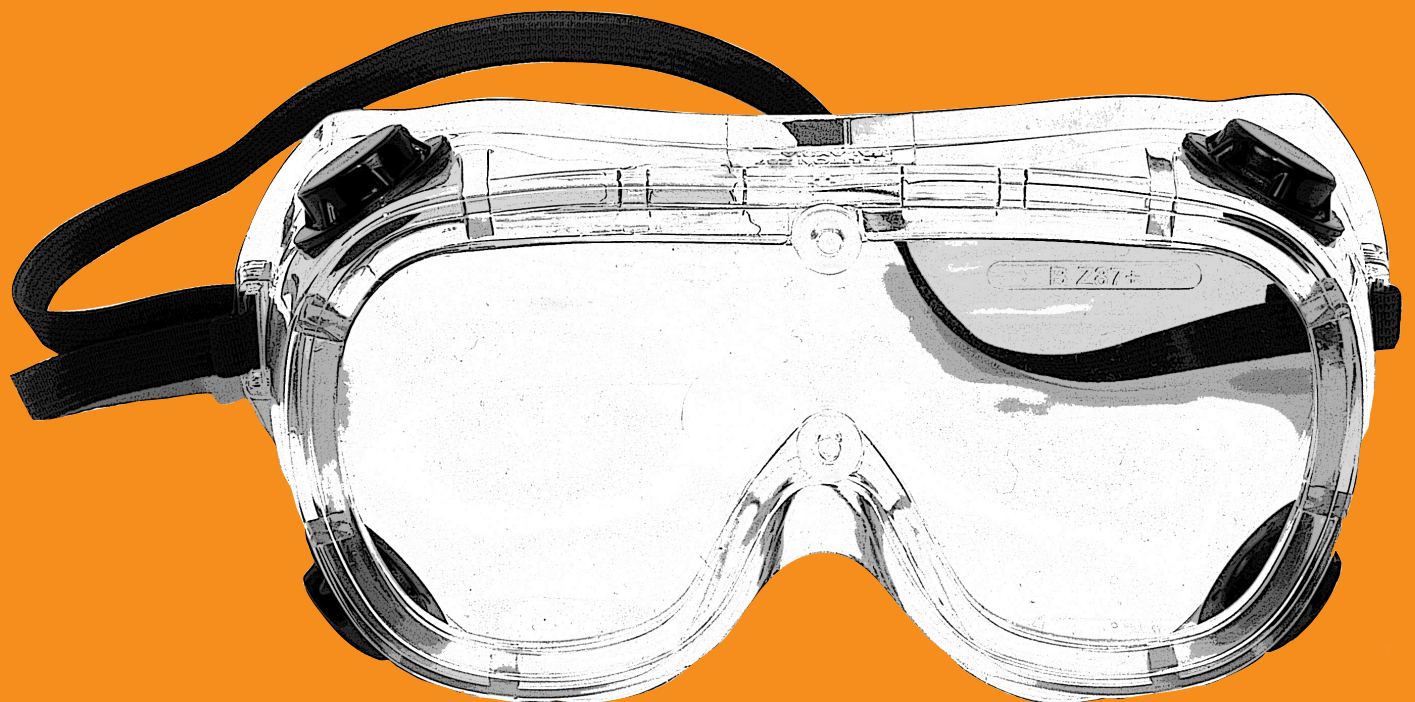


# SCIENCE SAFETY MANUAL

GRADES K-12



**NYC** Department of  
Education

Joel I. Klein  
Chancellor



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**NEW YORK CITY DEPARTMENT OF EDUCATION**

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# INTRODUCTION

Safety is everyone's responsibility and a safe working environment takes a team effort. The new edition of *Science Safety* will provide guidelines for school staff and students who are involved in making the classroom and the laboratory safe places to work.

This manual is intended for use by all individuals who are responsible for implementing a laboratory program in their school. Special sections in this safety manual will enumerate the individual responsibilities of the principal, assistant principal, science cluster teacher, science staff developer or coach, science teacher, laboratory specialist, custodian, and student. The manual also provides general guidelines for all laboratories and specific safety rules for each subject area. In these sections, safety rules and regulations for laboratory, demonstrations and activities will be discussed.

This revision is being designed with modern technology in mind. It will be available on the Department of Education website, and therefore, will be updated whenever new safety information or issues arise. This is extremely important as we discovered in the preparation of this revision. Some substances previously thought to be safe have proven to be carcinogenic. This impacts the choice of materials that can be selected for student labs and teacher demonstrations. Some examples of changes in thinking due to risk/benefit analysis based on current knowledge are as follows:

- In the past there have been four commonly used generators of heat in the laboratory—the alcohol burner, the Bunsen burner, the propane burner and the hot plate. The NSTA recommends that alcohol burners not be used under any circumstances in high schools due to the high rate of accidents related to their use. Alcohol stock bottles left open, hidden cracks in the glass, vapors in the room, flashbacks, or spilled alcohol can create dangerous situations.
- The National Science Teachers Association (NSTA) believes hot plates are a safe alternative to Bunsen burners because the hazards associated with open flames are eliminated. However, Bunsen burners may be used safely by advanced students, under strict supervision if recommended protocol is followed. However, hot plates can be substituted for most basic lab procedures that require heating. Laboratory exercises in advanced or AP classes may require an open flame, but strict safety procedures must be followed.
- When the 1997 edition of this book was written, we included blood typing as a possible exercise, using Standard precautions and parental permission. However since that time we have reconsidered and based on the positions taken by the National Science Teachers Association (NSTA) and the National Association of Biology Teachers (NABT) we now strongly feel that human body fluids should not be used for lab work. Specifically, student blood and urine should never be used for typing or testing. Synthetic blood kits are available commercially. Artificial urine is easy to prepare following steps found on line at <http://www.nabt.org/sup/resources/urine.asp>.
- Cheek cells are immersed in saliva and saliva is a human body fluid. Due to the growing concern of transmission of pathogens, many teachers no longer have students scrape the inside of their cheeks to harvest epithelial cells to observe under the microscope. Commercially purchased amylase substitutes for saliva to demonstrate hydrolysis of starch and prepared epithelial cells can be purchased from scientific supply vendors.

- With advances in technology and a living environment curriculum that teaches about DNA, electrophoresis and genetics, reputable organizations have prepared workshops and lab procedures for DNA extracting that students can do themselves. Although wheat germ and onion cells can be used, it is very exciting for students to use their own cheek cells. Our position on the collection of cheek cells for extraction of DNA is as follows:
  - In advanced, responsible biology classes cheek cells may be harvested for the extraction of DNA. A saline rinse of the mouth is the method most often used to harvest DNA. Safety considerations must be reviewed with the class and Standard Precautions must be observed. Safe disposal of waste at the end of the lab must be followed. NOVA on line at [www.pbs.org/wgbh/nova/teachers/activities/2809-genome.html](http://www.pbs.org/wgbh/nova/teachers/activities/2809-genome.html) is one website that offers a clear example of how to conduct a safe DNA extraction lab.

It is important to remember that a science laboratory by nature presents hazards. These hazards can, however, be minimized by using safe laboratory practices and procedures. The laboratory procedures, student seating, condition of supplies, positioning of equipment in the laboratory, and proper safety equipment all contribute to a safe environment

Demonstrations and laboratory investigations need to be routinely checked for safety considerations. The publication or public demonstration of a particular lab investigation does not necessarily mean that it is safe for your classroom. Risks versus benefits must be evaluated keeping in mind that safety is always the first consideration. If there is a laboratory procedure or demonstration that a member of the staff believes is unacceptably hazardous, and a compromise cannot be reached, the staff member should be able to go to a safety review panel consisting of the principal, assistant principal of the subject area or the LSO Science Instructional Specialist.

It is necessary to keep up with the latest technology, chemical advances, and safety procedures. Our choice of chemicals, demonstrations and class activities must reflect current knowledge of toxic substances. Always substitute less hazardous chemicals whenever possible and use the smallest amounts possible. For information concerning removal of substances/hazardous wastes, refer to page 104.

We have included in this manual a brief discussion of the *New York State Safety and Health Regulations* which form the foundation upon which school science safety is based. These include federal OSHA (Occupational Safety and Health Act) guidelines that pertain to laboratory safety. These regulations include:

1. OSHA (29 CFR 1910.1200) Hazard Communication Standard.
2. OSHA (29 CFR 1910.1450) Laboratory Standard.
3. OSHA (29 CFR 1910.132) Personal Protective Equipment Standard.
4. OSHA (29 CFR 1910.1030) Bloodborne Pathogens Standard.

Schools must comply with these *New York State Safety and Health Regulations* which were added to the New York State Public Employees Safety and Health Act (PESH) in the 1980's and with New York State Education Law Section 305, Subdivision 19. These laws, which include *The Toxic Substances Act* and *The Hazard Communication Act*, were mandated by federal law under 051-IA guidelines for public employees.

The texts of these laws and regulations can be found in the following Department of Education publications, copies of which must be available in every school for reference.

*The New York City Department of Education Chemical Hygiene Plan*

*The New York City Department of Education Hazard Communication Plan*

*The New York City Department of Education Bloodborne Pathogens Exposure Control Plan*

These publications can be obtained from:  
The Office of Occupational Safety and Health  
Emerson A. Greenidge, MS, CSP, Director  
65 Court Street, Room 706  
Brooklyn, N.Y. 11201  
(718) 935-2319

Each school must customize the books for their own premises.

Schools must also comply with:

- Environmental Protection Agency regulations for waste disposal and hazardous substance reporting (SARA and RCRA Title III).
- *New York City Fire Code for Schools* – Chapter 34.
- ongoing N.Y.C. Department of Education directives concerning health and safety issues.

We can only list things that are proven risky or dangerous today. It is the responsibility of everyone involved in science safety to keep abreast of new research and changes in the field themselves. This manual provides the resources to do the research, but those involved in science safety must continue to do their own homework for the safety of their students, their colleagues and themselves.

Adherence to safety rules and regulations should be standard operating procedure for all of the science instructors and their students. This safety manual is designed as a guide for use in classrooms, science laboratories, and on class field trips. All staff members are required to review this manual annually and file a signed statement that they have read the material.



# **SAFETY RULES FOR STAFF AND STUDENTS**



# GENERAL SAFETY RULES AND REGULATIONS

## I FOR THE STAFF: STARTING THE TERM

- At the beginning of each term *all* staff members should inspect their classrooms and laboratories and notify appropriate authorities of any hazards. Check for the presence of the following required safety equipment: fire extinguishers, (type ABC in all science spaces regardless of grades), eyewash stations (at teacher's demo table in all science rooms), safety showers (high schools where there is an acid room. Where demo or lab is not adjacent to prep room then that lab or demo gets an emergency shower. As per ANSI (American National Standard Institute, [www.ansi.org](http://www.ansi.org) the shower should be reached within 10 seconds, recommendation for distance is 50 to 100 feet, unobstructed). No emergency shower in middle or primary school. On the basis of that, middle and primary schools do not use chemicals that are stronger than vinegar, working fume hoods, (portable fume hoods in Middle School demo/lab and fixed fume hoods in Middle School prep—for SIRA projects, ductless fume hoods in middle School prep). Fixed fume hoods in High School prep and lab, portable fume hood in high school demo. NOTE: portable fume hoods are ductless. No fume hoods in high school Physics lab and primary school lab or prep.
- Every member of the staff should know the location of the MSDS (Material Data Safety Sheets) forms and be familiar with the information for each chemical on hand.
- The entire staff should also be familiar with New York State Right-to-Know laws, EPA regulations, New York City Fire Department regulations for schools, and Department of Education special circulars regarding safety.
- A Safety and Health training session should be given to review employee rights, employer responsibilities, and to review the health and safety hazards associated with the use of chemicals, and other substances. Staff must be knowledgeable of the identity of their Site Safety Officer, Chemical Hygiene Officer and Blood Borne Pathogens Site Administrator. MSDS and Right-to-Know information must be publicized and available.
- When supplies and equipment are set up, make certain that students do not have unsupervised access to chemicals in the preparation rooms, closets, stockrooms, classrooms, and laboratories.
- Be familiar with the procedure to be followed when an injury or accident occurs, give permissible first aid (see excerpts from the Administration of Safety in New York Schools, Curriculum Bulletin No. 13), then:
  - escort the injured person to the school medical office, if appropriate, or call for assistance.
  - report the accident immediately to the principal or assistant principal.
  - complete the accident report.
- Remember: the staff should always set a good safety example when teaching science in the classroom, the laboratory, or in the field.

## **II BEFORE THE FIRST ACTIVITY**

- Provide instruction on safety procedures to all students at the beginning of each term. Provide contracts for all students and their parents/guardians to sign indicating that they are aware of the safety rules. (See Student Laboratory Safety Contract.)
- Show students the location and proper use of eyewash stations, safety showers, fire blanket, fume hood, and first aid kit.
- Introduce students to safety equipment such as goggles, aprons, and gloves which they will use in the laboratory as they are needed.

## **III ALWAYS**

- The entire staff must serve as role models for safety and convey the importance of safety to their students.
- Employ approved safety standards and methods in the storage and use of all supplies. Keep chemicals, tools and sharp-edged instruments in good condition and stored in locked cabinets.
- Give safety instructions before starting an experiment or demonstration.
- Take approved safety precautions in the transportation of all equipment and supplies to and from the classrooms and laboratories
- Test each new laboratory experiment and demonstration prior to class use to verify that everything is working properly and safely. Routine experiments and demonstrations should be checked often for safety hazards.
- Provide close supervision when students are using science equipment, chemicals, tools, or sharp-edged instruments. Count and account for all substances and equipment used.



## GENERAL DIRECTIONS FOR SCHOOL PRINCIPALS

1. Students in school must be under the direct supervision of the Principal or his/her representative at all times as required by the By-Laws of the Department of Education.
2. The Principal is responsible for the administration of the Occupational and Safety Health Program which includes the *Right to Know (RTK) Program*, the *Chemical Hygiene Plan*, the *Hazard Communication Plan* and the *Bloodborne Pathogens Exposure Plan*.
  - A. Site Safety Officer whose duties are listed in the N.Y.C. Department of Education *Hazard Communication Plan* (yellow cover). These duties include but are not limited to informing and training all staff members regarding safety in the workplace when there is potential for exposure to hazardous chemicals. The Site Safety Officer must ensure that personal protective equipment and adequate engineering controls are provided, complete and maintain a chemical inventory, and acquire and maintain MSDSs for chemicals on inventory. The Site Safety Officer must make sure chemicals are properly labeled and act as the first point contact to the staff regarding RTK issues in the workplace. A Health and Safety Information File must be kept and an annual Right-to-Know/Hazard Communication Standard checklist must be submitted to the Borough Health Director or the Office of Occupational Safety (listed on page 123).
  - B. Chemical Hygiene Officer whose duties are listed in the N.Y.C. Department of Education *Chemical Hygiene Plan* (green cover). These duties include, but are not limited to training all science teachers and lab specialists in safe laboratory practices when using chemicals. The Chemical Hygiene Officer must complete and submit a Laboratory Safety Checklist annually to the Regional Health Director or the Office of Occupational Safety (listed on page 123).
  - C. Bloodborne Pathogens Site Administrator whose duties are listed in the N.Y.C. Department of Education *Bloodborne Pathogens Exposure Control Plan* (pink cover). These duties include but are not limited to training all employees to utilize Universal Precautions, guidelines for using personal protective equipment when there is potential exposure risk and what to do if there is exposure to Bloodborne pathogens. The Site Administrator coordinates the Hepatitis B vaccination program for employees who are determined to be at risk and must complete and submit a Bloodborne Pathogens Standard Checklist Annually.

These plans must be site specific and easily accessible to the staff. The N.Y.C. Department of Education's Office of Occupational Safety and Health coordinates the Safety and Health training program and updates it as necessary. The office is directed by Emerson Greenidge, MS, CSP, and may be contacted at (718) 935-2319. Right-to-Know posters must be prominently displayed to inform the staff of the names of the site officers and location of MSDS and RTK information.
3. The principal should communicate to the faculty and staff the conditions of the school in regard to safety and hazards that may have been eliminated.
4. If a modernization or construction is to be undertaken, the principal should be sure that students and staff are informed about and protected from any resulting construction hazards or unsafe conditions.

## GENERAL DIRECTIONS FOR HIGH SCHOOL ASSISTANT PRINCIPALS

1. Students in school must be under the direct supervision of a supervisor or his/her representative at all times as required by the By-Laws of the Department of Education.
2. Conduct departmental conferences at the beginning of each term to review and practice safety procedures, such as the use of ABC fire extinguishers, fire blankets, eyewash stations, and safety showers with all members of the science staff, including science teachers, special education teachers, out-of-license teachers, laboratory specialists, and laboratory technicians.

Make sure eyewash stations and safety showers meet safety standards and operate properly. (See details in General Directions for Laboratory Specialist.) The eyewash station should be run for 2 to 3 minutes per week to ensure clean water is available for emergencies.

3. Review periodically, with science staff members, the use of the various types of fire-fighting apparatus found in the science department. Practice how to remove extinguishers correctly from the wall. Practice the correct use of a carbon dioxide extinguisher (ABC extinguisher) and a fire blanket. Obtain the cooperation of the school custodian in replenishing the extinguisher. Ask the custodian to train the science department faculty in the proper use of the fire extinguisher. Note that if a fire is large enough to require the use of the fire extinguisher, the following steps should be taken:
  - a. evacuate the students.
  - b. call or send for help.
  - c. seal off the area.
4. Require all staff members to review this manual. A signed statement from each staff member that the safety manual has been read should be filed annually.

### SAMPLE STATEMENT

NAME OF SCHOOL

Principal's Name

I have read the General Directions for Teachers/Laboratory Specialists  
as well as the Specific Directions for the subjects I am teaching.

\_\_\_\_\_  
Teacher/Laboratory Specialist

\_\_\_\_\_  
Date

5. At the beginning of each term, in consultation with the laboratory specialist(s), notify the principal in writing of any hazards, such as:
  - improper organization of chemical storage.
  - defective gas fixtures, electrical outlets and connections, loose wiring, or exposed wires.
  - defective seats, desks, and tables that may cause injury.
  - inadequate storage cabinets.
  - lack of fire blankets and fire extinguishers.
  - uneven and defective floors.
  - defective, inoperable locks and inadequate security of preparation rooms and storage rooms.
  - inoperable safety showers, eyewash stations, or fume hoods.

If any hazards arise during the course of the term, notify the principal immediately.

6. As specified in the Dept. of Education regulations, make sure that a first-aid kit is in each science laboratory and preparation room for emergencies. Ample reserve stocks of first-aid material are to be available. A current copy of the American Red Cross *Standard First Aid* should be kept with each first-aid kit. It is desirable to post laboratory emergency charts in each laboratory and preparation room, including a CPR and a Heimlich Maneuver chart.
7. Prohibit storage of specified carcinogenic materials. A list of those substances currently considered carcinogens or probable carcinogens, has been included in the Appendix A. Some of these may have been considered safe in the past and thus may still be stored in the school. Those substances that are known, or probable carcinogens, are prohibited from purchase, use, or storage in schools.
8. While the use of white phosphorus, carbon disulfide, carbon tetrachloride, and picric acid has long been prohibited, mercury and para-Dichlorobenzene (1,4-Dichlorobenzene.) have now been added to the list of prohibited substances. Be sure to remove them from your school.
9. Make sure that storage cabinets for sodium, potassium, calcium, and calcium carbide exhibit this warning in bold, easily read letters. Make sure that they are near Class D fire extinguishers and that sand is available.

**In Case of Fire  
DO NOT USE WATER**

10. All chemicals should be stored safely and an inventory system **MUST** be established. Incompatible chemicals must **NOT** be stored together.

11. Make sure eyewash stations are plumber installed and conform to ANSI standard Z358.1 (American National Standard Institute, [www.ansi.org](http://www.ansi.org)). Safety shower or body shower/drench hose combination must also be installed. These units must be tested weekly for proper operation. (Refer to page 104 –105.)

The eyewash station must be run 2–3 minutes per week to ensure clean water is available for emergencies. (See Directions for Lab Specialist.)

12. Limit the number of students assigned to each science laboratory squad, so that they can be properly supervised.
13. Do not assign persons to the preparation room who are not licensed as laboratory specialists, laboratory technicians, or science teachers.
14. Do not permit teachers without a science license or qualifying experience to use potentially hazardous specialized science apparatus or chemicals unless they are well trained. Experiments, demonstrations, and work prepared by an out-of-license science teacher should be carefully reviewed.
15. Inspect classrooms, preparation rooms, storage rooms, and fume hoods frequently to prevent the accumulation of materials that could lead to safety hazards, including cluttered floors and window sills, blocked exits, exhibits or projects which overload shelves, and chemicals and glassware stored on demonstration tables. Science materials on shelves and rolling tables should not extend beyond the edge of the shelf.
16. Work with your laboratory specialist to arrange for proper disposal of unlabeled, contaminated, or prohibited substances.
17. The use of radioactive materials for experimentation raises issues of disposal and cleanup. Safe use of radioactive substances in high schools is questionable and NOT recommended. If you use radioactive material for demonstration, the following applies.
  - Only radioactive sources which are low in activity level, and require no regulatory license from the Nuclear Regulatory Commission should be used.
  - Isotopes that emit radiation on the order of 0.01 millirems per hour at a distance of one foot fall into the category of requiring no regulatory license. These are the only ones that should be used by the staff in the school. Scientific supply companies only stock radioactive sources that are usable by schools.
  - Since radiation strength is a function of distance, caution all persons handling radioactive materials to keep them as far away from their bodies as practical. The limit for whole body exposure set by the Nuclear Regulatory Commission for students is 500 millirems per year.
  - Radioactive isotopes and other ionizing radiation sources must NOT be stored in desks or cabinets near areas where students or staff sit or congregate. It is best to store them inside lead pipes with screw-on end pieces. Lead pipes and end pieces can be purchased in neigh-

borhood hardware stores. A box constructed of bricks is also acceptable for storage.

- NO COMPLETELY SAFE LEVEL OF EXPOSURE HAS BEEN OR IS LIKELY TO BE ESTABLISHED!
- Use cosmic background radiation and the radioactive element americium found in smoke detectors to activate classroom Geiger counters.

18. Provide Right-to-Know training for the staff.

19. A current MSDS should be available for each chemical in the building.

20. Eliminate laboratory activities involving human body fluids. Alternate experiences should be provided.

21. Eliminate the use of alcohol burners.

22. Establish Safety Review Panels when necessary.

# GENERAL DIRECTIONS FOR SCIENCE TEACHERS K-12

## I BASIC SAFETY

1. Notify the science supervisor and laboratory specialist immediately of any hazard which comes to your attention.
2. Familiarize yourself with the purposes and operation of the various kinds of fire extinguishers found in the science rooms. Learn how to deal with different kinds of fires; for example, do not direct a stream of water on oil or electrical fires, use the ABC fire extinguisher or sand. Make sure a fire blanket is available.
3. Distribute and discuss the *Student Laboratory Safety Contract* and information for students (see Student Safety section), to all of your laboratory classes. Stress the need for the students to read and sign the document. After the Parent/Guardian has signed, keep the tear-off slips on file for one year.
4. Be aware of special medical problems of students, such as asthma or high sensitivity to irritating fumes.

## II EQUIPMENT SAFETY

1. Examine all devices or equipment brought in by students and test them for safety hazards before demonstrating them to the class.
2. Observe the following precautions when performing experiments where there is a possibility of splintering or flying glass, a flash, or an explosion:
  - a. Keep students at least eight feet from the demonstration table.
  - b. Place a safety shield between the students, yourself, and the demonstration.
3. Provide individual straws or mouthpieces for students who are asked to blow into tubes, balloons or plastic bags. Students should wear goggles when blowing into a test tube containing chemicals. Have a container with 10% bleach solution available for used straws or mouthpieces.
4. Observe the following precautions when inserting glass tubing, thistle tubes, or glass rods into rubber stoppers:
  - a. The ends of the tubing or rod being inserted should be fire-polished.
  - b. The tubing should fit the hole in the stopper.
  - c. Moisten the glass tubing and the hole with a lubricant such as water or soap solution.
  - d. Use cloth or leather gloves to protect hands from injury in case the glass tubing breaks.

- e. Grasp the glass tubing very close to the rubber stopper.
  - f. Insert the glass tubing through the hole in the stopper with a gentle twisting motion. Never force glass tubing.
5. When removing glass tubing, thistle tubes or glass rods from rubber stoppers, observe the following precautions:
- a. Remove glass tubing from rubber stopper as soon as possible after use to prevent the glass from freezing to the stopper.
  - b. Remove glass tubing which has frozen in a rubber stopper by using a lubricated cork borer which is just large enough to slip over the glass. Protect hands with cloth or gloves. Slowly twist the cork borer through the stopper to bore the frozen glass tubing out of the stopper.
  - c. Note that special care must be taken if a knife or single-edge razor blade is used to split the stopper. Do not permit students to perform this procedure.
6. Dispose of all chipped, cracked glassware in a container that will not rip or tear.
7. Demonstrate correct pipette techniques. Arrange for students to practice these techniques with water. DO NOT pipette anything by mouth.

### **III HEAT AND LIGHT**

Heat is used in many experiments and may be generated by flames, light bulbs, or heated rocks. Place heat sources so that students do not have to reach across them during the experiment in order to reduce the hazard of burns. Students should be reminded that substances remain hot for some time after being removed from the heat source and they should continue to handle them with care. Equipment should be allowed to cool on insulated mats and must be completely cool before handling.

#### **INCANDESCENT LAMPS**

They are used as both light and heat sources. The surface of the lamp bulbs as well as the sockets and nearby material can reach high temperatures. Warn students not to touch the bulbs, sockets, or any other equipment or material that is near a bulb until the equipment is cool. Also, warn students not to splash water on a hot bulb as the sudden contraction of the glass upon cooling could cause the bulb to shatter.

## BURNERS

There are four commonly used generators of heat. These include gas burners, alcohol burners, propane burners, and hot plates.

### 1. GAS BURNERS

The Bunsen burner, which has been used for generations in high schools, is now considered dangerous. If you choose to use Bunsen burners in spite of the warning, be aware of the following:

- a. Bunsen burners are very common. The simple type has only an air regulator. The adjustable type also permits gas regulation.
- b. Tirrill and Meker burners permit adjustments to be made to both the air and gas supply. The Meker type are useful when an extremely hot flame is required.
- c. To light a gas burner safely, strike a match and hold the flame near the barrel of the burner. Then turn the gas on slowly. If the burner strikes back (burns at the spud), shut off the gas immediately. Never touch the hot barrel of the burner.
- d. Caution students who are about to heat material in test tubes not to look down into the tube. Tell them to hold test tube at a 45 degree angle to flame, and never to point the mouth of the tube toward themselves or others. The test tube holder or tongs should hold test tubes near the lip of the tube. If material boils over, this will prevent it from touching the hand holding it.
- e. Instruct students to slowly heat substances in test tubes, moving the tube evenly over the flame. Otherwise, the vapor meeting a mass of matter above it may cause the bottom of the tube to be blown out or the matter to be ejected violently. The test tube holder should not be heated and should be held carefully. Students should always be closely supervised when heating material in test tubes. Use caution when heating any plastic item. It may be flammable or give off toxic or harmful vapors. Make sure all test tubes are Pyrex or some other heat resistant glass.
- f. Be familiar with the location of the emergency gas shut-off button. Gas service, if needed, should be turned on with the key at the beginning of class. The teacher should use the gas shut-off button to turn off gas service when exiting the class/lab room. The gas switch should always be in the off position to reduce the chance of vandalism.

### 2. HOT PLATES

The NSTA advocates the use of hot plates instead of gas burners. Remember that hot plates remain hot after being turned off and should still be handled cautiously.

### 3. ALCOHOL AND PROPANE BURNERS

Many serious accidents have occurred due to alcohol burners. Alcohol burners are not permitted in schools. For information regarding the use of propane burners in the schools, see Special Circular #24 on page 121.



### **III CHEMICAL SAFETY**

#### **GENERAL**

1. Make sure that all rooms containing chemicals are properly ventilated. There is to be NO FLAME in the room when using flammable, volatile liquids such as alcohol.
2. Prepare chemical reactions that give off toxic vapors, or flammable gases under a fume hood.
3. Use only vinegar and lemon juice as acids in experiments conducted in Grades K-5. Sodium bicarbonate is the only base to be used.
4. Do not return surplus chemicals to their containers. Do not pour excess reagent solutions back into their stock bottles. Prepare the proper protocol for chemical clean-up for each laboratory exercise in advance.
5. Do not place any bottles, especially those containing acids, bases, or volatile organic liquids, near heating pipes or in direct sunlight. Dangerous gas pressures can develop under such conditions.

#### **RULES FOR USE OF ACIDS AND BASES**

1. When diluting acids always add the acid to the water slowly. If you were to reverse the procedure, violent splattering might take place. Be sure to wear gloves and goggles. Diluting sulfuric acid produces a good deal of heat when the acid is added to the water.
2. When preparing a diluted acid, use the following procedures:
  - a. Start with water in a heat-resistant container which is neither chipped nor scratched.
  - b. Place the container in a sink filled with cold water.
  - c. Slowly add small quantities of the concentrated acid to the water while stirring constantly.
3. Open containers of hydrochloric acid under the fume hood.
4. Never allow students to taste the salt formed by neutralization reactions.
5. Take extra precautions with concentrated acids and bases and other corrosive and toxic chemicals. Do not allow students to handle concentrated acids and bases. If acids or bases are spilled on skin or clothing, wash immediately with large quantities of water.
6. A good deal of heat is produced when solid sodium hydroxide is added to water, so follow the same steps as for sulfuric acid.
7. Have spill kits/materials readily available.

## IV ELECTRICITY

At the start of any activity involving electricity students should be reminded not to experiment with household current in school or at home. You should also be familiar with the location of the fuse or circuit breaker box.

Certain electrical sources of low amperage and voltage can, under certain circumstances, result in serious injury or death. There is a significant difference in the degree of hazard posed by DC and AC sources. Low voltage DC sources are not typically fatal, although they can cause burns. However, sources as low as 24 volts AC have been known to be fatal. Students should be instructed to avoid water spills near equipment and to avoid inserting objects into any electrical apparatus.

Electrical cords should never be allowed to hang over the edge of a table. Personal injury or breakage of equipment can occur if someone trips on or pulls a loose cord.

Examine all electrical equipment for frayed cords, exposed wires, or loose connections. It is strongly advisable to have a qualified repair service replace or repair all damaged equipment.

Caution students against grasping any electrical device which has just been used. Many electrical devices remain hot after use and may cause serious and painful burns.

## V ADMINISTERING FIRST AID

Administer first aid guided by the following statement from *The Administration of Safety in New York Schools* (Curriculum Bulletin No. 13).

In rendering first aid, the guiding principle is that the person is administering only immediate temporary care pending administration of competent medical care. First aid according to the New York State Education Department Bulletin, *First Aid Care of School Emergencies* is “treatment which will protect the life and comfort of the student until authorized treatment can be secured and is limited to first treatment only, following which, the child is placed under the care of his parents upon whom rests the responsibility for subsequent treatment.” Procedures included in the American Red Cross official textbook should be followed. Several especially relevant additional first aid procedures follow:

**NOSEBLEEDS.** Have papertowels available and carefully hand these to the student so the student can use these to control bleeding. Student should remain calm, sit upright in a chair and pinch the bridge of his nose. Notify the school nurse. Notify the custodian if it is necessary to clean up blood.

**BURNS FROM FIRES AND CHEMICALS.** For chemical burns, wash and flush area with water and remove any clothing or jewelry that may have been in contact with the chemicals. For burns caused by fire or hot objects, apply cold water IMMEDIATELY until the pain subsides.

If clothing catches on fire use stop-drop-and roll method and douse victim with water from the safety shower. Fire blankets should be used as a last resort because they retain the heat and increase the severity of the burns. Remove charred clothing, and cover burned area with a clean, cold, wet cloth. If victim appears to be in shock, make sure he/she is kept warm.

Summon medical help as quickly as possible.

**EYE INJURIES FROM CHEMICALS.** Quickly flush eyes thoroughly with running water for at least fifteen minutes. Be sure lids are kept open by holding them away from the eyeball. Remove contact lenses if present. In first aid treatment of the eye, use water only. Summon medical attention, but do not interrupt the washing procedure.

**INHALATIONS OF GASES.** If a student inhales a toxic gas such as chlorine, hydrogen sulfide, sulfur dioxide, remove the student to fresh air immediately, and immediately summon medical help.

**INGESTED POISONOUS CHEMICALS. CALL *Poison Control* IMMEDIATELY. THE NATIONAL HOTLINE # is 1-800-222-1222.**

Keep this number by the nearest telephone.

**Note:** Poison Control prefers you do use this number and will automatically connect you to the center. Poison Control takes preference to MSDS. Do not give water unless directed to do so by a qualified medical professional.

# GENERAL DIRECTIONS FOR LAB SPECIALISTS

## LABORATORY INSPECTION

1. Inspect eyewash stations, safety showers, fume hoods, fire blankets and fire extinguishers. Ask the custodian to inspect and service as needed.
  - a. **Eyewash stations** must conform to American National Standards Institute (ANSI) Z358.1-1998 standards. (American National Standard Institute, [www.ansi.org](http://www.ansi.org)) The eyewash should provide water (78F – 92F temperature) for 15 minutes of flushing at a rate of .4 gallons per minute.

The eye wash station must be located in a strategic place in the room no more than ten seconds from an accident.
  - b. **Safety showers** must conform to ANSI Z358.1-1990 standards. The emergency safety shower must be in a convenient place no more than 10 seconds from an accident. It must provide 20 minutes of tepid water. (American National Standard Institute, [www.ansi.org](http://www.ansi.org))
  - c. **Eyewash stations** and **safety showers** must be activated weekly and have an annual maintenance check .
  - d. **Fire blankets** must be inspected for rips and tears.
  - e. **Fume Hoods** must be adjusted so the average velocity across the face of the hood is 100 feet per minute (fpm). Use a velometer (available from scientific supply company) to check your hood.
  - f. **Fire extinguishers** must be placed according to NYC Fire Department code.
    - No point shall be further than 50 feet from an extinguisher.
    - Most labs have ABC rated fire extinguishers
    - Class D fire extinguishers are ALSO required if you store water-reactive metals such as sodium and potassium.
    - The chemical storage room must have an ABC type fire extinguisher inside the door or on the door.

## I TYPES OF FIRE EXTINGUISHERS

CLASS OF FIRE	DRY CHEMICAL ABC	CARBON DIOXIDE ABC	POWDER D	DRY SAND D
<b>CLASS A</b> Ordinary combustible materials like paper, wood, fabric, and usual trash	Yes	No Offers very little protection	No	No
<b>CLASS B</b> Flammable liquids (such as alcohols, ketones, etc.)	Yes	Yes But offers little protection	No	No
<b>CLASS C</b> Electrical equipment	Yes	Yes Only if it does not have a metal delivery hose	No	No
<b>CLASS D</b> Water-reactive chemicals	No	No	Yes	Yes

1. Ask the custodian to provide and check fire extinguishers. An outside agency should also inspect them once a year.
2. Inspect all spill clean-up kits and replenish chemicals if necessary.
3. Inspect gas jets for blockages caused by papers and other items. Remove, if possible, or have the gas jets serviced by the local gas company.
4. Notify the supervisor of the existence or development of any hazard.
5. Inspect student-made projects for safety hazards before these projects are demonstrated in the classroom.
6. Make sure that all rooms containing chemicals are properly ventilated and that there is no flame in the room when using flammable, volatile liquids such as alcohol.

## II CHEMICAL STORAGE

1. Conduct an inspection of all the chemicals in your laboratory (refer to “Steps to a Clean and Safe Laboratory” in the Appendix).
2. Keep all bottles labeled at all times. Labels should contain at least; the name or formula, concentration, date of receipt and/or preparation, and special hazards.

3. Replace old and damaged labels before they become useless. Disposal of unlabeled chemicals might require expensive analysis in the future.
4. Dispose of old chemicals that show bulging containers, liquids in solids, solids in liquids, darkening or clouding of solutions, spotting on solids. Dispose of chemicals that have specific shelf lives indicated on label. In general, dispose of chemicals that are 5 years old. (See disposal instructions found on pages 104–105.)
5. Carcinogenic and mutagenic chemicals should not be used or stored in schools. See the Appendix and the Chemistry Section for lists.
6. Explosives should not be used or stored in schools. See the Appendix “Explosives.” The N.Y.C. Fire Department Code Chapter 34 limits certain explosives and regulates the quantity of certain combustibles and dangerous chemicals that may be stored in public high schools.
7. Unlabeled bottles of chemicals whose identity is not known should be handled according to protocol in the section entitled, “Hazardous Waste Management” found in the Appendix.
8. Chemicals should not be arranged alphabetically by chemical cation names. Anions are a better indicator of reactivity and compatibility. See suggested storage arrangements in the booklet, *School Science Laboratories - A Guide to Some Hazardous Substances*, 1984, published by the United States Consumer Product Safety Commission or another reliable source.
9. Make sure that chemicals that react with each other are not stored in close proximity.
10. Store all acids in a soapstone or acid resistant storeroom, never in ordinary closets or wooden cabinets. To prevent breakage, store close to floor level if possible; never above eye level. Nitric acid should be isolated.
11. Make certain that combustibles and poisons are kept securely locked in metal, stone lined, or other cabinets designed for that purpose.
12. Store flammables in a dedicated flammable cabinet. This cabinet must adhere to N.Y.C. Fire Department codes. These codes conform to OSHA requirements, NFPA code 30. ([www.nfpa.org/faq.asp?categoryID=920](http://www.nfpa.org/faq.asp?categoryID=920))
13. Make sure that storage cabinets for sodium, potassium, calcium and calcium carbide exhibit this warning in bold, easily read letters:

**In Case of Fire  
DO NOT USE WATER**

14. Do not store sodium, potassium, calcium or calcium carbide on shelves above or below vessels containing water or aqueous solutions. After the original containers of sodium and potassium have been opened, these metals must be immersed and stored in water-free mineral oil.
15. Inspect chemical cabinets monthly for hazards and eliminate them if possible. Record the date of each inspection. Report any hazards that were not eliminated to your supervisor for further action.

16. Prepare a chemical inventory according to N.Y.C. Department of Education guidelines. This must be updated each year, kept in a secure location and be available for inspection. See the Appendix for a copy of the inventory sheet and instructions. This inventory is required by the New York State Commission of Education (Education State Law 305, Section 1., Subdivision 19). It is required by all elementary and secondary schools.
17. Prepare a N.Y.C. Right-to-Know Facilities Inventory Form for hazardous chemicals according to New York City Dept. of Education H.S. Memorandum #66 (January 14, 1991). See the Appendix for a copy of the Facilities Inventory Form and instructions for complying with Community Right-to-Know Laws (Title III of Federal Superfund Amendments and Reauthorization Act .SARA of 1986 and N.Y.C. Community Right-to-Know Law .Local Law 26 of 1988). The compliance package for annual reporting of hazardous substances in N.Y.C. may be obtained on line at [www.nyc.gov/dep/tier2filing\(?\)](http://www.nyc.gov/dep/tier2filing(?)). This report is due each year on March 1st.
18. When ordering chemicals, in general, a one year supply is the recommended maximum. It is often safer and more economical to purchase in smaller quantities than to pay for disposal of excess and/or deteriorated chemicals.

### **III EQUIPMENT AND SUPPLY STORAGE**

1. Employ appropriate safety standards and methods in the storage and use of all supplies.
2. Keep tools and sharp-edged instruments in good condition and stored in locked cabinets.
3. Explosion-proof refrigerators should be used. No food or beverages should be stored in refrigerators used for instructional purposes.
4. Secure all compressed gas cylinders when in use. Secure them to a hand truck while transporting them.

### **IV LAB SQUADS**

1. Acquaint all laboratory/preparation room squad members with safety regulations at the beginning of their service. Secure a parental consent slip for each squad member.
2. Limit the number of students on the lab squad to a number that can be supervised with ease.
3. Establish procedures so that students do not have unsupervised access to chemicals in the preparation rooms, closets, or stockrooms.
4. Instruct squad members never to handle apparatus or chemicals unless they have received specific instructions on their use.
5. Review specific procedures when assigning each task.
6. Do not allow students to touch anything in cabinets where dangerous materials are stored.

7. Student use of tools or sharp-edged instruments should be closely supervised.
8. Never permit squad members or students working on projects to remain unsupervised in preparation or stock rooms.

## **V FUNCTIONAL RESPONSIBILITIES**

1. Close and lock the preparation room whenever it is not under the direct supervision of a licensed laboratory specialist or science teacher.
2. Order protective eye goggles or face shields that comply with ANSI Z-87.1-1989 (American National Standard Institute, [www.ansi.org](http://www.ansi.org)) or current standards. Advise teachers and students that these are available whenever necessary.
3. Inspect new equipment for hazards before approving payment. Report any problems to the vendor and/or supervisor.
4. Inspect used equipment to make sure it is in good working condition, particularly electric wires, plugs, and glassware that will be handled by students.
5. Advise teachers regarding safety precautions required for the proper use and manipulation of specialized equipment and supplies. Suggest the use of plastic beakers, graduated cylinders, and other containers, rather than glass, for younger students.
6. In cooperation with the teacher, perform the actual procedures of each laboratory experiment or demonstration prior to the class session to see that all materials and apparatus work properly and safely.
7. Chemicals provided for student use should be put into smaller, labeled containers. The warnings and hazards on the MSDS (also on the original containers) should be copied onto the new labels. If chemicals are kept at the teacher's desk, a large, clear sign for each chemical used should be posted at each bin.
8. Review student laboratory experiments periodically for current safety practices. Disseminate information regarding any new safety regulations.
9. In case of an emergency, have MSDS readily available for hazardous chemicals used in laboratory experiments.
10. Make sure that demonstrations, experiments, or projects dealing with atomic energy or radioactivity are performed in accordance with approved safety practices in that field. Only radioactive sources which are low in activity level; those which do not require a regulatory license from the Nuclear Regulatory Commission, should be used for demonstration or experimental purposes. Isotopes that emit radiation on the order of 0.01 millirem per hour at a distance of one foot fall into this category. Scientific supply companies stock only radioactive sources of this type. When handling radioactive sources, keep them as far away from your body as possible. Store these materials in a quiet area away from student and teacher traffic inside of a lead pipe with screw-on



end pieces. These pipes can be purchased in a local hardware store.

11. Use safety precautions in the transportation of all equipment and supplies to and from the science classrooms and laboratories.
12. Transport long glass rods and tubing in a vertical position, observing door heights and other clearances.
13. Do not permit students to transport dangerous chemicals such as concentrated acids and bases, except under the direct supervision of a licensed laboratory specialist. Use safety carriers, if available.
14. Make sure that a fire extinguisher and fire blanket are included as auxiliary equipment when portable laboratory tables are sent to non-science rooms. For convenience, these may be attached to the table.
15. Have a first aid kit and American Red Cross first aid text available, as well as emergency telephone numbers and MSDS.
16. Post first aid charts including CPR and Heimlich maneuver.
17. Make sure Fire Drill Exit Route is posted.
18. Report any injury or accident to supervisor.
19. Make sure a copy of your school's *Chemical Hygiene Plan* is available, (Contact the N.Y.C. Department of Education Office of Occupational Safety and Health for a copy of the *Chemical Hygiene Plan* at (718) 935-2319. This plan is required under OSHA's Laboratory Standard Regulation (29 CFR1910.1450).
20. Know how to manage chemical spills and make sure the proper personal protective equipment and spill kits are available. Refer to the section entitled, "Chemical Spills" in the Appendix.
21. Know how to handle chemical waste. Refer to the section entitled "Hazardous Waste Management" found in the Appendix.
22. Report to the supervisor anyone who is not cooperating with the department's accepted safety practices.
23. If the proper equipment is not available for a safe experiment or demonstration, it should not be attempted.

## VI PERSONAL SAFETY

1. Be familiar with the OSHA Laboratory Standard (29 CFR 1910.1450) and regulations concerning the implementation of a *Chemical Hygiene Plan* (this document is with your school's Chemical Hygiene Officer). Under this standard, non-production laboratories must provide training for their employees, as well as, working fume hoods, and other safety equipment.
2. Always wear a lab coat or apron when working in the lab.
3. Never wear sandals or shoes with cut out toes or backs.
4. Make sure goggles conform to ANSI Z87.1 (American National Standard Institute, [www.ansi.org](http://www.ansi.org)). Wear them at all times when working in the lab.
5. Face shields and/or standing shields must be available when there is danger of implosion or explosion.
6. Make sure you are wearing the appropriate gloves for the job you are doing. Check charts for breakthrough time, permeation rate (none detected is ideal), dexterity, comfort, and heat resistance.

## GENERAL DIRECTIONS FOR CUSTODIANS

1. Provide proper ventilation and illumination of science storerooms, preparation rooms, laboratories, and science classrooms.
2. Have fire extinguishers inspected each term. Then, service and/or replace as necessary. Inspection dates should be recorded on the attached tag.
3. Provide fire extinguishers and, fire blankets for each science lab, prep room, and classroom.
4. Be familiar with the *New York State Right-to-Know Standards and the Blood Borne Pathogens Standard*.
5. Substitute safer chemicals for more hazardous ones if available, for performing custodial duties.
6. When notified by the lab specialist, chemical hygiene officer or science assistant principal that chemicals need to be removed from the school, the custodian prepares and submits a work order (PO-18) to his or her plant manager, attaching the list of chemicals that need to be removed. A request is then submitted to the Environmental Health and Safety Office at the Department of Education's Division of Facilities (fax number 718-361-3844).
7. Communicate any new fire regulations to the science department.
8. Act as liaison with the fire department if a current Fire Department Permit needs to be obtained for the chemical storage area.

# STUDENT SAFETY

(NOTE: Review the following rules with students, then distribute copies of their rules and contracts that they and their parents must sign and return to class.)

1. Students may not work in the laboratory or participate in performing demonstrations unless they are under direct supervision of a licensed teacher/laboratory specialist and have been given specific instructions.
2. Students must wear clothing that will not interfere with science apparatus or chemicals. Their hair must be tied back so it does not come into contact with flames or chemicals.
3. Students must wear goggles and other protective equipment when appropriate. Contacts may be worn in the laboratory in conjunction with non-vented safety goggles.

## 4. EYE PROTECTION

All persons must wear eye protection whenever chemicals are handled, glassware is used, flames are involved, or when there is a danger of splattering of liquids, or chipping of ores, minerals, and rock samples. This includes students and faculty who are not actively engaged in the experiment or demonstration.

Ordinary eyeglasses do not provide adequate protection for use in the science laboratory or classroom. Contact lenses afford no protection and may be harmful to the eyes because chemicals can be trapped beneath them. Only safety goggles marked with the code "Z87" provide the necessary protection. Safety goggles are either *Type G* which has no ventilation or *Type H* which is indirectly ventilated. Both types are equipped with flexible edging so they fit firmly against the skin of the face, protecting against splashes as well as flying fragments of glass or rock. Students who must wear contacts should inform the teacher and be required to wear non-vented goggles.

"Safety glasses" are unacceptable. These are similar in appearance to ordinary eyeglasses and have side shields which are not as effective against large chemical splashes.

Protective eyewear used by one class should be properly sterilized by an approved Board of Health method before being distributed to the next class. Ideally, a goggle sanitizer should be present in every laboratory room.

5. Students may not test any chemicals or substances nor drink out of laboratory glassware or vessels. Students may smell substances only when given specific instructions by the teacher. The teacher will demonstrate the appropriate method of wafting chemicals.
6. Students are to report immediately anything in the laboratory that seems unusual or improper, such as broken, cracked, or jagged apparatus, and reactions that appear to be proceeding in a peculiar or unexpected manner.
7. Students should behave properly and not try any procedures that have not been approved by the teacher. They should report to the teacher any behavior on the part of other students that is disruptive or dangerous.

8. Students should not grasp any apparatus that has been heated unless they have allowed ample time for cooling.
9. Students are to report immediately to the teacher any personal injury (burn, scratch, cut, or corrosive liquid on the skin or clothing) no matter how trivial it may appear.
10. Students should know the location of fire extinguishers, fire blankets, eye wash stations, safety showers, and first aid kits.
11. Students are never to pour reagents back into bottles or to exchange stoppers of bottles, or to place stoppers on the table. Stoppers should be replaced immediately after using reagents.
12. Students should be cautioned about the possible dangers from work done at home in connection with projects and science fairs. Use of dangerous substances, such as carcinogens, explosives, hormones, and radioactive substances should be avoided.
13. Students should transport materials through the halls only when classes are not passing. However, students may not transport dangerous chemicals, such as concentrated acids and bases.
14. Demonstrate how students are to pour liquids properly from a bottle, without spilling.
15. Students should do only the experiments assigned or approved by teachers.
16. Instruct students never to handle apparatus or chemicals in the laboratory unless they have had specific instructions. Before working with sharp tools, students must demonstrate to the teacher that they are competent to use them.
17. Students may not dilute any concentrated acid or base.
18. Advise students that glass wool and steel wool should be handled carefully to avoid getting fragments into the skin. Where appropriate, use a grasping tool, such as tongs, or wear gloves.
19. Caution students to make certain that the delivery tubes are not clogged when a gas is being collected by water displacement and a thistle tube is employed to add acid. Otherwise, explosive pressure may develop, or acid may be spattered.
20. Caution students that, in or out of school, certain activities involving chemicals are hazardous, e.g., setting fire to gasoline cans, breaking open fluorescent light tubes, and throwing aerosol cans into a fire.
21. Advise students against experimenting with rocket fuels. FORBID their use in school. Many rocket fuels are dangerous explosives that may not be used legally within city limits.
22. Students should not use direct sunlight as a source of light for the microscope. Students should not observe a solar eclipse directly through a telescope or binoculars. The image should be projected on a screen instead.

# STUDENTS LABORATORY SAFETY CONTRACT

*(NOTE: These two pages should be duplicated and distributed to each student.)*

Your health and safety are most important! In the science laboratory, you will be carrying out a number of laboratory activities that could be hazardous to your health and well being UNLESS they are done by following your teacher's instructions both oral and written. The rules listed below will help ensure your safety. They must be followed at all times. The bottom portion requires your signature and that of your parent or guardian. After both of you have signed the tear-off sheet, it must be returned to your teacher so that you can participate in laboratory activities. Failure to carry out laboratory experiments will result in a lowered class grade and might result in a failing grade in the course. The upper portion of this contract is to be pasted or taped in your science notebook and should be reread prior to starting each new laboratory activity.

## GENERAL RULES

1. Follow all instructions carefully. If you don't understand what you are expected to do, ask your teacher before proceeding.
2. Conduct yourself in a responsible manner whenever you are in the science laboratory. Horse play and pranks are dangerous and have no place in the science laboratory. When you enter the laboratory, do not touch any equipment or chemicals until you are instructed to do so.
3. Eating and drinking is not permitted in the laboratory. Do not use any glassware in the laboratory as a container for food or drinks. Keep your work area neat and clean. If available, wear a lab apron or coat.
4. Know where the safety equipment including the eyewash station, safety shower, fire extinguisher and fire blanket is located. Notify your instructor immediately of any unsafe condition.
5. Use the fume hood when working with gaseous substances. Never put your head inside the fume hood.
6. If a fire drill occurs during a laboratory period, be sure to close all chemical containers, gas and electricity.
7. Keep your hands away from your eyes, mouth and face when using chemicals or handling preserved specimens. Wash your hands with soap and water before leaving the laboratory.
8. Clean and return all equipment when instructed to do so by your teacher.
9. When handling sharp instruments such as scissors and dissecting instruments, always carry them with the tips and points in a downward position. Always cut away from your body. Hold the instruments by their handles. If a sharp instrument falls off the table, don't try to catch it!
10. Wear goggles when instructed by your teacher. There are no exceptions to this rule. If you wear contact lenses, ask your instructor for non-vented safety goggles. If a chemical should splash into your eye or get on your skin, immediately flush the eye or skin with running water from the safety shower or eyewash station for at least fifteen minutes. Notify your instructor at once. Report any accident including a chemical spill or breaking of equipment to your teacher at once. Notify your teacher of any injury no matter how slight. This includes cuts and burns and chemical splashes on any part of the body.

11. Long hair, hanging jewelry, and loose or baggy clothing are hazardous in the laboratory. Long hair must be tied back. Hanging jewelry and loose clothing must be secured. Sandals are not permitted in the science laboratory. Shoes or sneakers must be worn.
12. Follow instructions for handling chemicals. Do not taste, touch, or smell any chemicals unless told to do so. Don't return unused chemicals to their stock containers. Dispose of all chemicals by following your teacher's instructions. Don't use the sink drains for mixing chemicals.
13. Follow instructions for the handling and dilution of acids and bases.
14. Follow directions for inserting and removing glass tubing from rubber stoppers. Never handle broken glass with your bare hands. Use a dustpan and a brush or broom for cleaning up broken glass.
15. Do not use glassware that is chipped or cracked.
16. Make sure your hands are dry before removing an electric plug from a socket. Report any damaged electrical equipment, including, frayed wires and loose connections.
17. Be very careful when using a gas burner. Keep hair, clothing, and your hands safely away from an open flame. Never point the open end of a test tube that is being heated at yourself or anyone else. Hot glass and hot metal stay hot for a long time. Set them aside to cool on an insulated pad. Remember, hot glass and cold glass look exactly alike.

## AGREEMENT

I \_\_\_\_\_ of Class \_\_\_\_\_ have read and agree to follow all of the safety rules in this contract. I will follow my teacher's directions. I am aware that failure to follow these rules is dangerous and may result in my being barred from the laboratory, and that this may result in a failing grade.

---

Student Signature

Date

Dear Parent or Guardian:

Your signature indicates that you have read these safety rules and have instructed your child to follow these rules and procedures in the science laboratory.

---

Parent/Guardian Signature

Date





# **DIRECTIONS FOR SPECIFIC LABORATORIES**



# BIOLOGY

This section begins with instruction for overall safety in the Biology Laboratory. It continues with a series of units from the New York City Department of Education's Living Environment High School Scope and Sequence 2005 which is based upon the New York State Education Department's Core Curriculum in the Living Environment.

## GENERAL INSTRUCTIONS

### Human Body Fluids

With the advent of awareness that dangerous and currently incurable diseases can be spread through body fluid contamination, experiments and demonstrations using body fluids should never be done. Synthetic body fluids purchased from scientific supply companies can be used to offer students a safe experience. The only possible exception is in advanced, responsible classes where cheek cells may be harvested for the extraction of DNA. NOVA on line at [www.pbs.org/wgbh/nova/teachers/activities/2809-genome.html](http://www.pbs.org/wgbh/nova/teachers/activities/2809-genome.html) is one website that offers a clear example of how to conduct a safe DNA extraction lab.

### Protocols

The following instructions apply to all laboratory situations:

1. Students should be instructed not to eat, drink, or inhale anything in the laboratory, unless specifically told to do so.
2. Students should be told to wash their hands after using laboratory materials.
3. Teachers should demonstrate the proper way to smell in the laboratory (wafting).
4. Proper ventilation should be provided any time an odoriferous material is used in the laboratory.
5. Latex, vinyl or nitrile gloves and bleach should be available in the laboratory or classroom, particularly for accidents involving body fluids or other substances.
6. Long hair and loose clothing (including long sleeves) should be secured when working in a laboratory.
7. Students should never be directed to clean up broken glass or body fluids.
8. Goggles must be worn by students when there is any activity occurring anywhere in the laboratory room that might pose an eye hazard. If chemicals, glassware or heat are used, goggles must be worn.
9. Closed toe shoes should be worn in the laboratory.
10. Students should be notified that they are to report all (potentially) dangerous situations to the teacher immediately.

## **SUPPLIES AND EQUIPMENT**

### **Centrifuge**

Balance each tube of materials with another tube filled with water according to manufacturers' direction. Use only tubes designed for the centrifuge as these can withstand the strong forces created.

### **Glass**

1. Never use cracked, chipped, or broken glassware.
2. In certain instances plastic may be an acceptable alternative and should be used whenever possible, particularly with younger students.
3. When using prepared slides under a microscope, remind students how to focus under high power so as not to crack the microscope slide, or coverslip, resulting in damage. Thin glass cover slips are prone to breaking when students try to flex them. Warn students about this. Plastic cover slips are a good replacement and do not crack.
4. Students should be warned not to touch broken glass as it is sharp and often hard to detect until it pierces flesh.
5. Heat resistant glassware should be used when heating. HDPE plastic (Nalgene) is heat resistant.

### **Microscopes**

1. The proper use of the microscope should be reviewed with students prior to use.
2. Microscopes should be used only under supervision.
3. Microscopes are costly, heavy and somewhat delicate pieces of equipment and should be handled carefully. Students should be instructed on the correct method of carrying microscopes (with two hands, close to the body). Do not allow them to "swing" the microscope.
4. Care should be taken in placing the microscope on the desk so that it will not fall and hurt someone.
5. Students should be shown how to carefully clean the objectives and eyepieces with lens paper.
6. Students should be cautioned about cracking slides when changing to high power resolution. Students should not use the coarse adjustment knob when the high power objective is in use.
7. Microscopes should be maintained properly (adjusted / repaired if needed) approximately once a year.

## **Microtome**

1. It is recommended that schools purchase prepared slides whenever possible.
2. If it is determined that students need to use a microtome, they should be instructed to use caution and keep their fingers away from the blade while adjusting, cleaning, and cutting with it.

## **Dissection Protocols**

1. Students should be seated far enough apart to ensure that no crowding or jostling occurs.
2. Laboratory stations should be clear of any unnecessary materials
3. Never use organisms preserved in formaldehyde solutions.
4. Generally, preserved specimens should be rinsed off prior to use to remove excess preservative material.
5. Care should be taken with dissection instruments as the sharp edges represent cutting hazards.
6. Students should be cautioned about the dangers of the sharp dissection instruments.
7. Students should be directed to secure specimens to the trays, always cut away from the body, and to cut down against the dissecting tray. Caution students to keep the hand that is holding the specimen away from the instrument's cutting edge.
8. Teachers should carefully collect the dissection instruments, making sure that all are returned.

## **Chemical Protocols**

1. Be aware of any special precautions for the specific chemicals used in the laboratory lesson you are about to perform. Consult the MSDS for specific information pertaining to those chemicals. Refer to the Chemistry Section of the *Science Safety Manual*.
2. Acids and bases are harmful to body tissue and clothing. No concentrated acid or alkaline solutions should be handled by students.
3. Formaldehyde and related compounds are not to be used; safer preservatives exist that do not endanger students' and teachers' health.
4. Diethyl ether is not to be used. Other methods of anesthetizing drosophila exist.

# UNIT 1

## SCIENTIFIC INQUIRY

Students will use scientific inquiry to pose questions; make observations; plan, design and conduct experiments; collect and interpret data; communicate, draw conclusions and develop solutions. To engage in these activities, students may use a variety of organisms, both unicellular and multicellular, as well as other chemicals, supplies and equipment. For safety information review the units that follow and other appropriate sections of this Safety Manual.

### **Marine and Freshwater Animals**

Students should be cautioned against tasting or eating any organism collected in the field. Students should be warned of the hazards involved in the collection and handling of specimens with claws, spines, or poisonous secretions, such as crayfish, Portuguese men-of-war, sea urchins, and jellyfish. Some students may be hypersensitive to stings by aquatic organisms. Proper footgear (boots or sneakers) should be worn when collecting specimens. Decaying organisms should be discarded. Specimens which will be used for more than one day should be preserved or refrigerated.

### **Land Animals**

Teachers should provide instruction on the collection, care and handling of animals that are kept in school or might be encountered on a field trip. Students should be cautioned against touching certain field animals because of the diseases they may harbor or the injury they may inflict with teeth, tails and claws. Teachers should inform students not to treat an animal in a manner which may lead to the injury or death of that animal. Cages should be cleaned, disinfected and checked for hazards (frayed wires, sharp edges) regularly. When caring for rodents, pick up their cages by its handles, not the mesh, as the animal can often bite through the spaces of the mesh. When handling animals, or when cleaning cages wear appropriate, thickly padded gloves. For additional important safety information, please refer to the “Animals in the Classroom” section of the chapter, “Especially for Grades K – 8.”

### **Plants**

Caution students against tasting or eating any plant material that has been collected or used in a laboratory exercise. Many common house and garden plants are toxic: azalea, crocus, daffodil, dieffenbachia, foxglove, mistletoe, poinsettia, etc. Before a field trip, students should be instructed on the identification and avoidance of poison ivy, poison oak, poison sumac, nettles, burrs and thorns, if there is a possibility that they will be encountered. On all field trips that include visits to fields and woods, students should dress to prevent scratches and tick bites. This includes wearing caps or hats and dressing in light colored, long sleeved shirts and pants and tucking the bottom of students’ pants into their footgear. Advise students to tie back long hair. In lessons on flowers and molds, take care to prevent the excessive distribution of pollen or spores. Some students may be allergic to these materials.

## UNIT 2

### ORIGIN OF LIFE

Students will learn, how scientists believe life on Earth began billions of years ago. Scientists believe that from the primitive atmosphere single-celled organisms evolved.

Use caution if displaying ammonia or any of the other gases found in earth's primitive atmosphere.

## UNIT 3

### ECOLOGY

Students will learn the interrelatedness of all organisms to each other and to the physical environment.

- Creating model ecosystems, use of terraria, aquaria, aquaculture and/or hydroponics can demonstrate ecosystems. Refer to the sections on caring for living things found in Unit 1 of the Biology section when model ecosystems are created.
- Symbiosis – teaching mutualism can be done by dissecting the protozoa from a termite's intestine. For safety information refer to the section on dissection and other appropriate sections of this manual for safety information.

## UNIT 4

### ORGANIZATION AND PATTERNS IN LIFE

Students will learn about the structures and functions of the cell and the importance of the cell as the building block of all living things. The students will compare and contrast photosynthesis and respiration as chemical processes that occur in cells and one necessary to sustain life on earth.

#### PHOTOSYNTHESIS

##### **Investigating for the presence of chlorophyll in leaves**

Chlorophyll extraction: The use of isopropanol and acetone heated in a water bath on a hot plate presents a number of hazards. These hazards can be diminished by substituting 95% ethyl alcohol for the isopropanol, acetone, and heat. Grind the leaves in a mortar using the 95% ethyl alcohol as the solvent. Wait five minutes, then regrind the leaves. The solution will contain both Chlorophyll A and B. In addition to being safer, this procedure will preserve Chlorophyll B which is destroyed by heat. Ethyl alcohol is flammable and toxic, if ingested. Precautions should be taken against having any open flames in the room. Use a hot plate. Never use alcohol burners. If Bunsen burners are used, exercise extreme caution. Warn the students that ethyl alcohol is poisonous if swallowed.

## **RESPIRATION**

### **Test for carbon dioxide**

Bromthymol Blue: Caution students to blow into bromthymol blue. They should never ingest or inhale it.

### **Demonstrating heat energy from food oxidation**

When burning objects (marshmallow, walnut) make sure that the room is well ventilated.

Students with allergies, asthma or other respiratory problems should be placed near windows or asked to leave the room, if smoke will trigger an attack.

## **DIFFUSION**

For use of concentrated Hydrochloric Acid and Ammonium Hydroxide see “Acids and Bases” in General Directions for Science Teachers K-12.

# **UNIT 5**

## **HOMEOSTASIS AND IMMUNITY**

Students will learn that organisms maintain homeostasis, a dynamic equilibrium that sustains life. Students should be able to give examples of body systems and the role these systems play in maintaining homeostasis. They will also identify the diverse homeostatic mechanisms that maintain this dynamic equilibrium. Students will learn that when control mechanisms fail disease will result.

## **DISSECTION**

Dissections will enhance understanding of the body systems. For safety information see “Dissection Protocols” in the beginning of this chapter.

## **ENZYMES**

- **Oxygen test:** Use of glowing splints which will burst into flame in the presence of oxygen poses fire/burn hazards. Have water nearby to douse splints. Make sure the splints are long enough to hold safely. Keep students at a safe distance from the glowing splints and each other.
- **Starch Test:** Because of the potential for transmission of communicable disease, do not use saliva or salivary amylase to demonstrate digestion of starch by enzymes.
- **Urea-Urease Test:** This test is generally safe, however there may be a possible odor as ammonia,  $\text{NH}_3$  is emitted. Open the windows to provide adequate ventilation. Work under a fume hood, if possible.



## **NUTRITION**

In testing for the calorie content of foods a calorimeter is used. For its use refer to the general safety rules regarding an open flame. Students with long hair should have their hair pulled back or pinned up on their heads.

### **Test for simple sugar**

Benedict's Qualitative Solution/Powder presents no hazards.

Benedict's Solution Quantitative Solution contains potassium thiocyanate which is moderately toxic. Caution students not to ingest any of this solution, and to wear gloves or wash their hands thoroughly after using this solution to quantify the amount of sugar in a food.

### **Test for protein**

Biuret Solution contains 10% sodium hydroxide which is very corrosive to the eyes and skin. Students and staff **MUST** wear safety goggles when working with Biuret solution. Gloves are also recommended when using this solution to test for proteins. Immediately wash off any Biuret solution that splashes on a student's skin with water. Other tests for protein such as the Xanthoproteic test which uses heated concentrated nitric acid and the Ninhydrin test which employs triketohydrindene hydrate are either equally as hazardous, if not more hazardous than the Biuret test.

## **TRANSPORT**

Body fluids may not be used. Commercial blood (and other body fluid) substitutes are available.

## **NERVOUS SYSTEM**

### **Experiments related to taste receptors in tongue**

When students perform experiments related to taste receptors in the tongue they should be cautioned to properly dispose of any material that has been in their mouths, and not to touch anything that has been in someone else's mouth. Students should be reminded to wash their hands thoroughly after the laboratory exercise.

## **EXCRETION**

### **Investigating Metabolic Waste**

- When testing for carbon dioxide, caution students to blow into bromthymol blue. Tell them that they should never ingest or inhale it. Students should wear protective goggles while performing this activity.
- Never use real urine for testing or experimenting.

## **MICROORGANISMS**

### **Investigating the Role of Microorganisms in Health and Diseases**

#### Live Cultures

The degree to which microorganisms can be used safely in the laboratory depends upon the maturity and proper training of the students, the experience of the teacher, the availability of appropriate apparatus and the type of organism being studied. Precautions must be taken when handling microorganisms to prevent the possible spread of disease. All cultures must be handled as potential pathogens. Proper precautions must be taken when disposing of test tubes and Petri dishes where these organisms have been cultured.

- a. Culture only non-pathogenic species of bacteria, algae, fungi, protozoans, viruses and bacteriophages. Pathogens are regulated by the Federal Health Service and cannot be shipped to schools or individuals.
- b. Do not prepare cultures from students' saliva, mucous, cough spray or any other body fluid.
- c. Always use sterile technique when working with microorganisms.
- d. When transferring bacteria, sterilize wire inoculating loops before and after each use by holding loop in a flame until it glows bright red.
- e. Using transparent tape, seal any exposed Petri dishes which are passed around the class for inspection.
- f. Do not permit a broth culture to wet the cotton plug or cap.
- g. Do not permit fermentation to take place in a closed system or tightly sealed container.
- h. Pipettes used for transferring cultures or for making dilutions present a great potential hazard to untrained students. Teachers should emphasize the correct method for using pipettes. Do not use direct mouth pipetting for all fluids. Instead, use a bulb attachment. Caution students not to blow a fluid containing microorganisms out of the pipette because spattering might result. Use of disposable pipettes is recommended for transferring cultures of microorganisms. To prevent possible spread of disease, even disposable pipettes must be sterilized before discarding. This can be accomplished by autoclaving or soaking the pipettes in a solution of Lysol or 10% bleach. Nondisposable pipettes can be cleaned and reused by placing them into a cylinder containing disinfectant solution, washing them in an automatic pipette washer, and then sterilizing them. To sterilize pipettes, place them in a sterilizing can and heat them for two hours in a hot-air oven at 160 – 190 degrees Celsius. Keep the pipettes in the sterilized can. Alternatively, the pipettes can be soaked in a solution of Lysol or 10% bleach.
- i. Sterilize all contaminated material that is to be discarded.
- j. All exposed Petri dishes should be sterilized by autoclaving or soaking in a solution of Lysol or 10% bleach. Coffee cans with sealed lids work well as sterilization containers.
- k. Always keep hands away from the face while working with microorganisms.
- l. Strictly enforce rules against eating and drinking in the lab.

## UNIT 6

# REPRODUCTION AND DEVELOPMENT

Students will learn about reproduction at both the cellular and the organism level, including meiosis, fertilization and development. Students will learn about the structure and function of male and female reproductive systems. Students will identify and describe new techniques in reproductive technology, such as, in vitro fertilization, and the impact of these techniques in medicine and agriculture. They will also learn about recent scientific developments such as stem cell research. Review this section (Biology) and the General Directions for Science Teachers K-12, for standard safety procedures.

## UNIT 7

# GENETICS AND BIOTECHNOLOGY

Students will learn that inherited instructions that are passed on from parent to offspring exist in the form of a code. This code is contained in DNA and RNA molecules. Students will learn the structure and function of DNA and RNA, along with their role in protein synthesis. Students will be able to describe the characteristics of mutations and list their causes and the role they play in genetic diseases. Students will be able to explain how genetic engineering enables humans to alter the genetic make up of organisms.

### **Molecular DNA Analysis: Gel Electrophoresis**

The use of gel electrophoresis in the high school science laboratory is an extremely useful activity. A number of precautions should be taken when using gel electrophoresis since this technique may present certain hazards which need to be minimized. Be sure to review the safety rules with the class before engaging in gel electrophoresis activities.

1. Goggles must be worn during this procedure. Laboratory coats / aprons (or other protective clothing) are also suggested. Gloves should be worn to minimize exposure to chemicals and also ensure that the DNA is not degraded by nucleases found on the skin
2. When preparing the agarose gel, use tongs or padded gloves to remove the hot Erlenmeyer flask from the microwave or hot plate. Do not use an open flame (bunsen burner) to prepare the gel.
3. Make sure the gel electrophoresis apparatus is disconnected from the power supply before adding or loading the gel. The apparatus should remain disconnected until it is time to run the gel sample. Before turning on the power pack for the gel electrophoresis procedure, make sure the box is covered to prevent shocks. Students should faithfully follow the directions for connecting the leads to the gel electrophoresis chamber and never use voltage above those recommended. Turn off the power before disconnecting the leads or removing the cover of the electrophoresis chamber.
4. The most commonly used buffers for electrophoresis are TAE (Tris-acetate EDTA) and TBE (Tris-borate EDTA). Check the MSDS (Material Data Safety Sheets – these documents are with your school’s Site Safety Officer) sheets to decide which buffer is safest to use.

5. Polyacrylamide gels should not be used as acrylamide is a potentially serious health hazard (neurotoxin) and is possibly carcinogenic to humans.
6. Ethidium bromide, used as a staining agent in gel electrophoresis has been shown to be a potential mutagen in humans, and probably is a carcinogen. Therefore, it should not be used in the high school laboratory.
7. Methylene blue and its oxidation products, known as thiazin dyes and are considered the safest dyes to stain DNA and RNA.
8. The mouthwash method of DNA isolation may be used, however the liquid waste generated should be disposed of properly (mix with bleach and let sit for 15 minutes).
9. Agarose gel should be disposed of by throwing it in the trash; not down the drain as it will result in clogs. Disposable pipettes and pipette tips should also be thrown into the regular trash.

## **UNIT 8**

### **EVOLUTION**

Students will learn that individual organisms and species change over time. Students learn about the mechanisms and patterns of evolution including the role natural selection in evolution.

#### **MUSEUM SPECIMENS AND PRESERVED SPECIMENS**

Preserved specimens can be used when studying classification and evolution. The fluids in which these specimens are preserved may contain mixtures of water, formaldehyde (formalin), 1, 2-propanediol, phenol, and sodium citrate. Of these, formaldehyde and phenol are hazardous chemicals. Formaldehyde is a suspected carcinogen as well as a strong irritant to the skin and eyes. It should not be inhaled nor ingested. Phenol also is a strong irritant to the skin, and is toxic if ingested, inhaled or absorbed through the skin. Specimens preserved in formaldehyde and formaldehyde-related chemicals should not be used. Whenever possible, order specimens preserved in a non-carcinogenic and safe formaldehyde substitute. Preserved specimens should be rinsed off prior to use to remove excess preservation fluid and reduce odor. If a museum jar breaks, contain the spill with absorbent material, such as, paper towels or sand. Wear gloves to clean the spill. Absorbent material is hazardous waste and must be treated accordingly.

## **UNIT 9**

### **HUMAN INFLUENCES ON THE ENVIRONMENT**

Students will learn how human decisions and activities have had a profound impact; both helpful and harmful; on the physical and living environment. Students explore man's effect, both helpful and harmful, on the earth and its environments and organisms.

Review this section (Biology) and the General Directions for Science Teachers K-12, for standard safety procedures.

## MANDATED LABORATORIES

There are four New York State Education Department mandated Living Environment Laboratories, including:

- Diffusion Through a Membrane
- Making Connections
- Beaks of Finches
- Biodiversity.

Teachers may introduce these labs whenever they judge the time to be correct, based on the needs of their students. However, many experienced teachers have chosen to insert these labs as follows:

1. “Diffusion Through a Membrane” is performed in Unit 4, Organization and Patterns of Life.
2. “Making Connections” is performed in Unit 5, Homeostasis and Immunity.
3. “Beaks of Finches” is performed in Unit 8, Evolution.
4. “Biodiversity,” because it includes concepts taught throughout the year, is generally performed toward the end of the second semester of Living Environment.

There are safety concerns associated with each of the mandated laboratories. Therefore the following safety procedures should be followed when performing these laboratory experiments:

1. “Diffusion Through a Membrane”
  - Students should avoid skin contact with Benedict’s solution and iodine stains.
  - Goggles and protective gloves should be worn.
  - When using a hot plate to heat the water filled beaker in which dialysis equipment is inserted, students should take appropriate precautions to avoid burns.
  - Students should not be permitted to eat or drink during this laboratory activity.
2. “Making Connections”
  - Deal sensitively with students who have health issues, including asthma or heart problems, that may exclude them from doing the exercise component of the lab.
3. “Beaks of Finches”
  - Caution students that the tools used to pick up seeds may have sharp or pointy edges and should be handled carefully.
  - Wear goggles to protect eyes during the activity.
  - Make sure there is adequate space between students to minimize collisions and other accidents.
4. “Biodiversity”
  - Safety goggles should be worn and precautions should be taken when handling chemicals in the chromatography sections and enzyme identification sections of this activity.



# CHEMISTRY

In the teaching of chemistry, many different demonstrations and experiments may be done to illustrate a concept. In this section, only a few were chosen to illustrate the considerations when doing any chemical demonstration or laboratory experiment. Some are geared to fully equipped laboratory facilities while others can be substituted by schools with less comprehensive facilities.

## CHEMISTRY SAFETY

Every chemical is potentially unsafe. Therefore, every chemical must be handled properly and in minimal concentrations. Even salt (NaCl) and sugar if used improperly can be unsafe and have hazards listed in their MSDS (Material Data Safety Sheets) and NIOSH (National Institute for Occupational Safety & Health) ratings. However, most chemicals, if handled properly, are safe and are essential to teaching students about the world, its composition, and its chemical reactions. Chemicals and chemical reactions form a cognitive base upon which the more abstract principles of chemistry can be grounded.

The hazards that may be associated with a chemical fall into two broad categories.

1. Health Considerations - The health considerations of a chemical are based on its toxicity and biological effects. We are concerned with whether the chemical is poisonous, toxic, mutagenic, carcinogenic, or harmful to human organs.
2. Safety Considerations - The safety considerations of a chemical are based on its ability to be stable when handled. We are concerned with how explosive, unstable, flammable, reactive, and exothermic a chemical may be.

The New York State Education Department has developed scales for the health and safety ratings of many chemicals. This is in compliance with the Federal OSHA standards. OSHA (Occupational Safety and Health Administration, [www.osha.gov](http://www.osha.gov)), NIOSH (National Institute for Occupational Safety & Health), and MSDS (Material Data Safety Sheets) also list categories and levels of hazards for chemicals. A summary table of identified hazards for elements and compounds commonly used in schools follows.

x = permitted in schools when handled with care.

y = find a substitute, as risk outweighs usefulness even if handled with care. Do not use; remove these substances from the school and dispose of them according to the proper guidelines. (See disposal instructions found on pages 104–105.)

z = substances banned from use in N.Y.C. public schools

Chemical	Corrosive	Irritant	Mod. to Highly Toxic	Carcinogenic	Mutagen	Explosive	Flammable	Highly Reactive
acetaldehyde (ethanal)		Y	Y	Y			Y	Y
acetic acid (conc.) (ethanoic acid)	X	X	X				X	
acetic anhydride	X	X	X				X	X
acetone (propanone)	Y	Y					Y	
acrylonitrile			Y	Y			Y	
acetamide (ethanamide)		Y		Y	Y			
adrenaline		Y						
aluminum chloride (anhydrous)	Y	Y	Y					Y
ammonia (household)	X	X						
ammonium chromates	Y	Y	Y	Y				Y
ammonium hydroxide solution		X	X					
ammonium thiocyanate		X	X					
aniline + homologs (aminobenzene)		Y	Y	Y				
antimony oxide		Y	Y	Y	Y			
antimony salts	Y	Y	Y					Y
arsenic and all inorganic compounds		Y		Y				
asbestos (powder)		Z		Z				
barium chloride		X	X					
barium hydroxide	X	X	X					
barium nitrate		X	X					
Benedict's solution			X					
benzene		Z	Z	Z				Z
benzoyl peroxide		Y			Y	Y	Y	Y
beryllium carbonate				Y				
bismuth trichloride	X	X						
biuret solution 10% NaOH	X							
bromine	X	X	X					X
bromthymol blue Indicator sodium salt								
butanol n-butyl alcohol		X	X				X	
butyric acid butanoic acid		X	X					



Chemical	Corrosive	Irritant	Mod. to Highly Toxic	Carcinogenic	Mutagen	Explosive	Flammable	Highly Reactive
cadmium and salts		Y	Y	Y				
calcium acetate		X						
calcium carbide	X	X					X	X
calcium oxide	X	X					X	X
calcium fluoride		X						
carbon disulfide			Z			Z	Z	
carbon tetrachloride		Z	Z	Z				Z
chlorine	Y	Y	Y				Y	
chromium oxide salts		Y	Y	Y	Y			
chloroform		Z	Z	Z				
cobalt chloride			Y	Y				
cobalt nitrate		Y	Y	Y			Y	Y
colchicine		Y	Y		Y			
copper II chloride		X	X					
copper II sulfate		X						
cyanide salts			Y					
cyclohexane							X	
cyclohexene							X	
diisopropyl ether						Z	Z	Z
ethanol			X				X	
ether, petroleum		X					X	X
ethyl ether diethyl ether		Y				Y	Y	Y
ethylene dichloride 1,2- dichloroethane			Y	Y	Y		Y	
formaldehyde 37% solution		Y	Y	Y	Y		Y	
gasoline		Y		Y			Y	
gunpowder						Z		
hexane		X					X	
hydrochloric acid	X	X	X					X
hydrofluoric acid	Z	Z	Z					Z
hydrogen peroxide(30%)	X	X	X				X	X
hydrogen peroxide (52%)	X	X	X				X	X
hydrogen sulfide		X	X				X	
indigo carmine					Y			
iodine			X					X

<b>Chemical</b>	Corrosive	Irritant	Mod. to Highly Toxic	Carcinogenic	Mutagen	Explosive	Flammable	Highly Reactive
iron III chloride ferric chloride	X	X						
iron III oxide		X	X					
isopropanol							X	
lauric acid (dodecanoic acid)								
lead salts		X	X	X				
lithium	X	X					X	X
lycopodium							X	
magnesium							X	
manganese dioxide		X	X					X
mercuric salts			Z		Z			
mercury (vapor)	Z		Z		Z			
methanol			X				X	
methyl ethyl ketone (2-butanone)		X					X	
methyl orange			X					
methyl red								
methyl salicylate		X	X					
methylene blue								
naphthalene		X	X				X	
nickel acetate		Y	Y	Y				
nickel and salts		Y	Y	Y				
nicotine			X					
nitric acid	X		X					X
osmium tetroxide	Y	Y	Y		Y			
oxalic acid	X	X	X					
p-dichlorobenzene		Z	Z	Z	Z			
pentane							X	
pentanol (n-amyl alcohol)		X					X	
perchloric acid	Y							Y
perchloroethylene (tetrachloroethylene)			X				X	
phosphorous - red			X				X	
phosphorous – white	Z		Z			Z		
picric acid			Z			Z	Z	Z
phenolphthalein		X						

Chemical	Corrosive	Irritant	Mod. to Highly Toxic	Carcinogenic	Mutagen	Explosive	Flammable	Highly Reactive
potassium	X	X					X	X
potassium (aged, oxidized)		Y				Y	Y	Y
potassium chlorate		Y				Y	Y	Y
potassium chromate	Y		Y	Y	Y			Y
potassium iodate		X	X					X
potassium nitrate		X				X	X	X
potassium permanganate	X	X			X			X
salicylic acid			X					
silver nitrate	X		X		X			X
sodium	X						X	X
sodium azide			X		X	X	X	X
sodium nitrate					X			X
sodium nitrite			X		X			X
sodium ferrocyanide (sodium hexacyanoferrate II)		X						
sodium fluoride		X	X					
sodium hydroxide	X	X						
sodium metabisulfite		X						
sodium polyacrylate		X						
sodium silicate		X						
sodium sulfide		X	X					
stannic chloride (tin IV chloride)	X	X			X			X
sulfur (powder)		X					X	
sulfur dioxide	X	X	X					
sulfuric acid (conc.)	X	X						X
thermite mix (mix of ferric oxide & aluminum powder)								X
thioacetamide		Y	Y	Y	Y			
toluene (methylbenzene)		Z	Z	Z	Z		Z	
turpentine		X					X	
urea								
urethane		Y		Y	Y		Y	
zinc strips								
zinc sulfate		X						

**This list is not a complete list of all chemicals. This list, in fact any list, is never considered to be complete. Approximately fifty (50) newly developed/manufactured chemical compounds are added to Chemical Abstracts Service (CAS) daily. For a more complete listing, refer to <http://siri.org/msds>**

## GENERAL CONSIDERATIONS WHEN USING CHEMICALS

Teachers need to carefully choose the chemicals they use in demonstrations and laboratory activities. Obviously, the chemicals used should be relevant to the science topic being taught and should advance student understanding of concepts. In addition, teachers might use the following checklist of safety considerations before proceeding.

1. What health and safety hazards are reported for the chemicals? Check lists in this book, in MSDS sheets (Material Data Safety Sheets), on Federal OSHA (Occupational Safety and Health Administration, [www.osha.gov](http://www.osha.gov)) and State (New York State Department of Health, <http://www.health.state.ny.us/>) websites, and in other listings of potential chemical hazards. It is important to be aware of even small hazards, but they should definitely NOT prevent teachers from using the chemicals with appropriate care.

Generally, avoid chemicals with the following characteristics.

- a. Less than a 50mg/kg LD50 rating (a “poison”).
- b. Listed as a known human carcinogen.
- c. Flashpoints below 23°C (73°F) with boiling points below 38°C (100°F).
- d. Materials that form explosive mixtures with air.
- e. Materials that are explosive without a strong initiating source of heat.

2. What safety procedures are planned?

These can be as simple as the use of tools to handle the chemicals and equipment, such as a spatula to avoid direct contact with skin. Use procedures which will prevent a spill or the scattering of a chemical as a powder into the air.

3. Will there be good ventilation?

Many potential hazards of gasses or of vapors produced from liquids and solids can be minimized or removed by assuring good ventilation. The use of a fume hood is suggested to ensure proper ventilation.

4. Is heat required?

If so, be sure no explosive or flammable materials will be present during the heating. For example, alcohol can be warmed by placing samples into an already heated hot water bath, without a flame being present. Or, alternatively, loosely stoppered small samples in test tubes which are placed in large water baths.

5. What are the lowest concentrations of solution required?

The rule should be to use the lowest concentration needed for an effective result. Generally, the many hazards listed for compounds are based upon direct exposure to the pure solid or liquid. These hazards rapidly decrease in dilute water solution.

- Most solutions for use by students should be between 0.1 M and 1.0 M.
- Solutions of 1.0 M to 6.0 M should be kept at the teacher’s desk. The teacher should directly oversee student use of such solutions.
- Solutions greater than 6.0 M, such as drops of concentrated 12M acid, should be handled and dispensed to students by the teacher.

6. How long should a person be exposed to chemicals and their vapors?

Most ratings for chemicals given in MSDS (Material Data Safety Sheets) sheets are industry based. That is, hazards are listed where prolonged exposure is very possible or where the time-weighted average of multiple exposures is potentially high. Most chemicals used in schools are handled for very short periods of time, rarely more than forty continuous minutes. Brief exposures, and the use of lower concentrations reduce the hazards of most chemicals.

Plan for the shortest time of exposure to chemicals. Once an activity is completed see that its chemicals are properly disposed of or put into containers.

7. **What are some absolute prohibitions?**

Never taste chemicals. Waft gasses known to be safe at low ppm concentrations to the nose to discern odors. Do not smell materials directly. Never touch chemicals or their solutions unless they are known to be safe, as in feeling the slipperiness of a dilute base, which is then immediately rinsed off. Students should not be permitted to work with chemicals if they are not wearing eye goggles.

8. What amounts of chemicals should be used?

Procedures should call for small quantities of reagents, as small as possible yet sufficient to make observations. Generally,  $1\text{cm}^3$  -  $2\text{cm}^2$  of chemicals in tests tubes make adequate observations possible.

9. Are safer substitutes and procedures easily available?

Safe chemicals and procedures should always be substituted when available. An example of this is the substitution of lauric acid for para-dichlorobenzene for the sublimation.

10. The teacher must **model the procedures before letting students work.**

This rule should be followed even if a clear, simple, explicit instruction sheet is provided for students. When using chemicals the teacher must show the steps first, then allow students to read and follow the directions. This is also good instructional practice that saves much time and reduces the confusion which accompanies reading undemonstrated directions.

The following are standard chemistry demonstrations or laboratory activities. They are first described, then various teacher's safety considerations are suggested.^

# UNIT 1

## MATTER AND ENERGY

### Demonstration I: The Physical Nature of Matter

(Recommended as a Teacher Demonstration)

#### GAS LAW

In this experiment you will add water to a 500-mL Erlenmeyer flask and bring the water to a boil on a hot plate. Remove the flask and quickly place an inflated balloon over the mouth of the flask. Run the flask under cool running water and have the students observe what happens to the balloon.

1. **Hazards:** Water has no significant hazard.
2. **Safety Procedures:** Students should wear safety goggles and laboratory aprons. When heating a substance, make sure that the flask is not chipped or cracked.
3. **Ventilation:** Normal classroom conditions.
4. **Heat:** Heat is required. Glass retains heat. Heated glass should be cooled carefully under the stream of running water.
5. **Concentrations:** Not applicable because we are using pure materials.
6. **Exposure:** Does not apply.
7. **Prohibitions:** Safety goggles and laboratory aprons are required.
8. **Amounts:** 25 – 50 mL of tap water
9. **Substitution:** Substitutions are not necessary.

## Demonstration II: Physical and Chemical Changes - Iron and Sulfur

Iron filings and powdered sulfur—test each sample with a magnet. Mix in a test tube. Move a magnet along the bottom and sides of the test tube. Heat iron-sulfur mixture with a Bunsen burner until the contents glow. Test with magnet again.

1. **Hazards:** Iron and Sulfur have no significant hazards.
2. **Safety Procedures:** Students should wear safety eye goggles and laboratory aprons. When heating a substance in a test tube, make sure the test tube is not pointed at yourself or another person. Do not overheat or boil the sulfur and iron mixture. Sufficient heat will activate the reaction which will continue spontaneously. Overheating can lead to excess fumes and burning sulfur at the test tube's top.
3. **Ventilation:** Ventilation is not a priority, but the windows should be open. Sulfur dioxide has a choking odor if it builds up in an unventilated area. It is acrid, like a lit match.
4. **Heat:** Heat is required. When heating, test tubes should be pointed away from the experimenters and others. Glass retains heat. Heated glass should be given time to cool. Again, do not allow students to overheat the mixture.
5. **Concentrations:** 0.5 grams of each element in the laboratory is sufficient.
6. **Exposure:** Students should be cautioned not to inhale any fumes.
7. **Prohibitions:** Safety eye goggles and laboratory aprons are required.
8. **Amounts:**  
Laboratory Experiment: 0.5 grams of each.  
Demonstration: 4 grams of Sulfur and 6 grams of Iron filings.
9. **Substitution:** Better substitutions are not necessary.

## UNIT 2

### ATOMIC CONCEPTS

#### ELECTRON CONFIGURATION

In this experiment the students will use Fruit Loops® or Cheerios® to create Lewis dot structures. The cereal will be substituted for the dots that usually represent the valence electrons. The cereal pieces will be glued to the paper with the symbol and then the students will try to find a partner that will complete the octet needed for stability. (This will lead the students to the concept of bonding).

1. **Hazards:** There are no significant hazards with any of the materials.
2. **Safety Procedures:** Normal classroom conditions.
3. **Ventilation:** Ventilation is not a priority but the windows should be open.
4. **Heat:** Heat is not required.
5. **Concentrations:** Not applicable because we are using pure materials.
6. **Exposure:** Does not apply.
7. **Prohibitions:** None are applicable.
8. **Amounts:** One to seven pieces of cereal per student.
9. **Substitution:** Substitutions are not necessary.



## UNIT 3

# NUCLEAR CHEMISTRY

### HALF-LIFE

Students often have difficulty with the concept of half-life – the spontaneous decay of the nuclei in a sample of unstable isotope in a given period of time. Using graph paper and a piece of licorice, the students will plot “Number of Undecayed Atoms” (y-axis) vs. “Number of Half-Life Periods” (x-axis). Stand the licorice on the y-axis and mark the length. Break the licorice in half, eat one half and move the other to the “1” on the x-axis. Repeat six more times and plot the graph.

1. **Hazards:** Does not apply.
2. **Safety Procedures:** Teacher should check to see if there are any allergies or any student who should not ingest sugar.
3. **Ventilation:** Does not apply.
4. **Heat:** Does not apply.
5. **Concentrations:** Does not apply.
6. **Exposure:** Does not apply.
7. **Prohibitions:** Does not apply.
8. **Amounts:** One piece of licorice per student
9. **Substitution:** Substitutions are not necessary.

## UNIT 4

# CHEMICAL BONDING

(Recommended as a Teacher Demonstration)

This is a demonstration for bonding, polarity and solubility. Students will understand the idea of “like dissolves like.”

**DO NOT USE CARBON TETRACHLORIDE OR BENZENE. THEY ARE CARCINOGENIC AND ARE BANNED FROM USE IN PUBLIC SCHOOLS.**

In this experiment we test the miscibility of several liquids as well as test the solubility of iodine, sugar and sodium chloride in these liquids.

The liquids that may be used are water and pentanol. We compare the solubility of non-polar, polar, and ionic solids in these polar and non-polar solvents.

- 1. Hazards:** Sugar and sodium chloride do not pose any hazards. Pentanol is slightly flammable and poisonous if ingested. Solid iodine is poisonous and, therefore, should not be manipulated by hand nor disposed of in the sink.
- 2. Safety Procedures:** The experiment should not be done near an open flame. The alcohol is toxic and should not be ingested.
- 3. Ventilation:** The experiment may be performed with adequate general ventilation. Small quantities can be used at any time and do not require special ventilation.
- 4. Heat:** Alcohols are flammable liquids. However, heat is not required for this experiment since the experiment deals with a comparison of solubility relating to bonding as opposed to a change in temperature.
- 5. Concentrations:** Not applicable because we are using pure materials.
- 6. Exposure:** There should be no direct exposure to the skin. Mixing should be done in test tubes with stoppers and all solids should be handled with spatulas. Since all reagent bottles should be left closed and mixing is done in a closed test tube, the only exposure to fumes occurs during the measuring and pouring of the liquids. This should take a few seconds and therefore exposure is kept to a minimum.
- 7. Prohibitions:** It is not necessary for the students to smell the chemicals in this experiment. Students should be warned that alcohol should not be tasted under any circumstances.
- 8. Amounts:** Approximately 5m1 of each liquid should be used. A small amount (1–2 crystals of iodine) on a wooden splint or spatula can be used for the solids. These solids (sugar and salt) are everyday products and are safe to handle, however it is important that students learn to handle chemicals carefully.
- 9. Substitutes:** Use wax instead of iodine and different alcohol such as isopropanol.

## UNIT 5

# PERIODICITY

This unit contains two demonstrations. Please note that in the first demonstration, burning sulfur requires more stringent safety precautions. If your school does not have a fume hood, the second demonstration is preferable.

### Demonstration I: Burning Sulfur

(Recommended as a Teacher Demonstration)

Sulfur powder is to be burned. The gas produced will be collected in a collecting bottle, then covered. Water will be shaken in the gas ( $\text{SO}_2$ ) and the acidity of the solution will be tested with litmus paper. This shows the property that nonmetals form oxides which are acid and hydrides.

- 1 Hazards:** Sulfur itself has no significant hazards. However, the sulfur dioxide gas produced is an irritant.
- 2. Safety Procedures:** A small pinch of sulfur will be ignited at the tip of a polished glass rod. The rod will be quickly placed into a collecting jar as the sulfur burns. Once the burning stops the jar will be covered with a flat plate of glass. A small amount of water will be introduced into the jar using a dropper. Shaking the water and gas in the jar will be done by holding the glass cover in place. A clean stirring rod will remove a drop of the acid solution formed. That drop will be placed on a strip of blue litmus.
- 3. Ventilation:** Good ventilation is very important, as the sulfur dioxide is an irritant with a choking odor. This same gas is produced when a match is struck and is also found in a car exhaust. Even with proper ventilation the gas can be smelled in the air in small concentrations. Windows should be opened, and demonstration should be done under the fume hood.
- 4. Heat:** A gas burner is needed to ignite the sulfur at the tip of the glass rod. It can be turned off immediately. The sulfur burns slowly with a small, light blue flame which is easily controlled.
- 5. Concentrations:** The gas produced is expected to be in very few ppm in the well ventilated room, so even the choking sensation of its odor will be eliminated. The acid produced in the water is very weak.
- 6. Exposure:** The burning and capture of the  $\text{SO}_2$  gas requires less than one minute. After that, the gas is safely contained in the collecting jar. Much of the gas will dissolve into the water which is safely poured down drains. However, a trace amount of gas may escape into the room during clean up. The odor may linger for five minutes, but at very low concentrations in a well ventilated room.

- 7. Prohibitions:** The unmistakable odor of sulfur dioxide will be observed even without wafting the gas toward noses. Nevertheless, students should be warned not to inhale the gas fumes as the sulfur burns, or when it is in the collecting jar.
- 8. Amounts:** Only a pinch of sulfur will be burned, far less than is present in the tip of a standard wood or paper match. About 10 ml of water will dissolve almost all the gas collected in the jar.
- 9. Substitution:** Sulfur and red phosphorous are the only solid nonmetals that will burn to produce a visible gas, which forms weak acid solutions. These properties are important to observe in the study of periodic properties of elements. This is an important laboratory activity, for which better substitutes are not needed.

## Demonstration II: Water Quality

Tap water can vary from area to area because of chemicals that are found in the water. Hard water contains excess magnesium and can be measured in milligrams per liter (mg/L). Hard water is responsible for cleaning clothes and dishes and is the reason that water softeners are used. Have students compare the effects of “hard” water and distilled water on the production of suds.

- 1. Hazards:** Hard water, distilled water and liquid detergent have no significant hazard.
- 2. Safety Procedures:** Students should wear safety goggles and laboratory aprons.
- 3. Ventilation:** Ventilation is not a priority but the windows should be open.
- 4. Heat:** Does not apply.
- 5. Concentrations:** Add 3 grams of Epsom salts to 1 Liter of distilled water to make “hard” water.
- 6. Exposure:** Does not apply.
- 7. Prohibitions:** Safety goggles and laboratory aprons are required.
- 8. Amounts:**  
50 mL of each – “hard” water and distilled water.  
2 mL of liquid detergent per test tube
- 9. Substitution:** No substitutions are necessary.

## UNIT 6

# MOLES/STOICHIOMETRY

### Demonstration I: The Gas Laws - Graham's Law of Diffusion

(Recommended as a Teacher Demonstration)

A concentrated solution of ammonium hydroxide ( $\text{NH}_4\text{OH}$ ) should be introduced into one end of a glass tube held horizontally. Concentrated HCl solution will be introduced into the other end of the tube. The distance each gas travels in a time period will be determined experimentally from the point at which the white powder ammonium chloride is seen forming. The relative rates of diffusion will then be determined.

- 1. Hazards:** Both HCl and  $\text{NH}_4\text{OH}$  solutions are toxic by both ingestion and inhalation. HCl is corrosive to skin and eyes.
- 2. Safety Procedures:** Gloves and goggles should be worn by students. Only very small amounts will be used (enough to moisten a Q-tip). Stoppers will be used to close the end of the tube after the moistened Q-tips are inserted.
- 3. Ventilation:** Ventilation is very important since both solutions will produce irritating fumes. However, the ventilation must not create significant drafts which will interfere with the natural diffusion occurring in the tube.
- 4. Heat:** Heat is not required; the reaction occurs at room temperature.
- 5. Concentrations:** Concentrated solutions are necessary to ensure a clearly visible product.
- 6. Exposure:** The vapors of  $\text{NH}_4\text{OH}$  and HCl are enclosed in the tube. They react to form a solid that will be washed out with water at the end of the experiment. The time of exposure to fumes will be a few minutes.
- 7. Prohibitions:** Goggles and gloves are mandatory. Running water and eyewash stations should be available. Sodium bicarbonate should be available for acid spills, and citric acid solution for base spills.
- 8. Amounts:** Only a few drops of each solution will be used.
- 9. Substitution:** Vapors that produce a visible product are needed for this experiment. Substitutes are not possible.

## Demonstration II: Composition of a Hydrate

A hydrate is an ionic compound that has a definite amount of water as a part of its structure. The water is released as vapor when the hydrate is heated and the remaining solid is called the anhydrous salt. The percentage that is water can be determined experimentally by calculating the difference in the mass after heating.

1. **Hazards:** Copper sulfate is an irritant.
2. **Safety Procedures:** Gloves and goggles should be worn by students. This demonstration should be in the fume hood.
3. **Ventilation:** Ventilation is very important.
4. **Heat:** Heat is required. Apply heat evenly and steadily. Hot glass retains heat. Be careful to allow glass to cool before touching.
5. **Concentrations:** Concentrations are not needed in this experiment.
6. **Exposure:** Exposure to copper sulfate could cause irritation. Make sure to wear safety goggles and gloves during this experiment.
7. **Prohibitions:** Goggles and gloves are mandatory. Running water and eyewash stations must be available.
8. **Amounts:** 2.0 grams of copper sulfate hydrate per set-up.
9. **Substitution:** Magnesium Sulfate  $\cdot 7\text{H}_2\text{O}$  ( Epsom salts) may be substituted.

# UNIT 7

## KINETICS AND EQUILIBRIUM (GAS LAWS)

(Recommended as a Student Experiment)

### IODINE CLOCK REACTION

In this experiment we determine the relationship between the concentration of reactants and rate of a chemical reaction, and also the temperature and the rate of a reaction. The materials used are potassium iodate, sodium metabisulfite and a solution of sulfuric acid ( $\text{H}_2\text{SO}_4$ ) and starch. The experiments are carried out at room temperature and at the temperature of an ice bag.

- 1. Hazards:** Sodium metabisulfite is a skin and tissue irritant. Sulfuric acid is corrosive, toxic and reactive with water in concentrated form. Potassium iodate in solid form is a strong oxidizer. The solution has been diluted enough to be considered safe.
- 2. Safety Procedures:** Solid sodium bicarbonate should be available for any acid spill that might occur. Running water should also be available. Since the potassium iodate is dissolved in water it is no longer a fire hazard.
- 3. Ventilation:** Does not apply.
- 4. Heat:** Heat is not needed in this experiment since the solution is cooled in an ice bath to determine the effect of change in temperature.
- 5. Concentrations:** The solutions in safe concentrations are prepared by the laboratory specialist.
- 6. Exposure:** Exposure to sulfuric acid fumes will be minimal since the acid is diluted in the starch and sodium metabisulfite solution. Be careful not get it in eyes or on skin or clothing. The entire laboratory will be completed in one period.
- 7. Prohibitions:** Goggles should be mandatory. Students should not make up the solutions.
- 8. Amounts:** Each laboratory station should have 200 mL of the potassium iodate solution and 100 mL of a solution containing sodium metabisulfite, sulfuric acid, and starch.
- 9. Substitution:** Not necessary.

## UNIT 8

In the new Scope and Sequence, this unit covers two major topics: Acids and Bases and Oxidation-Reduction. A demonstration for each major topic is included.

### Demonstration I: Acids and Bases

(Recommended as a Student Experiment)

The teacher must exercise extreme caution if he/she expects students to handle solid NaOH which can cause blindness. An alternative would be to give students prepared solutions of known molarity.

A standard solution (about .05 M – .08 M) of NaOH is prepared for the students to titrate against an unknown strength of HCl. Hydrochloric acid in a buret will be titrated with phenolphthalein as the indicator. The strength of the acid will be determined.

- 1. Hazards:** NaOH and HCl are very corrosive and toxic when pure or concentrated. Otherwise they have no further hazards listed.
- 2. Safety Procedures:** A stopper must be provided to cover the flask until it is used in the titration. The burette will be firmly anchored to a stand. Its valve should be tested to assure no leakage of acid.
- 3. Ventilation:** Ventilation is not a priority, as only dilute HCl will be provided to the students. If concentrated HCl were needed for some other use, ventilation would become more important as HCl fumes from the strong acid solution are very irritating.
- 4. Heat:** Heat is not required. In fact, heat is produced as NaOH dissolves. In fact, adequate water is used and stirring is done to prevent heat buildup in the NaOH solution being made.
- 5. Concentrations:** The prepared NaOH solutions will be between 0.05 M and 0.08 M. The unknown molarity of the acid will be preset to be near 0.1 M, a safe concentration.
- 6. Exposure:** The preparation of an NaOH solution and the making of two titrations with the acid should require about one hour, allowing for discussion and calculations. Actual handling of solutions in this time is only about ten minutes. This is in contrast to MSDS doses that require four hours or longer to generate warnings.
- 7. Prohibitions:** Goggles will be mandatory. Running water must be available for spills, especially any spill onto hands.
- 8. Amounts:** About 100mL of the standard base solution will be made, but only about 50mL will be used in each titration. This just fills the bottom of the 250 mL flask that is provided. This ratio of volume of the sample taken to the container's volume is very safe. The burette is filled with 50 mL of the dilute acid, but only about 35 mL are expected to be titrated during each trial. These are small, safe amounts for the equipment being used.
- 9. Substitution:** Better substitutes are not required.



## Demonstration II: Redox and Electrochemistry Unit

(Recommended as a Student Experiment)

Add copper sulfate solution to a test tube and insert a strip of zinc; a dark red coating of copper is formed on the zinc.

1. **Hazards:** Does not apply.
2. **Safety Procedures:** Use goggles and gloves. Avoid contact with eyes and skin.
3. **Ventilation:** Normal classroom conditions.
4. **Heat:** Heat is not required
5. **Concentrations:** 0.1M copper(II)sulfate solution.
6. **Exposure:** Copper(II)sulfate stains clothing and skin.
7. **Prohibitions:** Avoid contact with skin and eyes.
8. **Amounts:** Use only small amounts such as 5mL of solution.
9. **Substitution:** Iron or magnesium in copper(II)sulfate solution, copper in silver nitrate solution as a teacher demonstration.

## Demonstration III: Simple Redox Reaction/Oxidation-Reduction

(Recommended as a Teacher Demonstration)

To demonstrate simple redox (reduction-oxidation) reaction, place a solution of copper(II)chloride ( $\text{CuCl}_2 + \text{H}_2\text{O}$ ) into a large test tube and add a crumpled piece of aluminum foil to the test tube.

1. **Hazards:** Heat is generated, so protective gloves or test tube holders are recommended.
2. **Safety Procedures:** Use goggles and gloves. Avoid contact with skin and eyes.
3. **Ventilation:** Normal classroom conditions.
4. **Heat:** Heat is not required.
5. **Concentrations:** 0.1 M copper(II)chloride solution
6. **Exposure:** Does not apply.
7. **Prohibitions:** Safety goggles and laboratory aprons are required.
8. **Amounts:**  
10 mL of 0.1 M copper(II)chloride solution  
2 grams of Aluminum foil
9. **Substitution:** Substitutions are not necessary.

# UNIT 9

## CARBON AND ORGANIC CHEMISTRY

This unit contains two demonstrations.

### Demonstration I: Esterification

(Recommended as a Teacher Experiment)

Alcohols will be combined with acetic acid and other organic acids and heated with concentrated sulfuric acid. This experiment will produce a recognizable fragrance and engage the students in organic chemistry.

- Hazards:** The alcohols are flammable. Special care should be given to keep them away from open flames. Sulfuric acid is corrosive to eyes and skin. Mixing with water improperly will cause considerable spraying and considerable heat produced. Acetic acid is corrosive to the skin. There is a moderate fire risk (flash point is 39°C). It is toxic by ingestion.
- Safety Procedures:** Gloves and goggles will be worn. Only very small amounts of chemicals will be used. Careful instruction will be given as to the correct procedure for wafting the contents. The required 4-6 drops of 12 M sulfuric acid will be obtained at the teacher's desk where the mixing will also take place. This demonstration should be done under a fume hood.
- Ventilation:** Ventilation is very important since reagents will produce irritating but nontoxic fumes.
- Heat:** Heat is required for these reactions. Since alcohol is flammable a hot plate and water bath must be used. Alcohol may not be heated over an open flame. An open flame should never be present when there are alcohol vapors present in a room.
- Concentrations:** Concentrated solutions are necessary for the reactions.
- Exposure:** The time of the preparation and reaction will be approximately twenty minutes. Good ventilation is required.
- Prohibitions:** Gloves and goggles are mandatory. Running water and eyewash stations should be available. Sodium bicarbonate should be available for acid spills.
- Amount:**

Substances			Aroma
5 mL ethanol	5 mL glacial acetic acid	8 drops of 18 M Sulfuric Acid	Apples
5 mL amyl alcohol	5 mL glacial acetic acid	8 drops of 18 M Sulfuric Acid	Bananas
5 mL methanol	2 grams salicylic acid	8 drops of 18 M Sulfuric Acid	Wintergreen

- Substitution:** None possible.

## Demonstration II: Chemistry Of Disposable Diapers

(Recommended as a Teacher Demonstration)

Sodium polyacrylate will absorb approximately 800 times its own weight in distilled water but only about 300 times its weight in tap water. This is due to the ions in tap water. Adding sodium chloride (table salt) will also drastically reduce its absorption power. Using a disposable diaper, remove the sodium polyacrylate and add water to demonstrate its absorption. Compare the use of tap water and distilled water. Also add sodium chloride and observe the effects.

1. **Hazards:** There are no significant hazards in this demonstration.
2. **Safety Procedures:** Students should always wear safety goggles and laboratory aprons.
3. **Ventilation:** Ventilation is not a priority but the windows should be open.
4. **Heat:** No heat is required in this demonstration.
5. **Concentrations:** Not applicable because we are using pure materials.
6. **Exposure:** Does not apply.
7. **Prohibitions:** Safety goggles and laboratory aprons are required.
8. **Amounts:**  
300 mL of tap water and 0.5 grams sodium polyacrylate  
300 mL of tap water and 0.5 grams sodium polyacrylate  
5 grams of sodium chloride (optional)
9. **Substitution:** Substitutions are not necessary.

## UNIT 10 REVIEW

This unit is listed as review in the new Scope and Sequence for Regents Chemistry. It is advised that simple experiments and demonstrations are addressed to reinforce the concepts that are contained in the Regents Chemistry syllabus.

## **SAFE USE OF ADDITIONAL CHEMICALS AND CHEMICAL EQUIPMENT DURING EXPERIMENTS**

These chemicals and chemical equipment have been divided into two subsets—those that are considered to be safely done are listed as “GENERALLY SAFE” and those that are not recommended are listed as “USE EXTREME CAUTION.” Exercise caution when doing using the chemicals and chemical equipment listed in the later category.

### **GENERALLY SAFE**

#### **Ammonia Fountain**

Use a thick walled, round bottom flask that has been examined for flaws. Use safety goggles and a safety shield.

#### **Boiling Point Determination**

The boiling point determination of organic compounds should be done under the fume hood. Use a water bath and boiling chips to help the liquid boil smoothly. Check the Chemistry Handbook for boiling points and MSDS for hazards when choosing compounds.

#### **Centrifuge**

Use only centrifuge tubes when operating the centrifuge. Make sure tubes are balanced and have equal masses in each tube. Make sure hand centrifuges are securely clamped to the table before using.

#### **Chromatography**

Use safe solvents such as water and ethyl alcohol. Use 95% ethyl alcohol for chlorophyll extraction.

#### **Conductivity of Water Testing**

Make sure there are no exposed wires on the conductivity apparatus. Do not hold on to the ring-stand when immersing electrodes into the solutions you are testing. Use glass or plastic containers to hold solutions (never metal). A 7.5 watt light bulb (110 volt) is recommended.

#### **Distillation**

Do not distill mixtures containing flammables or liquids with boiling points below 50°C. Connect cold water to the condenser (in at the bottom, out at the top.) Do not distill to dryness.

#### **Electrolysis of Water – Hoffman Apparatus**

Substitute 1% sodium sulfate for sulfuric acid in this demonstration. Compare the acidity of 1% sodium sulfate (pH 5) to 1% sulfuric acid (pH 1). Sodium sulfate is safer to use and works as well, but slowly. Collect gases at the top of the Hoffman Apparatus in small test tubes for testing. Use low voltage from a battery or power pack.

#### **Ester Preparation**

Use a water bath when heating reagents. Heat gently to avoid splattering of the mixture which contains sulfuric acid and flammable liquids. Use small amounts of reagents.

### **Flame Tests**

Perform flame tests in a well ventilated room.

### **Heating Curve**

Para-dichlorobenzene has been banned for use in the New York City Public Schools. Crushed ice is a safe alternative. Stir a 250 ml. beaker of crushed ice gently with stirring rod until the thermometer gives a steady reading. Record the temperature at half-minute intervals. When the ice is almost melted (about 5 minutes) gently heat the beaker and record temperature for five minutes after boiling begins. A hot plate or Bunsen burner may be used.

### **Hydrogen Peroxide**

Prepare small amounts using dilute HCl and mossy zinc. If using the water displacement method, be sure the pathway through the tubing is clear and that the end of the thistle tube is below the acid in the reaction bottle.

### **Iodine Sublimation**

Due to the poisonous nature of iodine, sublimation demonstrations are not recommended. Sealed tubes of iodine are available commercially. These tubes should be heated gently using safety goggles and a safety shield.

### **Liquid Nitrogen**

Special canisters are available commercially for safe storage of liquid nitrogen. Liquid air and liquid oxygen are not to be used in schools.

### **Magnesium**

The burning of magnesium ribbon emits ultraviolet radiation which can damage the retina of the eye. Use small pieces of magnesium and do not look directly at the bright flame.

### **Neutralization**

Use dilute acids and bases. Heat gently and stir constantly to avoid splattering. Students are not to taste the salt that is formed.

### **Oxygen Preparation**

Use 3% hydrogen peroxide with  $\text{MnO}_2$ . Reclaim unused  $\text{MnO}_2$  by pouring waste through a funnel with filter paper. Do not put  $\text{MnO}_2$  down the drain.

### **Potassium Chlorate**

Avoid using potassium chlorate for oxygen preparation. It is a strong oxidizing agent and may explode if mixed with a reducing agent, such as carbon or organic residues in the glassware. It often reacts with rubber stoppers in generating apparatus. It is extremely dangerous and should not be used or stored in schools.

## **Sodium**

Use a small piece of sodium about  $2\text{cm}^3$  to demonstrate its reactivity with water. Use safety goggles and a shield. A piece of screening should be placed on top of the container to minimize splattering. Sodium must be stored under mineral oil. Note: If sodium cannot be safely stored away from contact with water and/or acid, it should be banned from laboratory use.

## **Thermometers**

Mercury thermometers are prohibited in New York State schools.. Digital, spirit filled or alcohol filled thermometers are accurate enough for most purposes. Green colored enviro-safe thermometers are also available commercially.

## **Volatile Compounds**

Work with volatile reagents such as diethyl ether in a well ventilated room or under a fume hood.

## **Volumetric Flask**

Do not heat in a volumetric flask. If mixing, do not hold only by the neck. Support the flask under the bulb.

## **USE EXTREME CAUTION**

### **Ether**

Avoid the use of ether when possible. If you must use ether, order diethyl ether in small quantities. Purchase only what you will use in three months, keep in supply containers, date the containers, and store in refrigerator.

### **Halogen Preparation**

Due to the poisonous nature of chlorine, bromine and iodine they should not be prepared in the classroom. Solutions for class use should be purchased commercially if necessary. The preparation of halogens as a teacher demonstration is also NOT recommended.

### **Hydrogen Balloon**

It is unlawful to fill or charge toy balloons with hydrogen or any other flammable gas (see FDNY Code, Subchapter 17 – “Gases Under Pressure,” in the Appendix.

### **Methanol Cannon Experiment**

This demonstration should not be conducted due to serious burn accidents associated with the use of flammable liquids. Student participation in this demonstration is prohibited. Perhaps a smaller, safer substitute demonstration could be conducted using an empty film cannister ignited by a Piezo electric starter.

### **Mercury**

Liquid mercury and its vapors are poisonous. Mercury is absorbed through intact skin. Mercury is legally banned in New York State schools.

### **Mercuric Oxide**

Mercuric oxide (Mercury (II) oxide) is highly toxic and should never be heated to demonstrate decomposition. Mercury compounds are teratogenic and are banned from use in New York City Public Schools.

### **Phosphine**

Do not prepare this gas. Phosphine is extremely poisonous and must not be inhaled.

### **Phosphorus**

Demonstrations using white phosphorous are prohibited. Red phosphorous may be used with extreme caution.

### **Potassium**

Potassium reacts with water more violently than sodium and is not recommended for school use because it becomes explosive with age.

### **Reactions of Functional Organic Groups**

Benzene, carbon disulfide, and carbon tetrachloride are banned for use in New York City Public schools. In the past tetrachloroethylene (perchloroethylene “perk”) was used as a safer alternative. “Perk” is now considered a carcinogen. Find safer substitutes.

### **Soapmaking**

This teacher demonstration involves heating a solution of sodium hydroxide. It should be heated slowly using a hot plate and stirred constantly to prevent splattering. There is a high chance of this experiment igniting because of the use of animal fat. Extreme caution should be taken. Wear safety goggles, gloves, and an apron.

### **Sucrose Dehydration**

Teacher demonstration only. The room must be well ventilated and the use of a fume hood is highly recommended. Use small amounts and perform the experiment in the prep room before doing it before a student group. Children with asthma must be forewarned of the fumes and removed to a safe distance if there is no fume hood.

### **Thermite Reaction**

This demonstration requires extreme caution. Students must stand at least 30 feet from the reaction which must be performed behind a safety shield. Put a pail of sand under the set-up. Be careful approaching a mixture that has failed to ignite, because it could flare up suddenly. Safety goggles must be worn.

Demonstrations using white phosphorous are prohibited. Red phosphorous may be used with extreme caution.





# PHYSICS

## MECHANICS

### MASSES AND WEIGHTS

1. Masses or weights of no more than 500g should be given to the students. If heavier masses are required, then two or more masses of 500g each can be used. A combination of masses like 50, 100 or 200g is suggested.
2. When teachers or students are demonstrating Hooke's Law or Newton's Law, pieces of foam should be used to cushion the fall of masses or weights. This will help avoid damage to the masses and also prevent the mass from rolling away.

#### **Jet Action**

Note that gas from carbon dioxide cartridges should be carefully released. Make sure that the cartridge is under control and will not fly away and strike someone. If wire guides are used for cartridge propulsion demonstrations, they should be securely fastened and pre-tested before use in the classroom.

#### **Vacuum Experiments**

Use heavy walled, round-bottom flasks or apparatus especially designed for vacuum work to prevent implosions. Use a safety shield. This is especially important when demonstrating low pressure boiling of water, at room temperatures, in a stoppered Florence flask.

#### **Steam**

Check the steam generating apparatus to assure that excessive pressures cannot develop before the steam is emitted. Before each use, check safety valves on commercial apparatus such as pressure cookers and model steam engines in accordance with the manufacturers' instructions. When generating steam in a test tube or flask, do not insert the stopper tightly or wire it down. Caution students to direct steam outlets away from anyone's face. In set-ups involving the use of two or more valves, one must always be kept open.

## ELECTRICITY

1. Check all circuits before students power them. Take all necessary precautions to avoid accidental short circuits. Inspect all electric cords and extensions regularly for worn insulation and broken connectors. In schools where there is a main keyed switch, it should be used in the same manner as the gas key switch for the power supply or electrical outlets in the lab. This will ensure student safety and reduction of electrical equipment repair costs.
2. All power supplies or outlets located at a teacher's desk or students' tables must have an on/off switch. There should also be an LCD indicator to show if the power is on or off.

All electrical equipment used in physics must have an on/off switch. There should also be an external, replaceable fuse. Before plugging in or unplugging any equipment, outlet switches as well as equipment must be in the off position.

3. Avoid the use of the heavy old type lead acid batteries in labs. Use the smaller and lightweight lead acid batteries. Use only leak proof or sealed lead acid batteries. Most lead acid batteries made today are sealed.
4. A battery eliminator or adaptor is recommended in place of a dry cell. The use of an adaptor or eliminator with multi-voltage, a switch, and external fuse is less expensive and safer. If you must use dry cells, make sure they do not ooze and if they do, properly dispose of them using the chemical removal procedures. If students have touched the chemicals, make sure they wash their hands thoroughly.
5. Make sure that all appliances that connect to wall outlets have either polarized two-prong plugs or grounded three-prong plugs. When removing a plug from a wall socket, always grasp the plug, not the wire.
6. Whenever several outlets on the same line are used, the total power should not exceed 1500 watts.
7. Limit the line voltage in student experiments to a maximum of 30 volts. This does not apply to electrical laboratories or shops where students have special training and background.
8. Cover exposed water faucets and other grounded fixtures with an insulating material whenever there is a likelihood of contact with exposed parts of an operating electric circuit.
9. Make changes only on non-powered (power cord removed) circuits. When working on electrical devices such as radios, televisions, and computer monitors, make certain that the current is off. Wait a few minutes, and then, discharge large capacitors to chassis ground using a low-resistance insulated shorting wire before touching any internal components. Caution students about the high voltage STATIC charges that exist in these and many other electronic appliances even after the current has been turned off. Severe burns and shock can result from contact with high voltages.
10. Clearly mark the high voltage terminals of induction coils and caution students against touching these terminals when the induction coil is operating.
11. Stress that no foreign objects be pushed into any piece of electric equipment, especially when it is connected to a source of current.
12. Never bypass protective devices such as fuses and circuit breakers. When replacing fuses, do not substitute a fuse that has a higher current rating than the original.

## **MAGNETISM**

1. Avoid heavy and very powerful magnets. A powerful magnet can attract any loose steel object or fly to any stationary steel object hurting anyone in its path.
2. Avoid the use of iron filings that contain black iron powder. Black iron powder coming into contact with cuts can act as an irritant. Use instead magnetic chips or iron chips which are polished and free of dust. They can be purchased from science supply companies.
3. Safety goggles and disposable gloves should be worn while working with magnets and iron filings or chips.
4. Students should use long handled brushes to collect the iron filings or chips from the working area or lab bench. All equipment should be brushed until iron free.

## **SOUND**

Caution students to cover their ears before high intensity sounds are generated in the classroom or laboratory. This precaution will help avoid hearing loss resulting from high-pitched sounds.

## **LIGHT**

### **1. Optics**

- a. Avoid the use of burning candles to obtain the image produced by mirrors and lenses. Use low wattage bulbs instead of burning candles.
- b. Do not use broken glass slabs, mirrors or lenses.

### **2. Ultra-Violet Light**

Prolonged exposure to ultra violet (UV) light can cause serious burns to the retina. Make sure that no one looks directly into the source of ultra violet radiations. However, students may be momentarily exposed to this radiation as they observe the effects on minerals, ores, teeth, and paints. For activities requiring more prolonged exposure, such as the observation of UV fluorescence and charged electroscope phenomena, supply students with goggles, which are appropriate for the wavelength of UV light being used. Ordinary eyeglasses, polycarbonate plastic lenses, and glass shields between the demonstrator and the students will also provide a large measure of protection from UV light damage to the eye.

## LASER SAFETY

Although high-powered lasers can punch holes through concrete blocks and steel, there are no documented reports of anyone being hurt by a laser beam of 10 milliwatts or less. Nevertheless, because the beams are intense and concentrated, all lasers should be used with caution and common sense.

The lasers that are most useful for teaching science are those that emit low-power continuous-wave visible beams (wavelengths ranging from 400 to 700 nanometers). For special demonstrations or students' projects that require other types of lasers, close supervision by trained and knowledgeable personnel is important to avoid safety hazards.

All lasers used in schools must comply with the Laser Performance Standard of the U.S. Department of Health and Human Resources and with Title 21, Part 1040 of the Code of Federal Regulations ([http://www.access.gpo.gov/nara/cfr/waisidx\\_00/21cfr1040\\_00.html](http://www.access.gpo.gov/nara/cfr/waisidx_00/21cfr1040_00.html)). These regulations specify safety features and classify lasers into four classes. The least dangerous is Class 1, the most dangerous is Class 4.

Caution: It is strongly recommended that any laser with a rating above Class 2 be removed from the schools, and it is also strongly recommended that students not be allowed to operate any laser above Class 1.

Class 1. The power of a beam emitted by a Class 1 laser (below 0.4 microwatt) presents very little risk of damage to any part of the human body.

Class 2. The beam emitted by a Class 2 laser (visible light 0.4 microwatt to 5 milliwatts) is not considered hazardous to the skin regardless of the exposure time. However, because of the beam's dazzling brightness, a long exposure can present hazards to the eyes. Normal eye reflexes automatically prevent exposures longer than 0.25 second. However, an intentional exposure of fifteen minutes or more, by deliberately staring into the beam, is considered hazardous and should never be allowed.

The following have been determined to be unsafe for school use.

Class 3A. A focused beam from a Class 3A laser entering the eye, or a spread out beam viewed for an extended time is definitely hazardous.

Class 3B. The direct beams emitted by a class 3B laser (5 to 500 milliwatts) are considered to be an acute hazard to the skin and eyes.

Class 4. Both the direct and diffuse beams from Class 4 lasers (greater than 500 milliwatts) are not only dangerous fire and skin hazards, but they can cause immediate death.

## **APPARATUS**

### **High Speed Rotating Apparatus**

High speed rotating apparatus should be used only by teachers for the purpose of demonstration. Observe caution when using any apparatus that rotates at high speed. These include the Savart tooth wheel, siren disk, centrifugal hoop, and grindstones. Make certain that the safety nut is securely fastened and operate the apparatus at moderate speeds.

### **Tools**

NEVER use a dull cutting tool. It may slip and cause serious injury. Cut away from yourself when using any sharp instrument. Cut sheet metal only with sharp shears. File the edges smooth using a file or emery cloth.

Rest hot soldering irons on metal stands to avoid burns and prevent fires. Use pliers or clamps to hold wires and metals for soldering. Do not inhale fumes from soldering paste.

## **ELECTROMAGNETIC APPLICATIONS & MODERN PHYSICS**

### **Cathode-Ray Tube**

Because cathode ray tubes are fragile and will implode when stressed, only competent personnel should attempt to repair computer monitors, oscilloscopes, and TV equipment. Before making repairs, the equipment must first be disconnected from the 120-volt line and all high voltage capacitors. The picture tube shield must be discharged.

### **X-ray Tubes**

X-ray tubes may be displayed but not used to generate X-rays. Crookes' tubes should never be connected to voltages that are so high that the tubes produce X-rays. In case of doubt, always check with the tube's manufacturer.

### **Infrared Apparatus**

When transmitting infrared radiation with parabolic reflectors or other focusing devices, caution students to avoid areas where concentrated beams can cause severe burns.



# EARTH SCIENCE

## AEROSPACE

### Airplanes

Paper airplanes are used to learn about the principles of flight. Their sharp noses can cause damage if flown into an eye. Students must launch their airplanes in a single direction away from other students. All students should wear eye protection.

### Rockets

Rockets containing combustible chemicals are both illegal and dangerous and should not be used by students or staff in the New York City Schools. Rockets that use compressed air and/or water pressure must be used with caution. Students must wear eye protection when working with pressurized water or air. Air/water pressure should not exceed 100 lbs/inch<sup>2</sup>. Rockets must not be pressurized until the area around the rocket is clear and the rocket is aimed away from students. The launching mechanism must allow students to be a minimum of ten feet from the rocket. Any rockets that do not launch must be carefully handled while determining the reason for launch failure. Be sure the faulty rocket is pointed away from both students and the teacher when it is being checked.

## ASTRONOMY

### Lasers

Educational scientific supply houses sell both Class II and Class III(a & b) lasers for school use. Students should not be allowed to operate any lasers above Class I. It is strongly recommended that any lasers above Class II be removed from the schools. Emissions from Class II lasers can cause eye damage after direct, long term exposure while Class III lasers will cause eye damage in a shorter interval of exposure. Keep the room well illuminated when using lasers. The pupils of the eyes will dilate if the amount of light in the room is low. This will increase the chances of damage from the laser beam (also see Laser Safety in the "Physics" section, page 72).

### Spectroscopic Analysis Using Flame Tests

The most common chemicals used when performing nichrome wire flame tests are recognized as toxic, and adequate precautions should be taken to ensure good ventilation of the experimental area. In poorly ventilated or confined laboratories, flame tests should be performed in a fume hood.

When large numbers of students are performing flame tests, the potential exists for individual acute toxicity exposure or instructor chronic toxicity exposure. The general nature of an unknown compound should be ascertained before performing a flame test. Students should never ingest the chemicals.

### Chemicals Often Used in Flame Tests

Health/Safety #	Compound
1/0	Sodium Chloride ( $\text{NaCl}$ )
2/1	Strontium Chloride ( $\text{SrCl}_2$ )
3/1	Lithium Chloride ( $\text{LiCl}$ )
3/1	Copper Chloride ( $\text{CuCl}_2$ )
4/1	Barium Chloride ( $\text{BaCl}_2$ )

The higher the health/safety number, the greater the health hazard.

When performing flame tests, the nichrome wire or paper clip that is used should be held in a well-insulated holder or long-handled pliers. The wire and holding device should be placed on an insulated mat and allowed to cool thoroughly before handling.

Goggles should be worn. An overloaded wire causes splattering and material can fall into the burner jets, causing blockage. Unknown chemicals should not be placed in the flame.

It is recommended that teachers use spectrum tubes to show the properties of spectrum analysis. These spectrum tubes are safe and can be used in any classroom setting. Care should be used when changing tubes as they can get hot when used for a few minutes. These spectrum tubes and power supplies can be bought in most science warehouses.

### Viewing the Sun

Light from the sun, even during eclipses of the sun, is harmful when viewed directly. Whenever students are observing the daytime sky, they must be clearly instructed not to look at the sun directly or through lenses, even momentarily. The danger of retinal burn comes from the invisible infrared rays which penetrate light filters and instantaneously damage eyes. Students should not sight objects close to the sun, which would increase risk of accidental viewing of the sun. Dark glasses, smoked glass, exposed photographic film, and welder's goggles are insufficient protection against the rays of light from the sun. Watching an eclipse on television is the safest way to view an eclipse of the sun. Images of the sun, projected onto a piece of paper through a pinhole or a convex lens can be safely viewed. Filters, designed specially for viewing the sun can be used.



# PHYSICAL GEOLOGY

## ROCKS AND MINERALS

### Acid Tests

Most chemical experiments with naturally occurring minerals involve the application of dilute hydrochloric acid to the specimen (most often to identify calcium carbonate, marble, and limestone). Dilute hydrochloric acid is not particularly dangerous, but students should learn to treat it with the respect deserved by all acids. Students should always wear protective goggles when using acids in rock or mineral identification. Acid should be rinsed from the specimen before it is handled or returned to its container. Dilute hydrochloric acid is not very corrosive, but students should be warned to avoid contact with skin or clothing and to guard against splashes into the eyes. After handling rocks or minerals, students should wash their hands. This sensible housekeeping procedure is a wise precaution after performing any experiment whether it involves hazardous substances or not. Water should never be added to the acid. The saying, acids go swimming in water should be repeated.

When dilute hydrochloric acid is applied to mineral specimens, gases often result. Due to the varied composition of the minerals, it is not always possible to predict which gases will be involved. Therefore, such experiments should be performed in well-ventilated areas or in the fume hood. Gases should not be smelled directly.

### Cleavage/Fracture Tests

The wearing of safety goggles is essential when breaking rocks or mineral samples with a hammer. Students should be told of the dangers from flying particles from a work group other than their own. When breaking rocks, care should be taken to ensure that other students are not within range of flying particles. Rocks should be held firmly with long-handled pliers to avoid injury to the fingers and prevent movement. Students should not handle or be exposed to asbestos bearing minerals such as tremolite and chrysolite.

### Crystallization

Some texts suggest observing the process of crystallization by examining the evaporating edge of an aqueous solution or the cooling edge of a pool of molten chemical on a glass slide with a microscope. If solutions are used, be aware of the toxicity of the substances used and take adequate precautions. If a molten chemical is used, care should be taken to avoid burns.

### Hardness Tests

Students must always be properly instructed on the proper technique used to determine hardness of a mineral. When scratching one mineral sample against another, care should be taken not to cut or gouge fingers and hands. Sharp, angular specimens should be handled with gloves. If testing hardness by scratching a glass plate, students should not hold the glass plate in the palm of their hands. The glass plate should be placed on a flat surface and scratched away from the body. Goggles should be worn in case the glass breaks and splinters or a piece of the mineral chips away.

### **Ultraviolet Light Used for Viewing Fluorescent Minerals**

Any radiation with a wavelength shorter than 250nm should be considered dangerous. This includes the ultraviolet light (black light) used in some mineralogy laboratories. Never remove the protective shield in front of a UV source. Safety glasses with UV-absorbing lenses should be provided, and care must be taken that students do not get a painful sunburn from the ultraviolet light.

## **EROSION/DEPOSITION**

### **Diatomaceous Earth**

Due to the possible inhalation of dust, use of Diatomaceous Earth should be avoided. Diatomaceous earth is used for modeling erosional processes in small stream tables. Diatomaceous earth contains amorphous diatomaceous silica and crystalline silica. Breathing crystalline silica over a prolonged period of time can cause silicosis. Crystalline silica has been classified as a probable human carcinogen (Class 2A) by the IARC, and therefore should be properly disposed of by using the chemical removal procedures.

### **Stream Table**

Stream tables can have electric motors attached in order to pump water. Precautions should be taken to avoid spillage of water onto the electrical contacts. All electrical equipment should be regularly inspected for frayed power cords or damage to the housing.

### **Water**

When collecting water samples from natural water sources there should be close supervision. If it is necessary to enter the water, protective boots should be worn and the water should always remain below the ankles. If samples are collected from an elevated bank, a collecting device should be used that does not require stretching out over the water. Students should never work alone. Water that is stagnant or contains sewage effluent or industrial effluent should not be sampled.

### **Wind**

Some texts have wind experiments in which fine sand is blown into a dune. Students should be instructed not to blow too hard, which can cause sand to fly into the eyes. Continuous hard blowing may also induce dizziness and fainting. If fans are used to blow sand, long hair should be tied back to prevent it from being pulled into the blades. Fans should have adequate guarding. Safety goggles are to be worn.

## **EARTHQUAKES/VOLCANOES**

### **Volcanoes**

Although some texts suggest an experiment involving ammonium dichromate that dramatically simulates the effects of a volcano, this experiment should never be performed in the classroom. Ammonium dichromate is highly toxic.

## **METEOROLOGY**

### **Air Pressure**

Air under pressure can cause explosions or make objects or parts of objects move suddenly and violently. Containers that are to be pressurized or evacuated must be able to withstand the differences in pressure without violently shattering. Glass containers should not be subjected to differences in air pressure unless they were designed for such purposes. Students should always wear protective goggles when performing air pressure experiments.

Magdeburg Hemispheres are often used to demonstrate the force exerted on a surface by air pressure. When attempting to pull apart the hemispheres, students should be reminded of Newton's First Law. If they are braced and pulling hard and the hemisphere gives way, they could go flying into objects behind them. Do not release the vacuum inside the hemispheres while students are pulling on them.

### **Barometers**

Mercury barometers are never to be used in classrooms. Mercury is a known carcinogen and must be removed from all school laboratories. Use aneroid barometers to explain air pressure readings.

### **Sling Psychrometers**

Sling psychrometers are used to measure relative humidity. Never use mercury barometers in sling psychrometer experiments. It is also highly recommended that sling psychrometers only be done as teacher demonstrations. It is far safer for students to wet gauze and place it on a digital thermometer. Use a small fan to blow air across the gauze and the temperature will readily drop.

### **Thermometers**

Mercury filled thermometers should never be used in schools.

### **Earth Science Performance Exam**

As of the writing of this manual, a new performance exam has been created by the New York State Education Department. This exam is to be administered for the first time during June 2008. Based on a preliminary supply list, the following precautions should be taken into account.

1. Student backpacks and notebooks must be stored in a location that permits students to safely walk around the classroom. Student materials must not be stored on the floor or under desks.
2. Anytime students are using acid, they must wear protective goggles. Administrators, teachers and lab specialists should also make sure that goggles are properly disinfected.
3. When plotting earthquake epicenters, safe drawing compasses must be used. Students should never use sharp pointed compasses.
4. When determining the density of liquids, never use glass graduated cylinders. Use plastic cylinders to prevent breakage.



## **DIRECTIONS ESPECIALLY FOR GRADES K-8**

An effective elementary or middle school science program involves a strong experiential component, including direct hands-on learning experiences for each student. These experiences should include experiments, investigations, manipulative activities, field trips and, when necessary or appropriate, teacher demonstrations. Science activities, as all content area lessons which require active student involvement, carry special concerns for safety.

You can assess the level of safety in your science teaching by evaluating five significant areas:

- (1) your management of the classroom environment,
- (2) your instruction and supervision of students,
- (3) the selection, use, and storage of science materials,
- (4) the incorporation of living plants and animals in your classroom instruction, and
- (5) the planning and conducting of field trips.

The guidelines below, although not inclusive, have been identified to alert and promote the implementation and maintenance of safe elementary and middle school science learning environments. All safety procedures should be periodically reviewed and updated.

### **CLASSROOM ENVIRONMENT**

The following suggestions concerning the physical arrangement of your classroom, as well as its maintenance, will help improve the level of safety within your classroom:

- Arrange furniture so that students have sufficient space to work and move about their work space.
- Students' work areas should be adequately lit; avoid using dark corners of the room.
- Maintain neat work areas, free of unnecessary books or papers.
- A whisk broom and dust pan should be readily available for clean up.
- Immediately wipe up all spills on the floor to prevent falls. (Refer to "Chemical Spills" in the Appendix.)
- Teacher and students should know the locations of all safety equipment, such as fire extinguishers and first aid kits, and teachers should be trained in how to use them properly.

### **INSTRUCTION AND SUPERVISION OF STUDENTS**

1. Parents and students should inform the teacher of all known allergies (i.e., food, fur and feathers) medical conditions, and medications at the start of the school year.
2. Consider the age and composition of your class when planning science activities; younger children and students with special needs require closer supervision.

3. Limit group size and plan for adequate amounts of time. This will enable your students to perform activities efficiently and without confusion.
4. Prior to beginning an activity, familiarize yourself with safety procedures or concerns that may come up during the activity. Review precautions with the students before and during activities.
5. If any sense of danger is anticipated, the activity should be modified to make it safe, or eliminated.
6. Do not allow students to transport equipment or materials when unsupervised or while classes are moving through the halls.
7. Never leave a class unattended while students are engaged in a science activity. Never permit students to undertake a scientific investigation without your supervision. Active monitoring of students during activities is suggested.
8. Warn students not to engage in horseplay, practical jokes, or other behavior that might confuse, startle, or distract another student.
9. Students must never touch, taste, or smell any chemicals unless told that it is safe to do so by the teacher.
10. Warn students not to chew gum, eat, or drink in the science classroom/lab. Chemicals and their vapors can come into contact with food and drink and cause harm.
11. Students should be warned not to drink from glassware used for science experiments since trace amounts of previously stored chemicals may remain on surfaces and cause harm.
12. Instruct students how to safely smell substances by using their hands to waft the scent toward their noses, rather than by bringing their faces close to the substance and inhaling deeply.
13. Instruct students in the proper way to handle and use all glassware, hand tools, and sharp instruments.
14. Make sure students tie back long, loose hair and roll up loose sleeves when working with chemicals, or working near flames or any equipment that they may get caught on.
15. Instruct students not to wear loose jewelry in the science classroom/lab since this can get caught on equipment and cause accidents.
16. Instruct students never to pour chemicals back into stock bottles, and never to exchange stoppers or bottle caps.
17. Students should never mix chemicals together just for fun. Explosive mixtures or hazardous fumes can be produced.
18. Caution students never to handle hot glassware or other heated equipment without using appropriate equipment such as test tube holders, pot holders, or oven mitts

19. Students must never heat chemicals unless directed by the teacher to do so, since some chemicals are harmless when cool, but can become dangerous when heated.
20. Students must never heat a liquid in a closed container since expanding gases may blow the container apart.
21. Warn students never to tilt a test tube towards themselves or anyone else.
22. Warn students not to touch their eyes, face, mouth or any other body parts while working with chemicals, animals or plants. Hands should be washed after each activity.
23. If a substance gets into the eye, flush the eye out with water for fifteen minutes, and call for assistance. Seek medical attention immediately. Call the school doctor or nurse if one is on staff.
24. If a toxic chemical contacts skin, flush the affected area with water for fifteen minutes. Seek medical attention immediately. Call the school doctor or nurse if one is on staff.
25. Instruct students on the importance of drying their hands completely before touching any electrical appliances; wet hands can act as an electrical conductor.
26. Students should report all accidents, injuries, or damage to clothing and equipment (no matter how minor) to the teacher immediately.
27. Allow for time at the end of the science class for materials collection and clean up.

## **MATERIALS MANAGEMENT**

The selection and safe storage of appropriate science equipment and materials is essential to safety. The following should be considered when selecting or storing science equipment and materials:

- Take appropriate precautions when using fire and/or heat sources. In general, a heat source without a flame, such as a hot plate, is safer to use than one with a flame. Alcohol lamps should not be used. Bunsen burners should be used with extreme caution, by very advanced students under strict supervision by the teacher.
- Make sure all water faucets, burners, electric hot plates and other equipment are turned off and/or unplugged before you leave the room.
- Substitute plastic utensils for glass or metal knives whenever possible. If glass containers are essential, temperature resistant glassware should be used.
- Elementary school students should only work with weak, non-corrosive acids. Vinegar, lemon juice, and seltzer can generally be used in place of the more dangerous acids. Middle school students should not be allowed to work with concentrated acids and bases, but, may be allowed to work with dilute acids and bases under strict teacher supervision.
- Elementary and middle school students should not be allowed to work with any bodily fluids such as blood, saliva, urine, etc.

- Loose iron filings should never be handled by students; filings must be placed inside sealed plastic bags for student magnetism experiments.
- Only those thermometers that do not contain mercury are to be used.
- Never use cracked or chipped glassware, mirrors, prisms, or glass slides.
- Rolling carts with raised edges or guard rails on each shelf should be used for transport of materials.
- Store all equipment safely. Dangerous materials should be kept under lock and key.

## **ANIMALS IN THE CLASSROOM**

When animals are present in the classroom special care should be taken to insure that neither students nor animals are harmed. The following are suggestions to consider and rules you may wish to adopt:

- Children may experience allergic reactions to certain animals or the dust from their cages. If this occurs, remove the animal from the classroom. Check student health records prior to introducing animals to the class.
- Potentially dangerous animals, including poisonous snakes, reptiles, and insects should never be allowed into the classroom.
- Parent permission must be granted before students are allowed to handle live animals.
- All animals brought into the classroom should be healthy and free of transmissible disease or any other problems that may endanger the students' health. It is strongly suggested that you obtain all animals from reputable science supply houses. Pay attention to common signs of illness in animals, such as a loss of appetite or weight, lethargy, a change in behavior, or respiratory problems. Fish should be selected from tanks in which all fish appear healthy. You can legally purchase only mature turtles with a shell length of at least four inches in order to control the spread of salmonella.
- Certain live or dead animals collected from their natural environment should not be allowed into classrooms. Diseases may be transmitted from turtles, several species of birds, snakes, insects, arachnids (such as ticks and mites), and certain mammals. These diseases may be transmitted to humans either directly, through handling or bites, or indirectly, through airborne organisms.
- Prior to bringing live animals into a classroom, students should be asked if they have a fear of the animals being introduced. Students should not be exposed to animals they are afraid of.
- Students should only be allowed to handle animals when supervised.
- Instruct students in the proper care and handling of classroom animals used as part of the school science program. Prohibit abuse and teasing of animals.
- Students should not insert their fingers or other objects into cages.



- Use gloves when handling animals. Thicker gloves should be used with animals that have teeth and/or claws.
- Have students wash their hands both before and after handling animals. Germs can be spread from humans to animals, as well as from animals to humans.
- All animal bites or scratches should be reported immediately. Victims must get prompt and appropriate medical attention to avoid infection.
- Animals should be kept in secure cages and tanks. Check that all tanks and cages close securely and have no sharp edges that can harm either the children or the animal(s). Repair or discard all hazardous cages and tanks.
- Cages and tanks should be kept clean and absorbent material should be replaced on a regular basis. Waste materials should be disposed of in sealed bags or covered trash cans. Cages and tanks should also be periodically washed down with soap and water. Gloves should be worn when cleaning cages and tanks.
- It is advised that animals not be handled during their first few days in the classroom in order to give them time to adjust to new surroundings. If young offspring are to be picked up and handled it is best to first move the mother to another cage. She may be fiercely protective of her young.

## **PLANTS IN THE CLASSROOM**

Many teachers have plants in their classrooms for both decorative and educational purposes. Plants that are known to be safe may be brought into the classroom; and plants known to contain harmful substances should be avoided. All plant parts including leaves, stems, berries, bulbs, and seeds may contain potentially toxic substances. You should be aware that not all plants have been analyzed for their toxicity; therefore several practical suggestions for working with plants are listed below.

- It is suggested that you check student health records prior to introducing specific plants to the classroom environment. Some children may experience allergic reactions to specific plants. If a child reacts to a new plant, keep the child a safe distance away from the plant, or remove the plant from the classroom.
- Instruct students not to place any part of a plant in their mouths without your permission. Many common plants such as daffodil bulbs; foxglove leaves; rhododendron leaves, stems, and flowers; and certain mushrooms may be toxic or fatal if eaten.
- Advise students that no sap, i.e., poinsettia, should be allowed to get onto their skin. If a student comes in contact with sap, instruct the student to wash the area of contact thoroughly.
- On field trips, make sure that students do not pick or eat any unknown flowers, seeds, berries or plants.
- If a trip is planned to a location where poisonous plants, i.e., poison ivy, poison oak, or poison sumac, may be found, it is important that students be taught, prior to the trip, how to identify and avoid such plants, and how to dress for safety. (Cornell University Poison Plants Information Database, <http://www.ansci.cornell.edu/plants/>)

- Precautions should be taken to avoid contact with thorns, burrs, and other plant parts which can scratch or cut students in the classroom or the field.
- Do not allow students to eat food after handling plants, unless they have thoroughly washed their hands.
- Warn students of dangers associated with inhaling or exposing skin or eyes to the smoke from burning plant matter.
- In lessons using flowers, take care to prevent the distribution of excess pollen..

### **FUNGI, PROTISTS, AND MONERANS**

- Do not culture pathogenic organisms such as molds, algae, protozoa, bacteria, or viruses. Do not prepare cultures using student's saliva or spray from a cough or sneeze, since these may contain pathogens.
- Bread mold activities should be conducted in sealed containers or closed, sealable bags because some students are highly allergic to them.

### **SCIENCE PROJECTS/EXIT PROJECTS**

- All safety procedures and guidelines included in this manual must be followed as students work on science projects and exit projects.
- Use of laboratory chemicals and sharp instruments must be supervised.
- Vertebrate animals should not be used for experimentation purposes with the exception of humans solely in terms of behavioral, memory, or achievement related studies that do not involve ingestion of or exposure to substances that could result in adverse health effects.

### **FIELD TRIPS**

A well organized field trip, with carefully planned activities, greatly enhances the safety and educational value for all participants. The following strategies can make field trips safer:

- Visit the field trip site prior to the trip. Note any obvious dangers and investigate for any unique hazards. Share this information with your students before taking the trip.
- Request written permission for the trip from the school administration and obtain written parental consent for all students who will be going on the field trip.
- Plan for and arrange adequate adult supervision. For elementary and middle school students, at least one staff member and two additional adults are required for up to 30 students. The required staff member must be a teacher or supervisor. The other adults may be parent volunteers or members of the instructional staff or paraprofessionals or school aides.

At the elementary level, for each additional ten students participating, an additional adult is required. At the middle school level, an additional adult is required for each additional fifteen students participating.

- Establish and review rules for safe conduct prior to the trip.
  - Organize a buddy system.
  - Teach children to respond to pre-arranged signals such as a whistle, clap, or silent hand signal.
  - Each child should have an identification tag which contains the school name, address, and telephone number. Students should never wear tags displaying their names.
  - Arrange a rendezvous location for students who may become separated from the group.
- Instruct students as to proper behavior on transportation vehicles. Check that all students are safely seated and, if available, that all seat belts have been secured.
- Develop and distribute a list of appropriate clothing (New York City Department of Health and Mental Hygiene, [www.nyc.gov/html/doh/html/ehs/ehstick.shtml](http://www.nyc.gov/html/doh/html/ehs/ehstick.shtml)) and essential supplies or equipment to be brought on the trip. Inform students of any fees or costs and whether to bring a bag lunch or lunch money. Parents should be notified of the details well in advance of the trip.
- Familiarize students with all the potential dangers related to the trip, such as:
  - deep or rapid water hazards.
  - poisonous plants or potentially dangerous animals.
  - the risks associated with mites, ticks, and other insect stings.
  - caution students not to turn over logs or rocks unless given permission.
  - warn student to never taste, touch, or smell anything without permission or specific instruction.
- It is suggested that you prepare and carry with you a first aid kit if one will not be available at the site.
- It is suggested that you also carry with you tissues, band-aids, wet wipes, and extra liquids on hot days.
- Consult with authorities to find out if you are allowed to collect specimens. If specimens are collected, try not to disturb the ecological system. Have an adequate number of unbreakable containers, i.e., plastic containers or cups for student collection.
- Conduct a post trip check for mites and ticks, bites, scratches and cuts, etc. when appropriate.
- Be prepared (for the unexpected)!



# APPENDIX



# **APPENDIX**

**STEPS TO A SAFE AND CLEAN LABORATORY**

**SPECIFIC CHEMICAL INCOMPATIBILITIES**

**GUIDELINES FOR NEW YORK CITY COMMUNITY RIGHT-TO-KNOW LAWS**

**CHEMICAL SPILLS**

**HAZARDOUS WASTE MANAGEMENT**

**EXPLOSIVES**

**SUBSTANCES IDENTIFIED AS HUMAN CARCINOGENS  
by the National Institute of Safety & Health (NIOSH)**

**NIOSH CARCINOGEN LIST**

**FIRE CODE OF THE CITY OF NEW YORK CHAPTER 34 SCHOOLS**

**CHEMICAL CONTAINER LABELS**

**EYE PROTECTION REQUIREMENTS  
Special Circular No. A-732 (October 1, 1979)**

**USE OF PROPANE BURNERS IN THE SCHOOLS  
Special Circular No. 24, 1963-1964 (November 25, 1963)**

**SAFETY TELEPHONE NUMBERS AND WEBSITES**





## STEPS TO A SAFE AND CLEAN LABORATORY

1. A chemical inventory should be conducted yearly in order to determine your supply needs and to guarantee the safety of you laboratories. Conduct your inspection by following the attached Chemical Storage protocol, that can be found in the Laboratory Specialists section of the Science Safety Manual. Following the protocol will enable you to both rearrange the chemicals and decide which ones should be removed.
2. Decide which chemicals need to be discarded before rearranging the remaining stock. These chemicals to be discarded should include:
  - Unlabeled chemicals
  - Explosive chemicals
  - Carcinogenic chemicals
  - Old chemicals in excessive amounts
  - Chemicals that exhibit:
    - Bulging containers
    - Liquids in solids
    - Solids in liquids
    - Darkening or clouding of solutions
    - Spotting on solids
3. Identify the chemicals you want removed using colored self-adhesive labels. Do not remove the chemicals yourself; merely attach the colored “dots.”
4. List these chemicals on the attached Chemical Removal Request Form found in the appendix of the Science Safety Manual.
5. Make two copies of the list. Keep the original for your own records, give one copy to the assistant principal and the other to the custodian.
6. The custodian will prepare a work order PO18 using the Trade Code 75 and attach the list of the chemicals.
7. The custodian will then fax the PO18 form listing the chemicals to M. Pedram at (718) 610-0320 via the Passport System and request a pick up.
8. The chemicals you are keeping should be rearranged according to the Chemical Storage protocol and listed on the attached Chemical Inventory Form which can also be found in the appendix of the Science Safety Manual.

## CHEMICAL INVENTORY FORM

### INSTRUCTIONS

Please be aware that for purposes of this inventory, the term **chemical** refers to any liquid, gas or solid used in the school or facility (e.g., rubber cement or duplicating fluid), as well as items used in science, vocational or trade shops. The Chemical Inventory form must be updated on an annual basis. The Chemical Inventory must be completed for each room, collected, and stored in a file on site.

- A. Each room in your facility must be surveyed. This includes annexes, basements and storage closets. Use a new form for each room.
- B. List all chemical substances found in the room. Do not list articles such as furniture, machinery, or equipment. If you are not sure whether a substance should be included, list it anyway. If there are too many chemicals in the room to fit on one sheet, use additional sheets and number each successive sheet.
- C. If there are no chemicals in a room, prepare a form for that room with "No Chemicals" written in the body.
- D. Please make sure that the heading on the form is carefully filled out. Enter your name and telephone number on the form, so that if there is a question about an entry you may be contacted.
- E. Enter "N/A" in spaces where information is not available. Do not leave any space blank.
- F. Please print all information clearly.

### DEFINITIONS

#### Item 1 – Product Trade Name

Enter the name as it is listed on the product label (e.g., "Red Devil Paint" or "Phenol").

#### Item 2 – Manufacturer's Name, Address and Telephone Number

This information is found on the label. If there is a telephone number, please list this also.

#### Item 3 – Exact Storage Location

By law, storage location must be precise. State exactly where in the room the product is stored (e.g., "under copy machine; third closet from the window").

#### Item 4 – Warnings on Label

State the immediate health hazard listed on the label (e.g., "eye irritation, flammable, skin burns"). If there are no warnings on the label, write "No Warnings Indicated".

#### Item 5 – Other Identifying Information

Use this column to describe the product if it does not have a label (e.g., "floor cleaner; white powder in can; liquid in brown bottle"). If the label has a CAS number (Chemical Abstracts Service) please write this number in the space provided. If one does not exist, write "None" in the space provided.

#### Item 6 – Physical State

Each chemical will be either a pure chemical (e.g., "acetone; nitric acid"), or a product mixture (e.g., "Titan's Floor Stripper; Speedball Textile Ink"). Use codes listed on the inventory sheet.

#### Item 7 – Quantity

Number of containers (e.g., 50 bottles, 13 cans, 6 boxes).

#### Item 8 – Container Type

Use code listed at the bottom of the inventory sheet.

#### Item 9 – Units of Measure

Use code listed on the bottom of the inventory sheet to describe the size or volume of the container (e.g., 6 oz, 1 G). If units of measure are metric, use the metric measure. It is not necessary to convert.

#### Item 10 - # of Employees Exposed

Enter the number of employees who handle the substance or who may be routinely exposed to the substance.

#### Item 12 – MSDS

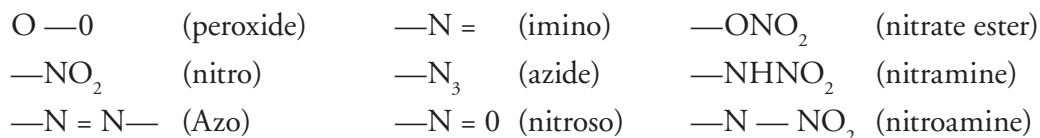
Material Safety Data Sheets (MSDS) are supplied by the manufacturer of the chemical substance. Place a check (✓) in this box if a MSDS is on file in your school. If you do not know whether your school has a MSDS for a particular product, enter "N/A" in this box.





## SPECIFIC CHEMICAL INCOMPATIBILITIES

In general, chemicals with the following functional groups are prone to instability:



These reagents should be dated, handled according to prescribed storage conditions, and disposed of after use. The following list provides some additional information dealing with specific chemical incompatibilities. It is not all-inclusive.

The list is reprinted by permission from *Better Science Through Safety* by Jack A. Gerlovich and Gary E. Downs, © 1981 by the Iowa State University Press, 2121 South State Ave., Ames, IA 50010.

Chemical	Chemicals Incompatible With
Acetic Acid	Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl compounds, perchloric acid, or chromic acid
Acetone*	Concentrated sulfuric and nitric acid
Acetylene*	Bromine, chlorine, fluorine, copper, silver, mercury and their compounds
Alkali metals	Carbon tetrachloride <sup>+</sup> , carbon dioxide, water, halogens*
Alkaline metals (powdered aluminum or magnesium)	Carbon tetrachloride <sup>+</sup> , or other chlorinated hydrocarbons*, halogens*, carbon dioxide
Ammonia*, anhydrous	Mercury*, hydrogen fluoride*, calcium hypochlorite, chlorine*, bromine
Ammonium Nitrate	Acids, flammable liquids, metal powders*, sulfur, chlorates*, any finely divided organic or combustible substance
Aniline*	Nitric acid and hydrogen peroxide
Bromine*, Chlorine*	Ammonia*, petroleum gases, hydrogen, sodium, benzene*, finely divided metals
Carbon, activated	Calcium hypochlorite and all oxidizing agents
Chlorates*	Ammonium salts, acids, metal powders*, sulfur, and finely divided organic or combustible substance
Chromic Acid*	Nitric acid, peroxides, permanganates, ethylene glycol, hydroxyl compounds, perchloric acid, or chromic acid
Copper	Concentrated sulfuric and nitric acid

List continued from page 97.

Chemical	Chemicals Incompatible With
Flammable liquids	Bromine, chlorine, fluorine, copper, silver, mercury and their compounds
Hydrocarbons (propane, benzene*, gasoline)	Carbon tetrachloride <sup>+</sup> , carbon dioxide, water, halogens*
Hydrofluoric Acid*	Carbon tetrachloride <sup>+</sup> , or other chlorinated hydrocarbons*, halogens*, carbon dioxide
Hydrogen Peroxide	Mercury*, hydrogen fluoride*, calcium hypochlorite, chlorine*, bromine
Hydrogen Sulfide*	Acids, flammable liquids, metal powders*, sulfur, chlorates*, any finely divided organic or combustible substance
Iodine	Nitric acid and hydrogen peroxide
Mercury <sup>+</sup>	Ammonia*, petroleum gases, hydrogen, sodium, benzene*, finely divided metals
Nitric Acid (concentrated)	Calcium hypochlorite and all oxidizing agents
Oxygen	Oils, grease, hydrogen, flammable liquids, solids and gases
Perchloric Acid*	Acetic anhydride*, bismuth and its alloys*, alcohols, paper, wood and other organic materials
Phosphorus Pentoxide*	Water
Potassium Chlorate*	Sulfuric and other acids, any organic material
Potassium Permanganate	Sulfuric acid, glycerine, ethylene glycol*
Silver	Acetylene*, ammonia compounds, oxalic acid, tartaric acid
Sodium Peroxide*	Ethyl or methyl alcohol, glacial acetic acid, carbon disulfide <sup>+</sup> , glycerine, ethylene glycol*, ethyl acetate*
Sulfuric Acid	Potassium chlorate*, potassium perchlorate*, potassium permanganate, similar compounds of other light metals

<sup>+</sup>Carbon tetrachloride, carbon disulfide a mercury already **been prohibited** for use in high school labs. It is a probable human carcinogen.

This is a fairly comprehensive list, and many of the other chemicals on this table are also highly reactive and inappropriate for high school laboratories. They should not be used or stored in public high schools. They have been marked with an \*.

For additional information refer to the specific chemical incompatibilities tables published by national science teachers organizations such as NSTA or by commercial suppliers of chemicals

# GUIDELINES FOR NEW YORK CITY COMMUNITY RIGHT-TO-KNOW LAWS

The following school-related items were abstracted from the compliance package of the *New York City Community Right-to-Know Guidelines for Reporting* (NYCCRTK).

The purpose of the Right-to-Know (RTK) regulations is to protect the public from dangers associated with hazardous substances, extremely hazardous substances (EHS) and regulated toxic substances.

Instructions for complying and reporting is now on a web-based system at <http://www.nyc.gov/html/dep/html/tier2.html>.

## **COMPLIANCE IS MANDATORY      Due Date: March 1st**

- Report any hazardous substances stored or used at the facility that are present ~ or above their individual threshold reporting quantities at any one time during the reporting year. (Consult the NYC Hazardous Substance List included in the compliance package you will find on line.
- Report a mixture according to the type(s) and quantities of hazardous components present in that mixture.
- Submit an updated Material Safety Data Sheet (MSDS) for every hazardous substance and mixture you report on the Facilities Inventory Form (FIF) to the Department of Environmental Protection, the Fire Department, and the State Emergency Response Commission (SERC). Material Safety Data Sheets are submitted **ONLY ONE TIME** to the SERC for each substance present.
- Label all hazardous material containers with chemical names and Chemical Abstract Service (CAS) numbers. This includes the labeling of hazardous ingredients present in mixtures.

## **WHO MUST REPORT HAZARDOUS SUBSTANCES?**

The owner or operator of a facility must report all hazardous substances present in a quantity equal to or greater than a threshold reporting quantity. The reporting is due every year on March 1st. The above requirements apply to all facilities you own or operate, whether or not a particular facility received this package.

### **If you maintain the chemical inventory on a computer:**

You can submit a computer printout provided that your report follows the format of the Facility Inventory Form (FIF). Make sure you include all the information that would otherwise be provided on the FIF. For mixtures, the ingredients should be listed under the chemical name along with a CAS number and the concentration. Remember to number the pages, include the reporting period, and have an original signature of the responsible party of the facility.

Taken from: *Instructions for Complying with Community Right-to-Know Laws*

# MATERIAL SAFETY DATA SHEET

**ALDON CORPORATION**  
 1533 W. Henrietta Rd.  
 Avon, New York 14414  
 (716) 226-6177

MSDS No. SS 1116  
 Effective Date February 5, 1998

## SECTION I NAME 24 HOUR EMERGENCY ASSISTANCE

Product	SULFURIC ACID, AQUEOUS SOLUTION
Chemical Synonyms	(2 Molar) (4 Normal)
Formula	Mixture.
Unit Size	up to 4 LI.
C.A.S. No.	Mixture.

SECTION II INGREDIENTS OF MIXTURES	
Principal Component(s)	% TLV Units
Sulfuric Acid: (CAS No. 7664-93-9)	10.48% See Section V.
Water: (CAS No. 7732-18-5)	89.52% None established.

SECTION III PHYSICAL DATA	
Melting Point (°F)	Approx. 0°C (32°F)
Boiling Point (°F)	Approximately 100°C (212°F)
Vapor Pressure (mm Hg)	14 (water)
Vapor Density (Air=1)	0.7 (water)
Solubility in Water	Complete.
Appearance & Odor	Clear colorless liquid; no odor.

SECTION IV FIRE AND EXPLOSION HAZARD DATA	
Flash Point (Method Used)	Non-flammable.
Extinguisher Media	If involved in a fire situation use water spray.

**SPECIAL FIREFIGHTING PROCEDURES**

This solution is very dilute. In fire conditions, wear a NIOSH/MSHA-approved self-contained breathing apparatus and full protective clothing and eye protection.

(1986 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.7, GUIDE PAGE NO. 157)

**UNUSUAL FIRE AND EXPLOSION HAZARDS**

Attacks many metals, releasing hydrogen. Fire or excessive heat may produce hazardous decomposition products, can react vigorously with alkali materials.

D.O.T. **SULFURIC ACID, 6, UN 2796, PG II**  
 Approved by U.S. Department of Labor "essentially similar" to form OSHA-20

## SECTION V HEALTH HAZARD DATA

**Threshold Limited Value**  
 TWA: 1 mg/m<sup>3</sup> STEL: 3 mg/m<sup>3</sup> (ACGIH 1982-93).

**Effects of Overexposure**  
 May be harmful if swallowed. Contact may cause irritation and/or burns to skin, eyes and mucous membranes. Exercise appropriate procedures to minimize potential hazards.

**Emergency and First Aid Procedures**  
**SKIN:** Flush with water for 15 minutes, then wash with mild soap and water. **INGESTION:** If swallowed, if conscious, give large quantities of water to drink. **DO NOT** induce vomiting. Call physician immediately. Never give anything by mouth to an unconscious person. **EYES:** Flush with water for 15 minutes, lifting upper and lower eyelids occasionally. Get prompt medical attention. **INHALATION AS A MIST:** Remove to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.

SECTION VI REACTIVITY DATA	
Stability	Unstable Stable X
Incompatibility (Materials to Avoid)	Excessive temperature and heat. Attacks many metals, bases. Reacts with alkalis and organic materials.

SECTION VII SPILL OR LEAK PROCEDURES	
Hazardous Decomposition Products	When heated to decomposition, may release sulfur dioxide fumes. Toxic and explosive hydrogen sulfide and/or sulfur trioxide may be formed under certain conditions.
Hazardous Polymerization	Conditions to Avoid
May Occur	Will Not Occur X
Steps to be taken in case material is released or spilled	Not applicable.

**Waste Disposal Method**  
 Discharge, treatment, or disposal may be subject to Federal, State or Local laws. These disposal guidelines are intended for the disposal of catalog-size quantities only. Flush neutralized acid to sewer with copious amounts of water.

SECTION VIII SPECIAL PROTECTION INFORMATION	
Respiration Protection (Specify Type)	None needed in normal laboratory handling. If misty conditions prevail, work in a ventilation hood or wear a NIOSH/MSHA approved dust mask or respirator.
Ventilation	Local Exhaust Recommended. Special No. Mechanical (General) Recommended. Other No.
Protective Gloves	Rubber. Eye Protection Chemical safety glasses.
Other Protective Equipment	Goggles, smock, apron, eye wash station, proper gloves.

**SECTION IX SPECIAL PRECAUTIONS**

**Precautions to be Taken in Handling & Storing**  
 Store in a cool place. Wash thoroughly after handling. Keep container tightly closed when not in use.

**Other Precautions**  
 Read label on container before using. Do not wear contact lenses when working with chemicals. Avoid contact with skin, eyes and mucous membranes. Remove and wash contaminated clothing.

For laboratory use only. Not for drug, food or household use. Keep out of reach of children.  
 Revision No. 1 Date 2/05/98 Approved Michael Raszeja Chemical Safety Coordinator MR



## CHEMICAL SPILLS

1. Treat chemical spills on the skin or in the eyes IMMEDIATELY. Flush with water as soon as possible for at least fifteen minutes. Refer to the MSDS. Seek medical attention if necessary.
2. Assess the type of spill that has occurred and take the appropriate steps to the spill cleaned up and disposed of promptly and properly. Have a spill control kit in each lab. It should include the following:
  - safety goggles
  - acid resistant gloves
  - apron
  - pH paper
  - large container of sodium bicarbonate labeled *For Acid Spills*
  - large container of citric acid labeled *For Base Spills*
  - activated charcoal
  - paper towels
  - spill pads and/or absorbent pillows
  - 5 gallon bucket with 50 lbs of clean sand
  - 5 gallon bucket with plain kitty litter
  - plastic broom and dustpan
  - large heavy duty garbage bags
  - mercury spill kit
3. Know the protocol for all types of chemical spills before they happen. Have proper personal protective equipment available and be familiar with your school's *Chemical Hygiene Plan* (the document is located with the Chemical Hygiene Officer; check with the principal of the school to see who this contact person is in your school). Analyze the type of spill you are dealing with. Has anyone been injured or endangered? What is the nature and amount of the spill? What emergency steps must be taken in terms of ventilation, drafts, gas and electricity? Is it necessary to keep people away from the spill area? Who must be contacted and when? Who should be responsible for the clean up? What should be done after the spill is cleaned up?
4. Assess the spill situation and know your limits. There are three categories of spills:
  - a. Those that may be picked up and disposed of by the teacher or other trained members of the school staff.
  - b. Those that can be cleaned by in-school personnel, but are too large to be disposed of by school resources.
  - c. Those that are so large or so toxic that help must be called in to clean up and dispose of them.

If a chemical spill is too large or too toxic, clear the area. Take precautionary steps such as opening windows or turning off electric power and gas if necessary. Use Emergency Shut Offs.

Notify the Assistant Principal of Science and the Chemical Hygiene Officer.

Follow the Emergency protocol as outlined in your School Safety Plan.

5. If the spill is manageable (type a) clean it up using the proper protective equipment and following safety protocol, then dispose of it safely. If the chemical must be held for chemical pick up (type b), assess its reactivity, toxicity, flammability and store it in an appropriate container and location. Label and date the container correctly with the identity of the substance. Do not mix incompatible substances.

Follow the guidelines for chemical removal by notifying the Assistant Principal of Science and completing a Chemical Removal Request Form. The custodian will prepare a PO 18 request and use Trade Code 75. Small amounts of refuse from type b spills may be stored until the end of the school year and removed by one request.

6. Specific spills include:

- a. **Non Hazardous Solids**

Non hazardous solid chemicals can be brushed up and disposed of as regular waste. Minimize the breathing of dust by misting with water.

- b. [(Type c)hazardous solid chemicals should not be cleaned up by lab specialists or teachers.]

- c. **Acids and Bases**

Acids can be neutralized with sodium carbonate or sodium bicarbonate.

Bases can be neutralized with boric acid, citric acid or sodium bisulfate.

Check for neutralization with pH paper. If the spill has been neutralized, paper towels can be used to soak it up and it can be disposed of as regular waste. Wash the affected area with water and a detergent. \*Absorbent pads and pillows are not recommended for acid/base spills. Since the (type b) spill has not been neutralized it must be stored as corrosive waste until chemical pick up is arranged.

- d. **Hazardous Liquids**

If the spill is a hazardous solution such as a heavy metal salt solution (type b), it cannot be poured down the drain. It can be cleaned up with paper towels or spill pads which now become hazardous waste that must be properly labeled and stored as chemical waste in an appropriate container. The procedure for chemical pick up must be followed.

- e. **Flammable Liquids**

Flammable liquids (type b) require a rapid response. Evacuate the area, shut off any ignition sources and turn off electrical power. Keep fume hood on, open windows and soak up the spill with paper towels, sand, absorbent material or spill pads. Cover the liquid with activated charcoal to absorb flammable vapors. Use plastic tools for clean up and store waste material in a separate container that is correctly labeled and dated. Store until chemical pick up is arranged.

f. **Mercury Spills**

Although mercury is no longer allowed in schools the need to clean up a small spill could arise. If there is a small spill such as a cracked thermometer (type b) use a special mercury clean up trap (commercially available) or cover with zinc dust to form an amalgam. Use an aspirator bulb to pick up the mercury droplets. Avoid breathing zinc dust. A spill larger than the amount contained in a mercury thermometer (2 mL.) (type c) demands specially trained responders. Call the Department of Education Office of Occupational Safety and Health at (718) 935-2319 (DOE OOSH) or the Department of Education Division of School Facilities Environmental Health and Safety (BOE DSF EHS) at (718) 361-3808. They will coordinate the mercury spill response with the proper outside agency.

Never use a vacuum or dustpan and broom. Further contamination over a larger area will result. Store in an appropriate waste container until there is a hazardous waste pick up.

Safety tips:

- Remember the lab is always equipped with a safety blanket. The blanket can be used to prevent a large spill from expanding if necessary.
- Never reorder thermometers containing mercury.

g. **Leaking Gas Cylinders**

Use soap solution to determine if there is a leak present. If a valve, safety valve or valve threads are at fault notify the supplier (type b). Do not attempt to repair a leak yourself.

- Notify the supply company.
- Isolate the leaking cylinder in a well vented area with a warning sign.
- If the cylinder is leaking a flammable gas it should be isolated outdoors in a secure area.

h. **Biohazard Spills**

Standard (Universal) Precautions must be followed when dealing with human body fluids. Cover the area with a paper towel without touching the fluid. Clear the area and notify the custodian for immediate clean up. Solutions of 10% bleach are necessary to clean the contaminated site. If the spill happens in a room where a new class is entering, inform the teacher and prevent student access to the area.

# HAZARDOUS WASTE MANAGEMENT

Hazardous waste is any material regulated by the Environmental Protection Agency (EPA) under their solid waste guidelines. Under the Resource Conservation and Recovery Act (RCRA) (1976, 1984, 2002) hazardous waste includes chemicals on one of several regulatory lists or chemicals categorized as **Ignitable**, **Corrosive**, **Reactive** or **Toxic**.

Most school waste can be placed in one or more of the categories above. Use the MSDS to help with classification or call your regional DEC office (718) 482-4996 to categorize the waste.

RCRA categories are defined as follows:

**Ignitable:** Substances that give off vapors that can ignite. This group includes flammable solvents.

**Corrosive:** Substances that destroy living tissue as well as equipment on contact. Acids and bases are included in this category.

**Reactive:** Substances that are not stable under certain conditions. Different substances may have violent reactions due to chemical incompatibilities, exposure to air, water or oxygen. These violent reactions may include the generation of large amounts of heat, gas and/or an explosion. Water reactive metals such as sodium and potassium are included in this category.

**Toxic:** Substances that are health hazards when inhaled, ingested or in contact with skin. Cyanide and sulfide compounds are included in this category.

Hazardous waste must be disposed of in compliance with local, state and federal laws and therefore must be stored in appropriate containers until the waste can be picked up by a licensed transporter. (Procedure to follow)

The New York City Department of Environmental Protection (NYCDEP) regulates the disposal of hazardous waste under the Federal Resource Conservation and Recovery Act (RCRA). The New York State Department of Environmental Conservation (N.Y.S. DEC) enforces these regulations.

To simplify hazardous waste management, prepare in advance for the chemical waste that will be generated for a particular lab activity. Have appropriate, properly labeled containers for the particular chemical waste in front of each lab class so students can place the waste from their experiment in the container. These containers should be metal, plastic or plastic-coated glass. Glass jars and bottles should be enclosed in a non-breakable secondary container.

Chemical waste that is waiting for a chemical pick-up must be stored in a safe place. Unless there is an emergency mercury pick-up, non-emergency chemical waste may be stored until the end of the school year and then removed from the school as one chemical pick-up request.

Storage containers must be appropriate for the type of waste. These containers must be clearly labeled with information that includes the identity of the substance, hazard or toxicity of the contents and date the particular substance became waste. Records of chemical waste and pick-ups must be kept for 3 years.

Follow protocol for chemical pick-up.

1. Notify the assistant principal and custodian.
2. Use chemical removal request form to list type of chemicals, amount and room location.
3. The custodian will complete a PO-18 and attach the list of chemicals being removed from the school.
4. The custodian will use a Trade Code 75 on the PO-18, Crew #IN27.
5. The custodian will Fax (718-361-3844) information to M. Pedram via the passport system.

Planning for the future will minimize hazardous waste:

1. Substitute less hazardous chemicals for more hazardous ones, when possible.
2. Order chemicals in quantities consistent with the manner in which they are used.
3. Time order chemicals with short shelf lives.
4. Never mix hazardous and non hazardous waste. It will increase the total volume of hazardous waste that must be picked up and increase cost of disposal.

Always follow safe storage and disposal procedures for hazardous waste:

1. Store different chemical waste substances separately in labeled containers. The labels should list the specific hazards and the date the substance became waste.
2. Aqueous solutions of strong acids and bases diluted to a pH range of 5–9 can be disposed of by pouring them down the drain. However, if they are contaminated with other toxic chemicals such as heavy metal salts, they must be stored for hazardous pick up.
3. Alkali metals such as potassium and sodium must be stored under mineral oil.
4. Magnesium and other pyrophoric metals must be stored in tightly sealed metal containers.
5. Mercury is prohibited in schools. Waste mercury must be stored in tightly sealed bottles or jars and must be removed immediately following chemical disposal protocol.
6. If you have any chemicals that you cannot identify due to poor labeling, the best action to take is NO action. Leave the chemical alone until you are ready for a chemical pick up. The transporters will classify the unknown substance and pack it for disposal. In some instances the transporters may send a sample for chemical analysis.
7. It is important to keep records of the chemical waste you have on hand and those chemicals that have been picked up. Records should include a description or name of the waste, the amount, the date it became waste, and how it was disposed of. Keep records for three years.

- \*Make as many copies of this form as needed.
- \*Attach the form(s) to a PO 18 request
- \*Keep a copy for your records
- \*Use Trade Code 75 on the PO 18 request.

FAX TO:  
 (718) 361-3844  
 Att: M. Pedram  
 Via Passport System-  
 Notify M.Pedram

### CHEMICAL REMOVAL REQUEST FORM

School \_\_\_\_\_  
 Address \_\_\_\_\_  
 Borough \_\_\_\_\_ Zip \_\_\_\_\_  
 Date \_\_\_\_\_

No.	Type of Chemical	Number x Size = Total			Room
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___
_____	_____	___	x ___	= ___	___

Principal's Signature \_\_\_\_\_  
 Contact Person \_\_\_\_\_ Telephone No. \_\_\_\_\_  
 Custodian \_\_\_\_\_ Telephone No \_\_\_\_\_.

# EXPLOSIVES

**CAUTION:** This is not a comprehensive list of all possible explosive chemicals. This table has been taken from *School Science Laboratories, A Guide to Some Hazardous Substances*. It was published by U.S. Consumer Product Safety Commission in 1984 and has not been updated. The substances in this table are highly explosive and should not be used or stored in schools.

**REMOVAL:** Explosives should be removed by trained fire or police bomb squads, or other qualified officials. Limit movement of containers of such chemicals in order to minimize the chance of detonation.

SUBSTANCE	CAS NO.	RECORD OF REMOVAL	WHO, WHERE TAKEN, DATE
Benzoyl Peroxide	94-36-0		
Carbon Disulfide <sup>1</sup>	75-15-0		
Diisopropyl Ether <sup>2</sup>	108-20-3		
Ethyl Ether <sup>2</sup>	60-29-7		
Picric Acid <sup>3</sup>	88-89-1		
Perchloric Acid <sup>4</sup>	7601-90-3		
Potassium Metal <sup>2</sup>	7440-09-7		

<sup>1</sup> The flashpoint of carbon disulfide (-22°F) is well below room temperature and small amounts of the vapor in air can be explosive.

<sup>2</sup> These chemicals become dangerous upon aging. Ethers and potassium metal can form explosive peroxides upon exposure to air. Old opened containers of ether should be treated with great caution as should potassium metal not stored under kerosene.

<sup>3</sup> Picric acid should always contain 10-20% water and bottles should be disposed of after two years. Dry picric acid is explosive and if crystallized must never be touched or moved by school staff. An outside agency trained in its removal must be called.

<sup>4</sup> Although the 70% acid/water mixture is not explosive by itself, the use of perchloric acid often leads to the formation of perchlorates which are very explosive.

## **SUBSTANCES IDENTIFIED AS HUMAN CARCINOGENS**

### **by the National Institute of Safety and Health (NIOSH)**

**CAUTION:** The chemicals listed in the NIOSH list that follows are those that have substantial evidence of carcinogenicity. Further, each substance listed here may have additional health hazards. This list was published by The National Institute of Safety and Health (NIOSH) in 2005. It is available on line at <http://www.cdc.gov/niosh/npotocca.html>. Many reputable scientific organizations publish current comprehensive test results. TRI produces a table that reviews current NTP, IARC and OSHA results.

These substances are NOT recommended for use or storage in schools unless an absolute need is determined and appropriate use and storage safety procedures are instituted. If it is determined that there is a definite need to use one of these carcinogenic chemicals, obtain additional information on the risk involved. Information on many carcinogenic chemicals can be obtained from the National Institute of Safety and Health (NIOSH) or the Consumer Product Safety Commission (CPSC). Ask for the NIOSH criteria document on the chemical of interest by writing to NIOSH, Publications Dissemination DSDTT, 4676 Columbia Parkway, Cincinnati, OH 45226, or write for additional information to CPSC, Directorate for Health Sciences, Washington, DC 20207.

**REMEMBER – Some carcinogens are more potent than others and risk increases with level and duration of exposure.**

**REMOVAL:** These substances should be safely stored until a chemical pick up is arranged. Once removed, the substances should not reenter the school. Instructions should be added to the procedures for ordering chemicals to make sure that, once removed, these chemicals are not reordered.



## NIOSH CARCINOGEN LIST

The following is a list of substances NIOSH considers to be potential occupational carcinogens.

A number of the carcinogen classifications deal with groups of substances: aniline and homologs, chromates, dinitrotoluenes, arsenic and inorganic arsenic compounds, beryllium and beryllium compounds, cadmium compounds, nickel compounds, and crystalline forms of silica. There are also substances of variable or unclear chemical makeup that are considered carcinogens, coal tar pitch volatiles, coke oven emissions, diesel exhaust and environmental tobacco smoke.

Some of the potential carcinogens listed in this index may be re-evaluated by NIOSH as new data become available and the NIOSH recommendations on these carcinogens either as to their status as a potential occupational carcinogen or as to the appropriate recommended exposure limit may change.

### a

- Acetaldehyde
- 2-Acetylaminofluorene
- Acrylamide
- Acrylonitrile
- Aldrin
- 4-Aminodiphenyl
- Amitrole
- Aniline and homologs
- o-Anisidine
- p-Anisidine
- Arsenic and inorganic arsenic compounds
- Arsine
- Asbestos
- Asphalt fumes

# b

Benzene  
Benzidine  
Benzidine-based dyes  
Beryllium  
Butadiene  
tert-Butyl chromate; class, chromium hexavalent

# c

Cadmium dust and fume  
Captafol  
Captan  
Carbon black (exceeding 0.1% PAHs)  
Carbon tetrachloride  
Chlordane  
Chlorinated camphene  
Chlorodiphenyl (42% chlorine); class polychlorinated biphenyls  
Chlorodiphenyl (54% chlorine); class polychlorinated biphenyls  
Chloroform  
Chloromethyl methyl ether  
bis(Chloromethyl) ether  
B-Chloroprene  
Chromium, hexavalent [Cr(VI)]  
Chromyl chloride; class, chromium hexavalent  
Chrysene  
Coal tar pitch volatiles; class, coal tar products  
Coke oven emissions

# d

DDT (dichlorodiphenyltrichloroethane)  
Di-2-ethylhexyl phthalate (DEHP)  
2,4-Diaminoanisole  
o-Dianisidine-based dyes  
1,2-Dibromo-3-chloropropane (DBCP)  
Dichloroacetylene  
p-Dichlorobenzene  
3,3'-Dichlorobenzidine  
Dichloroethyl ether  
1,3-Dichloropropene  
Dieldrin  
Diesel exhaust  
Diglycidyl ether (DGE); class, glycidyl ethers  
4-Dimethylaminoazobenzene  
Dimethyl carbomoyl chloride  
1,1-Dimethylhydrazine; class, hydrazines  
Dimethyl sulfate  
Dinitrotoluene  
Dioxane

# e

Environmental tobacco smoke  
Epichlorohydrin  
Ethyl acrylate  
Ethylene dibromide  
Ethylene dichloride  
Ethylene oxide  
Ethyleneimine  
Ethylene thiourea

f

Formaldehyde

-

g

Gallium arsenide

Gasoline

h

Heptachlor

-

Hexachlorobutadiene

Hexachloroethane

j

Hexamethyl phosphoric triamide (HMPA)

Hydrazine

k

Kepone

-

m

Malonaldehyde

Methoxychlor

Methyl bromide; class, monohalomethanes

Methyl chloride

Methylhydrazine

Methyl iodide; class, monohalomethanes

Methyl hydrazine; class, hydrazines

4,4'-Methylenebis(2-chloroaniline) (MBOCA)

Methylene chloride

4,4-Methylenedianiline (MDA)

## n

-

## o

a-Naphylamine

B-Naphylamine

Nickel, metal, soluble, insoluble, and inorganic; class, nickel, inorganic

Nickel carbonyl

Nickel sulfide roasting

4-Nitrobiphenyl

p-Nitrochlorobenzene

2-Nitronaphthalene

2-Nitropropane

N-Nitrosodimethylamine

## p

-

## q

Pentachloroethane; class, chloroethanes

N-Phenyl-b-naphthylamine; class, b-naphthalene

Phenyl glycidyl ether; class, glycidyl ethers

Phenylhydrazine; class, hydrazines

Propane Sultone

B-Propiolactone

Propylene dichloride

Propylene imine

Propylene oxide

## r

Radon

Rosin core solder, pyrolysis products (containing formaldehyde)

## S

Silica, crystalline cristobalite  
Silica, crystalline quartz  
Silica, crystalline tripoli  
Silica, crystalline tridymite  
silica, fused  
Soapstone, total dust silicates

## t

Tremolite silicates  
2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) (dioxin)  
1,1,2,2-Tetrachloroethane  
Tetrachloroethylene  
Titanium dioxide  
o-Tolidine-based dyes  
o-Tolidine  
Toluene diisocyanate (TDI)  
Toluene diamine (TDA)  
o-Toluidine  
p-Toluidine  
1,1,2-Trichloroethane; class, chloroethanes  
Trichloroethylene  
1,2,3-Trichloropropane

## u

Uranium, insoluble compounds    Uranium, soluble compounds

## V

Vinyl bromide; class, vinyl halides

Vinyl chloride

Vinyl cyclohexene dioxide

Vinylidene chloride (1,1-dichloroethylene); class, vinyl halides)

## W

Welding fumes, total particulates

Wood dust

## X

-

## Z

Zinc chromate; class, chromium hexavalent

# FIRE CODE OF THE CITY OF NEW YORK

## CHAPTER 34 SCHOOLS

### **§34-01 Storage and Use of Limited Quantities of Chemicals, Acids, and Flammables for Instructional Purposes in Public High Schools.**

- a. No liquefied chlorine may be stored in any school.
- b. No more than five gallons of volatile flammable oils derived from petroleum, shale oil or coal tar should be stored at any one time.
- c. No more than 25 pounds of potassium and/or sodium chlorate is permitted to be stored.
- d. No chemicals or substances as listed under §27-4234 and §27-4240 (see page 118) of the Administrative Code should be stored in a school.
- e. It shall be unlawful to store chemicals in close proximity to each other when they are of an explosive nature, or when one increases the energy of decomposition of the other, or when they are so constituted that they may react upon one another and become explosive or flammable.
- f. The storage of acids in containers should be confined to either the lowest shelves of a soap-stone cabinet, or within crockery or earthenware containers, so as to prevent spillage.
- g. Safety cans shall be provided for the storage of volatile flammable oils.
- h. A bucket filled with sodium bicarbonate or soda and ash shall be provided near storage of acids.
- i. The storage of dangerous chemicals, volatile flammable oils and liquids shall be confined to approved flammable storage cabinets. A cardholder should be provided for a visible record of the contents and maximum amount stored therein; also, a caution sign, if applicable to read: "In case of fire do not use water."
- j. All preparations, storage and classrooms should be provided with portable fire extinguishers of a type suitable for chemical fires. Same should be examined frequently to make sure that they have not been tampered with or removed from their designated places, and, at least once yearly all such devices must be examined for deterioration or injuries due to misuse, and recharged. The date of charging and signature of the person who performed it should appear on the tag attached to each extinguisher.



## MAXIMUM QUANTITIES OF COMBUSTIBLES THAT CAN BE STORED

Listed below are maximum quantities of combustibles and dangerous chemicals which may be stored in public schools:

<b>Volatile Flammable Liquids (Soluble)</b>	
Acetone	1 lb.
Alcohol, Denatured	5 gals.
Alcohol, Methyl	5 gals.
<b>Non-Volatile Flammable Liquids (Soluble)</b>	
Glycerine	5 lbs.
<b>Combustible Fiber and Powders (Vegetable)</b>	
Lycopodium	1 lb.
<b>Dangerously Corrosive Acids</b>	
Glacial Acetic Acid	5 gals.
Hydrofluoric Acid	1 lb.
Nitric Acid	2 gals.
Sulphuric Acid	12 gals.
<b>Peroxides</b>	
Hydrogen Peroxide, U.S.P.	10 lbs.
Other Hydrogen Peroxides over 3 percent, not to exceed 15 percent	5 lbs.
<b>Chlorates</b>	
Potassium Chlorate	
<b>Permanganates</b>	
Potassium Permanganates	1 lb.
<b>Nitrates</b>	
Barium Nitrate	1 lb.
Strontium Nitrate	1 lb.
Cobalt Nitrate	1 lb.
Copper Nitrate	1 lb.
Iron Nitrate, Ferric	
Potassium Nitrate	10 lbs.
Silver Nitrate	5 lbs.
Sodium Nitrate	15 lbs.
Other Metallic Nitrates	5 lbs.

#### **§27-4234: Restrictions**

It shall be unlawful to store for use, or to use in any technical establishment any liquid acetylene, acetylide of copper or other metallic acetylide; fulminate of mercury, or any other fulminate or fulminating compound; nitroglycerine; chloride of nitrogen; amide or amine; blasting powder; smokeless powder; or gunpowder in any form; or any volatile product of petroleum (except rhigoline) having a boiling point lower than sixty degrees Fahrenheit.

#### **§27-4240: Prohibited Materials**

It shall be unlawful to manufacture or store in a wholesale drug store or drug and chemical supply house any of the following substances:

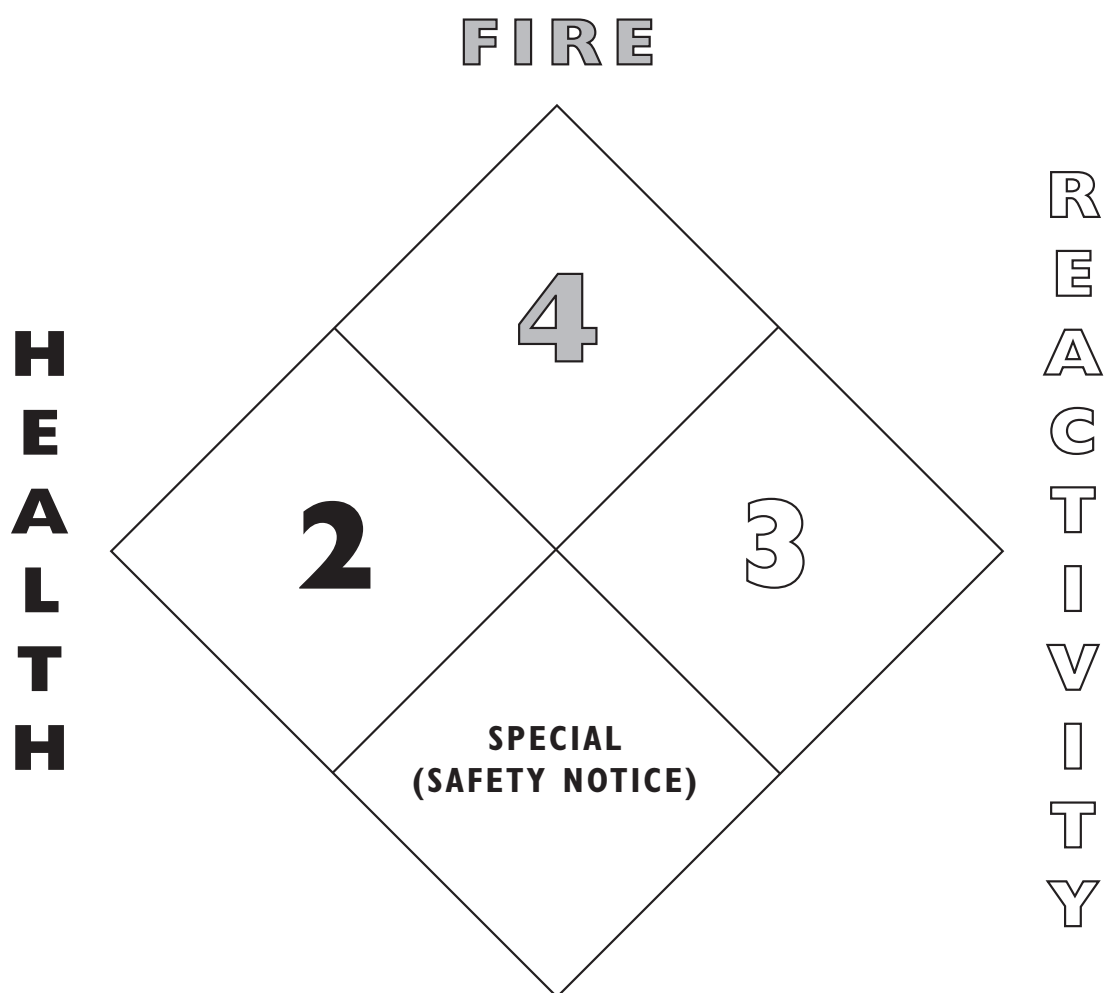
1. Acetylide of copper;
2. Amide or amine explosive;
3. Chloride of nitrogen;
4. Colored fire in any form;
5. Cymogene or any volatile product of petroleum (except rhigoline) or coal tar having a boiling point lower than sixty degrees Fahrenheit;
6. Flashlight powders;
7. Fulminate or any fulminating compound;
8. Guncotton;
9. Gunpowder in any form;
10. Liquid acetylene;
11. Nitroglycerine, except in official U.S. pharmacopoeia solution, or in the form of pills, tablets, or granules containing not more than one-fiftieth of a grain each;
12. Picrates;
13. Potassium chlorate in admixture with organic substances or with phosphorus or sulphur; provided that this restriction shall not apply to the manufacture or storage of tablets of chlorate of potash intended for use solely for medicinal purposes;
14. Rubber shoddy.

#### **g§27-4099 Permit: Toy Balloons**

It shall be unlawful for any person to fill or charge toy balloons with hydrogen or any other flammable gas, or to sell, transport, store, or have any such toy balloon in his or her possession.

## CHEMICAL CONTAINER LABELS

Each chemical container must be properly identified. The label should provide accurate information listing the chemical name, purchase date, manufacturer or supplier, and precautionary information. An excellent hazardous coding system, developed by the National Fire Protection Association, is explained in their publication entitled (#704). The NIOSH safety manual entitled *Safety in the School Science Laboratory* also provides information on the coding system.



### HAZARD RATING

- 4 = EXTREME
- 3 = SEVERE
- 2 = MODERATE
- 1 = SLIGHT
- 0 = MINIMAL

# **EYE PROTECTION REQUIREMENTS**

## **Special Circular No. A-732 (October 1, 1979)**

### Regulation of the Chancellor

1. This regulation incorporates the regulations of the Commissioner of Education that pertain to eye safety devices (Section 141.10). Goggles are to be worn by all pupils, teachers, and visitors observing or engaging in the activities which involve the following:
  - 1.1. Hot solids, liquids, or molten metal; or
  - 1.2. Milling, sawing, turning, shaping, cutting, or stamping of any solid materials; or
  - 1.3. Heat treatment, tempering, or kiln firing of any metal or other materials; or
  - 1.4. Gas or electric arc welding; or
  - 1.5. Repairing or servicing of any vehicle; or
  - 1.6. Caustic or explosive chemicals or materials.
2. Eye safety devices within the meaning of this regulation include face shields, goggles, safety glasses, welding helmets, hoods and other specialized equipment. Such devices must meet the American National Standard Practice for Occupational and Educational Eye and Face Protection, 287.1-1968, promulgated by the American National Standards Institute, Inc.
3. Teachers involved in the above categories shall ensure that children under their jurisdiction use the goggles provided for them in all of the listed processes and any other activities that might create a hazardous condition for their eyes. Those eye protective devices listed by the Bureau of Supplies are acceptable under this regulation.

# USE OF PROPANE BURNERS IN THE SCHOOLS

## Special Circular No. 24, 1963-1964 (November 25, 1963)

This circular modifies the joint Academic and Junior High School circulars to the Principals issued on May 10, 1963. In the circular the principals were advised that the Fire Department of the City of New York had issued a regulation forbidding the use of Propane Burners in the science classrooms and laboratories in our schools.

On October 29, 1963 a hearing, requested by the Bernzomatic Corporation, the distributors of propane gas, was held before the Board of Standards and Appeals of the City of New York. As a result of this hearing the previous ruling of the Fire Department was modified as follows:

“RESOLVED, that the decision of the Fire Commissioner, dated June 11, 1963, be and it is hereby modified and that the appeal be and it hereby is granted to permit the use of one pound cylinders of Bernzomatic propane in school laboratories, classrooms and workshops, on condition that the cylinders shall be identical with the sample submitted to the Board; on further condition that in school laboratories, classrooms and shops the cylinders shall be used only by custodians, teachers and students under the direct supervision of teachers; that they shall be used only on surfaces which are non-flammable; that at any one time the number of cylinders in a building shall be limited to two cartons, each containing 12 cylinders; that the storage shall be in metal cabinets which are louvred, kept locked and properly labeled.”

Please be advised that propane burners should not be used by students for laboratory experiments. They may be used by custodians, teachers or by individual students only under direct supervision of teachers. Care should be taken to use the propane burners on non-flammable surfaces only. It will also be necessary to store the cylinders containing propane in locked metal cabinets.

# SAFETY TELEPHONE NUMBERS AND WEBSITES

**POISON CONTROL NATIONAL HOTLINE 1-800-222-1222**

**American Chemical Society**

1155-16 St. NW  
Washington D.C. 20036  
[www.acs.org](http://www.acs.org)

**American Chemical Society Health and Safety Referral Service**

800-227-5558  
8am – 5pm M-F  
(not an emergency service)

**National Association of Biology Teachers**

[www.nabt.org](http://www.nabt.org)

**National Institute for Occupational Safety & Health (NIOSH)**

[www.edc.gov/niosh](http://www.edc.gov/niosh)

**National Science Teachers Association**

[www.nsta.org](http://www.nsta.org)

**New York City Department of Environmental Protection (NYCDEP)**

59-17 Junction Blvd.  
Flushing, N.Y. 11373-5107  
718-595-4659

**Community RTK Online Filing System**

[nyc.gov/dep/tier2filing](http://nyc.gov/dep/tier2filing)

**New York City Department of Education Office of Occupational Safety and Health (DOEOOSH)**

65 Court Street, Room 706  
Brooklyn, N.Y. 111201  
718-935-2319

*Chemical Spill or Release:*

Bernie Orlan, Division of School Facilities,  
Environmental H&S  
718-361-3808

*Chemical Removal, Mercury Removal,*

*Servicing of Acid Neutralization:*

Mavesh Pedram, Division of School Facilities,  
718-361-3701

BOROUGH	DOH REG	DISTRICTS	NAME	PHONE/FAX	E-MAIL	ISC EXECUTIVE DIRECTOR	ADDRESS
<b>Bronx</b>	<b>2</b>	7, 8, 9, 10, 11, 12	<b>Alma Idehen</b>	P: 718-741-5097 F: 718-741-7602	aidehen@schools.nyc.gov	Marlene Siegel	1 Fordham Plaza Room 817 Bronx, NY 10458
			<b>Dawn Carter</b>	P: 718-741-8573 F: 718-741-7602	DCarter2@Schools.nyc.gov		
<b>Brooklyn</b>	<b>3</b>	13, 14, 15, 16, 19, 23, 32, 79	<b>Delia Loney</b>	P: 718-935-3315 F: 718-935-4456	DLoney@schools.nyc.gov	Mariano Guzman	131 Livingston Street Room 507 Brooklyn, NY 11201
			<b>Neil Somerfeld</b>	P: 718-935-3987 F: 718-935-2843	nsomerf@schools.nyc.gov		
<b>Manhattan</b>	<b>1</b>	1, 2, 3, 4, 5, 6	<b>Fred Kaeser</b>	P: 917-339-1701 F: 212-356-7535	fkaeser@schools.nyc.gov	Robert Wilson	333 7th Avenue Room 835 New York, NY 10001
			<b>Norberto Perez</b>	P: 917-339-1749 F: 212-356-7535	NPerez4@schools.nyc.gov		
<b>Queens</b>	<b>5</b>	24, 25, 26, 27, 28, 29, 30, 75	<b>Janice Blake</b>	P: 718-391-6867 F: 718-391-6887	jblake@schools.nyc.gov	Yvonne Torres	28-11 Queens Plaza North Second Floor Long Island City, NY 11101
			<b>Carine Jean-Pierre</b>	P: 718-391-6868 F: 718-391-6887	CPierre@schools.nyc.gov		
<b>Staten Island</b>	<b>4</b>	17, 18, 20, 21, 22, 31	<b>Jody Stoll</b>	P: 718-390-1596 F: 718-556-8374	JStoll@schools.nyc.gov	Espí Semetis	715 Ocean Terrace Room 119 Staten Island, NY 10301
			<b>Helena Bowens</b>	P: 718-390-1588 F: 718-556-8374	HBowens@schools.nyc.gov		

New York City Department of Education Office of Occupational Safety

65 Court Street, Room 706

Brooklyn, New York 11201

718-935-2319