and industrial power lines.

The damage from shock also depends on the number of vital organs in the current path and especially on the amount of current that reaches the heart.

Ventricular fibrillation of the heart occurs when the current through the body approaches 100 mA. Ventricular fibrillation, which is uncoordinated action of the walls of the ventricles, causes the heart to lose its regular pumping action. Fibrillation will usually continue until some action is taken to restore the regular heartbeat.

Currents between 100 and 200 mA are lethal. However, currents over 200 mA usually do not cause death if the victim is given immediate attention; these high currents clamp the heart muscles and prevent ventricular fibrillation. Such currents will cause severe burns and unconsciousness, but the victim will usually respond to artificial respiration. When a person is rendered unconscious by a current passing through his body, it is impossible to tell how much current caused the unconsciousness. Artificial respiration must always be applied immediately if breathing has stopped.

Treatment of Electric Shock

Familiarize yourself with the following procedures for the rescue and care of shock victims:

1. Remove the victim from electrical contact at once, but do not endanger yourself.

    a. Throw the switch if it is nearby.

    b. If no switch is nearby, cut the cable or wires to the apparatus, using an ax with a wooden handle. Be careful to protect your eyes from the flash when the wires are severed.

    c. If you are unable to de-energize the equipment immediately, use a dry stick, rope, belt, coat, blanket, or any other nonconductor of electricity to drag or push the victim to safety.

2. Determine whether the victim is breathing. Keep them lying down in a comfortable position and loosen the clothing about their neck, chest, and abdomen so that they can breathe freely. Protect them from exposure to cold and watch them carefully.

3. If the victim is breathing, treat them for traumatic shock. Keep them quiet and warm (but not hot.) Cover them with a coat or blanket to conserve body heat, and elevate the feet slightly (12 to 18 inches.) Treat any visible burns and stop any visible hemorrhaging. Some traumatic shock (often called "shock of injury") is always present in injury cases and sometimes does not develop immediately. It frequently causes death even though the injury itself was not fatal.

3. Keep the victim quiet and prevent them from moving about. After electric shock, the heart is very weak, and any sudden muscular effort or activity may result in heart failure. After a severe electric shock, patients sometimes die from the effects of shock or injury after they have been revived.

5. Do not give stimulants or opiates. Send for a doctor at once, and do no leave the victim until they have adequate medical care.

6. If the victim is not breathing, it is essential to apply artificial respiration without delay, even though they may appear to be lifeless. Although there have been some exceptions, in general, the brain and nervous system can be restored to normal function only if the air and blood circulation have not been stopped for longer than five minutes. Do not stop artificial respiration until medical authority pronounces the victim beyond help.

A P P E N D I X T

HANDLING BODY FLUIDS

Purpose

To insure that body fluids involving blood, urine, vomitus, feces, semen, saliva and nasal discharges are handled properly.

Those Affected

All school staff should be alerted to dangers of infections (see chart) from body fluids. School nurses, custodians and teachers should be particularly alert to the proper techniques in handling and disposal of materials**.**

Equipment Needed

Soap
Paper towels
Disposable gloves
Disinfectant - should be one of the following classes:

Dust pans
Buckets
Mops

a. Ethyl or isopropyl alcohol (70%)

b. Phenolic germicidal detergent in a 1% aqueous solution (e.g. Lysol *)

c. Sodium hypochlorite solution (household bleach), 1 part bleach to 10 parts water. (Example 1 1/2 cups bleach to one (1) gallon of water. Needs to be prepared each time used.

d. Quaternary ammonium germicidal detergent in 2% aqueous solution (e.g. Tri-quat *, Mytar *, or Sage*

e. Iodopho germicidal detergent with 500 ppm available iodine (e.g. Wescodyne*)

* Brand names are used as examples and are not endorsements of products.

Procedures

1. General

   a. Wear disposable gloves before making contact with body fluids if you have an open sore or cut on hands.

   b. Discard gloves after each use.

   c. Wash hands after handling fluids and contaminated articles, whether or not gloves are worn.

d. Discard disposal items including tampons, used bandages and dressings in plastic-lined trash container with lid. Close bags and discard daily.

e. Do not reuse plastic bags.

f. Use disposable items to handle body fluids whenever possible.

g. Use paper towels to pick up and discard any solid waste materials such as vomitus or feces.

2. Handwashing

a. Use soap and warm running water. Soap suspends easily removable soil and microorganisms allowing them to be washed off.

b. Rub hands together for approximately 10 seconds to work up a lather.

c. Scrub between fingers, knuckles, backs of hands, and nails.

d. Rinse hands under warm running water. Running water is necessary to carry away debris and dirt.

e. Use paper towels to thoroughly dry hands.

f. Discard paper towels.

3. For washing surfaces

a. For table, desks, etc.:

1. Use ethyl or isopropyl alcohol (70%), Lysol, or household bleach solution of 1 part bleach to 10 parts water, mixed fresh.

2. Rinse with water if so directed on disinfectant.

3. Allow to air dry.

(a) Gloves should be worn since the solution is irritating to skin.

(b) Avoid applying on metal since it will corrode most metals.

b. For floors:

1. One of the most readily available and effective disinfectants is the bleach solution (1-1/2 cups bleach to one (1) gallon of water.)

2. Use the two bucket system -- one bucket to wash the soiled surface and one bucket to rinse as follows:

(a) In bucket #1, dip, wring, mop up vomitus, blood.

(b) Dip, wring, and mop once more.

(c) Dip, wring out mop in bucket #1.

(d) Put mop into bucket #2 (rinse bucket) that has clean disinfectant (such as Lysol solution)

(e) Mop or rinse area.

(f) Return mop to bucket #1 to wring out. This keeps the rinse bucket clean for second spill in the area.

(g) After all spills are cleaned up, proceed with #3.

3. Soak mop in the disinfectant after use.

4. Disposable cleaning equipment and water should be placed in a toilet or plastic bag as appropriate.

5. Rinse non-disposable cleaning equipment (dust pans, buckets) in disinfectant.

6. Dispose disinfectant solution down a drain pipe.

7. Remove gloves, if worn, and discard in appropriate receptacle.

8. Wash hands as described in #2.

4. For non-washable surfaces (rugs, upholstery)

a. Apply sanitary absorbing agent, let dry, vacuum.

b. If necessary, use broom and dust pan to remove solid material

c. Apply rug or upholstery shampoo as directed. Re-vacuum according to directions on shampoo.

d. If a sanitizing carpet cleaner (only available by water extraction method is used, follow the directions on the label.)

e. Clean dustpan and broom, if used. Rinse in disinfectant solution.

f. Air dry.

g. Wash hands as described in #2.

5. For soiled washable materials (clothing, towels, etc.)

    a. Rinse item under running water using gloved hands if appropriate.

    b. Place item in plastic bag and seal it until item is washed.

    c. Wash hands as described in #2.

    d. Wipe sink with paper towels, discard towels.

    e. Wash soiled items separately, washing and drying as usual.

    f. If material is bleachable, add 1/2 cup bleach to the wash cycle. Otherwise, add 1/2 cup non-chlorine bleach (Clorox II, Borateem) to the wash cycle.

    g. Discard plastic bag.

    h. Wash hands as described in #2 after handling soiled items.

Table 1
Transmission Concerns in the School Setting
Body Fluid Source of Infectious Agents

Body Fluid Source	Organism of Concern	Transmission Concern
Blood -cuts/abrasions -nosebleeds -menses	Hepatitis B. virus AIDS virus Cytomegalovirus	Bloodstream inoculation through cuts and abrasions on hand
-contaminated needle	Direct blood stream inoculation	
*Feces -incontinence	Salmonella bacteria Shigella bacteria Rotavirus Hepatitis A virus	Oral inoculation from contaminated hands
*Urine - incontinence	Cytomegalovirus	Bloodstream, oral and mucus membrane inoculation from hands
*Respiratory Secretions -saliva	Mononucleosis virus Common cold virus Influenza virus	Oral inoculation from contaminated hands
-nasal discharge	Hepatitis B virus	Bloodstream inoculation through bites
*Vomitus	Gastrointestinal viruses (e.g. Norwalk agent Rotavirus)	Oral inoculation from contaminated hands
Semen	Hepatitis B AIDS virus Gonorrhea	Sexual contact (Intercourse)

*Possible transmission of AIDS is currently thought to be of little concern from these sources.

A P P E N D I X U

POLICY FOR PROVIDING EDUCATION TO STUDENTS WITH ACQUIRED IMMUNE DEFICIENCY SYNDROME (AIDS) AND AIDS RELATED COMPLEX (ARC)

1. A child entering grades kindergarten through twelve with AIDS/ARC or HTLV-III antibody shall be permitted to attend school unless the child:

   (a) has open sores that cannot be covered,
   (b) demonstrates physically aggressive behavior with a documented history of biting or harming others,
   (c) is, in the opinion of his/her physician, at risk from communicable diseases present in the school or has other medically related problems.

2. Any removal of a child with AIDS/ARC or HTLV-III antibody by the school district will be reviewed by a State Advisory Panel appointed by the State Department of Public Instruction and consisting of the State Health Officer, State Epidemiologist, a representative from the Medical Society of Delaware, a representative from the State Department of Public Instruction, a school nurse, and a school superintendent. The local district will submit to the panel:

   (a) evidence that the child exhibits or manifests the symptoms which justify exclusion;
   (b) a current report from the child's personal physician. If recommended by the child's physician, the child will remain in the school until a determination is made by the panel.

3. The child shall be re-admitted to school when the child's physician verifies to the State Advisory Panel that the condition for which removal occurred has been corrected or has abated, and the Panel determines the child can return to school.
4. The school nurse, in cooperation with the building principal, shall function as: (a) the liaison with the child's physician and the State Advisory Panel; (b) advocate for the AIDS/ARC child in the school (i.e., assist in problem resolution, answer questions); (c) the coordinator of services provided by other staff.
5. A school-aged child with AIDS/ARC who is removed for reasons stated in item #1 shall be provided with an appropriate alternative education according to already established procedures.
6. Preschool children with AIDS/ARC or HTLV-III antibody will be evaluated on a case-by-case basis by the Advisory Panel to determine if the special program for which the child has applied is feasible.
7. Dissemination of the knowledge that a child has AIDS/ARC or HTLV-III antibody is subject to State and Federal privacy laws and regulations.
8. Routine and standard procedures for handling all body fluids will be established by the State Department of Public Instruction and Division of Public Health and will be utilized in every school. These procedures will be found in the School Nurse's Handbook, School Bus Drivers' Handbook, and Handbook for School Food Services.
9. Educational programs about AIDS/ARC infection, mode of transmission, care of body fluids, and good hand washing techniques shall be offered to all school personnel. The Department of Public Instruction shall coordinate training programs for school nurses and other designated personnel who will be responsible for school district programs.

Appendix V
Internet Resources in Science

Because we live in a technological world where resources are literally "at our fingertips", it is often easier to find the regulations covering safety, or manufacturer's Material Safety Data Sheets on lin than it is to find them in any other way. It is certainly faster than writing or calling a manufacturer. Poison control information, toxicity information, latest alerts, recalls and hazard bulletins – all come to us with the speed of light limited only by our hardware.

The followint is a list of useful sites in science. It is by no means comprehensive or complete. Further, because the animal we call the internet is a constantly changing beast, new sites pop up every day. The list is provided only as a starting point and only sites that have been consistently on line for at least for years are listed. If you have any other that are worth visiting, please let anyone on the Science Advisory Committee know. We will be glad to add such sites to future editions of this manual.

Biology and Life Sciences:

http://www.udel.edu.ohs
http://www.nabt.org -resources and position statements
http://www.accessexcellence.org/AE/AEPC/WWC - statements 1993 with some html – Biotech Safety Precautions
http://134.225.167.114/NCBE/SAFETY/main.html - Safety when working with DNA, Enzymes or Microbiology (Site includes lists of classroom approved bacteria, viruses, and fungi.)
http://keats.admin.virginia.edu/lsm/home.html - Laboratory Survival Manual
http://schmidel.com/bionet.cfm - BioChemNet - teaching science

Chemistry:

http://www.chem4kids.com
http://www.hhmi.org/coolscience/
http://www.chemcenter.org
http://www.chemicalonline.com
http://www.chemistry.co.nz

MSDS Information:

http://www.msdsprovider.net
http://siri.uvm.edu/msds

Earth and Ocean:

http://www.aims.gov.au
http://www.cousteau.org
http://www.earthwaves.com
http://www.topixgallery.com
http://www.volcano.und.edu

Environment:

http://www.conservation.org
http://www.earthisland.org
http://www.earthwatch.org
http://www.tnc.org

Organizations:

http://www.aaas.org
http://www.nobel.se
http://www.epa.org
http://www.dnrec.state.de.us