**2018**

**RICHMOND COUNTY SCHOOLS SYSTEM SECONDARY LABORATORY SAFETY MANUAL**

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**Disclaimer**

The materials in this manual have been compiled from sources believed to be reliable and to represent the best current opinions on the subject in order to provide a basic safety manual for use in Richmond County schools. This manual is intended to provide basic guidelines for safe practices and does not purport to specify minimum legal standards. Therefore, it cannot be assumed that all necessary warnings and precautionary measures are contained within this document and that other or additional measures may not be required. However, as a science teacher, you have a legal obligation to read and understand the information contained in this manual and to keep the manual readily accessible for review and emergency use. It will be updated as new safety information or governmental regulations are obtained. This manual is to be used as an informational resource. The handbook is not a contract, nor a legal document. Occupational hazards and regulatory rules are constantly being updated and changed as new information becomes available to policy makers.

**Note:** This manual was originally created by Nathalie Thrash.

**Introduction**

In 1983, the Federal Occupational Safety and Health Administration (OSHA) set forth the Occupational Safety and Health Standard entitled **Hazard Communication Standard" (29 CFR 1910.1200) and Laboratory Standard (29 CFR 1910.1450).** These standards and similar existing State and local governmental ordinances have been commonly called the "Worker's and Community Right to Know" laws which provide minimum standards that employers must adhere to for informing employees about occupational related hazards in the work place.

On August 28, 1987, OSHA published a Final Rule (Standard), which supersedes all State and Local regulations regarding the use of toxic substances in laboratories. All employers in the nonmanufacturing sector had until May 23, 1988 to be in compliance with all provisions of the Standard.

The policies, regulations and procedures defined in this manual are one means of compliance with the Right to Know laws. However, this manual has a much broader scope than occupational related hazards. It is not just a means for the Richmond County School System to resolve its obligation to inform its employees, but a guide to follow in making this a safer workplace. Accordingly, this manual covers a wide spectrum of safety precautions, ranging from daily housekeeping chores to procedures to follow in emergencies. It addresses the following five specific issues:

1. Legal Responsibilities and Laws Governing Laboratory Operations
2. Biology and Environmental Science Laboratory Safety
3. Safety in the Earth Science, Physics, and Physical Science Laboratories
4. Chemistry Laboratory Safety
5. General Safety Procedures

**As a science teacher, you have a legal obligation to read and understand the information contained in this manual and to keep the manual readily accessible for review and emergency use**. It will be updated as new safety information or governmental regulations are obtained. This manual is to be used as an informational resource. The manual is not a contract, nor a legal document. Occupational hazards and regulatory rules are constantly being updated and changed as new information becomes available to policy makers.

A science program at any grade level has certain potential dangers. Yet, with careful planning, most dangers can be avoided in an activity-oriented science program. It is essential for all involved in the science instruction program to develop a positive approach to a safe and healthful environment in the laboratory. Safety and the enforcement of safety regulations and laws in the science classroom and laboratory are the responsibility of the principal, teacher, and student—each assuming his/her share. Safety and health should be an integral part of the planning, preparation, and implementation of any science program.

**Professional And Legal Responsibilities**

Safety in the science classroom requires thorough planning, careful management, and constant monitoring of student activities. Teachers should be knowledgeable of the properties, possible hazards, and proper use and disposal of all materials used in the classroom. This information is available through Materials Safety Data Sheets (MSDS; See Appendix D). Federal law requires that vendors of laboratory chemicals provide an MSDS for each substance they sell. The law also requires that MSDSs be available at the worksite.

**Section 1: Stakeholders' Responsibilities**

**1.1 Administrators' Responsibilities**

1. Provide a safe and effective laboratory area for science activities.
2. Provide safety items and ensure they are in good condition.
3. Provide regular inspections of the laboratory.
4. Document inspection and maintenance of safety equipment.
5. Develop a chemical hygiene plan.
6. Become familiar and comply with **O.C.G.A 45-22-2– Public Employee Hazardous Chemical Protection and Right to Know Act of 1988**.
7. Become familiar and comply with federal regulations for the procurement, use, storage, and disposal of chemicals.
8. Establish a school safety committee and ensure that it meets regularly.
9. Attempt to provide a class size appropriate to the laboratory and in keeping with recommendations of professional societies.
10. Provide time for and monitor participation in mandatory safety training for science teachers, administrators, public safety officers, and maintenance personnel.

**1.2 Teachers’ Responsibilities**

1. Make sure that all safety rules are obeyed, and comply with the procedures in the school chemical hygiene and safety plans.
2. Know the properties and hazards associated with each material used in a laboratory activity before the students carry out the procedure.
3. Ensure that all safety equipment is present in the laboratory and is in good working condition. Report any accidents or unsafe conditions in writing to your department chairperson, principal, AND other appropriate administrators.
4. Provide eye protection and other necessary personal protective equipment for students and instruct students in their use.
5. Before each laboratory experiment, instruct students about the hazards associated with each activity. Reemphasize the use of eye protection and other necessary personal protection equipment.
6. Ensure that all containers are properly labeled with their contents and hazards (section
7. Promptly clean up or direct the clean-up of spilled chemicals and remains of biology experiments.
8. Dispose of chemical and biological wastes properly.

**1.3 Students’ Responsibilities**

1. Understand the experimental procedure before starting to work in the laboratory.
2. Be familiar with the hazards of the equipment, materials, and chemicals with which you are working.
3. Sign a safety contract and obey all safety rules and regulations.
4. Know the location and know how to use of all safety equipment in the laboratory.
5. Clean your work area immediately after use. Obey good housekeeping practices.

**1.4 Parents’ Responsibilities**

1. Read the laboratory safety rules. Discuss these rules with your child.
2. Sign the safety contract indicating that you have read and understood the safety rules.
3. Work with the teachers and administration at your school to develop a strong safety program.

**Section 2: Legal Responsibilities**

Several parties are potentially liable in the event of a charge of negligence in the science laboratory: the state, the school district, the school board, the school administration, and the teacher. Among these, the classroom teacher is most likely to be placed in the position of being the accountable person. It makes little difference whether you teach in the elementary classroom, middle school classroom, high school classroom, or outdoor education facility. The classroom teacher is ultimately responsible for the welfare of the student, and has three basic duties relating to the modern concept of negligence:

**2.1 Duty of Instruction**

**Duty of instruction** includes adequate instruction before a laboratory activity (preferably in writing) that is accurate; is appropriate to the situation, setting, and maturity of the audience; and addresses reasonably foreseeable dangers. Regardless of the grade level being taught, all teachers should

1. Provide sufficient instruction to make the activity and associated risks understandable, and demonstrate the essential portions of the activity.
2. Provide prior warning of any hazards associated with an activity.
3. Control access to materials and equipment having the potential for harm or misuse (e.g., chemicals, heat sources, sharp objects)

**2.2 Duty of Supervision**

**Duty of supervision** includes adequate supervision as defined by professional, legal, and district guidelines to ensure students behave properly in light of any foreseeable dangers. Points to remember include:

1. Misbehavior of any type must not be tolerated.
2. Failure to prevent accidents, instruct students, supervise students, or act appropriately in the event of an emergency is grounds for liability.
3. The greater the degree of hazard the higher the level of supervision should be.
4. The younger the age of students or the greater the degree of inclusion of special population students, the greater the level of supervision should be.
5. Students must never be left unattended, except in an emergency where the potential harm is greater than the perceived risk to students.

**2.3 Duty of Maintenance**

**Duty of maintenance** includes ensuring a safe environment for students and teachers. This requires that teachers:

1. Never use defective equipment for any reason.
2. File written reports for maintenance/correction of hazardous conditions or defective equipment with responsible administrators.
3. Establish regular inspection schedules and procedures for checking safety and first-aid equipment.
4. Follow all safety guidelines concerning proper labeling, storage, and disposal of chemicals.
5. Keep files of all hazard notifications and maintenance inspections, teacher liability in the event of an accident is minimized.

**Section 3: Negligence**

The legal definition of **negligence** is important for every teacher to know. **Negligence**, as defined by the courts today, **is conduct that falls below a standard of care established by law or profession to protect others from an unreasonable risk of harm, or the failure to exercise due care**.

It is understood that a teacher has the legal duty of one person to another, notably as teacher to student. A breach of this duty may be defined as a) a failure to properly instruct; b) a failure to properly supervise; c) the witting use of damaged equipment; and/or d) a failure to report to the proper authorities unsafe conditions in the laboratory. The teacher is legal liable if any personal injury or monetary damage is caused to a student in the teacher's classroom as a result of a breach of duty when this legal breach is judged to be the proximate cause of injury or damage.

Legal action against a teacher stems from the presumption that he or she is the expert in the laboratory and, as such, has the responsibility to ensure that exercises and operations are carried out in a prudent and safe manner. Liability exists to the extent that an injury can be shown to be the result of some action or inaction on the part of the teacher.

**3.1 Degree of Negligence**

A teacher may be found fully, partially, or not at fault at all depending upon how the court judges culpability among the following:

1. A teacher may be deemed negligent if the teacher is judged to have been able to prevent or foresee the results of the action in the event he or she
2. allows a foolish or imprudent act to be committed
3. is careless in performing a demonstration
4. neglects to warn of any hazards associated with an exercise, operation or demonstration
5. neglects a pre-existing unsafe condition or fails to take corrective actions when he or she is able to do so independently of school administration.
6. The student's injuries were a result of the student's own action.

**3.2 Negligence in Tort Law**

1. Such a breach may arise in one of three ways:
2. **Misfeasance**: the defendant acts in an improper manner.
3. **Nonfeasance**: the defendant did not act at all when he or she had a duty to act.
4. **Malfeasance**: the defendant acts with a bad motive or inflicts deliberate injury.
5. Four elements must exist for a liability tort to be brought:
6. A legal duty of one person to another, as a teacher's duty to protect the students in his or her charge.
7. A breach of this duty existing between two parties.
8. Personal injury or monetary damages directly caused by the breach in legal responsibility.
9. Legal breach of responsibility judged to be the proximate cause of the injury or damage.

**Section 4: Protection Against Claims of Negligence**

In the event of a charge of negligence in the science laboratory, several parties are potentially liable: the state, the school district, the school board, the school administration, and the teacher.

Among persons potentially liable, the classroom teacher is most often considered to hold the accountable position. Legal action against a teacher stems from the presumption that he or she is the expert in the laboratory and, as such, has the responsibility to ensure that activities are carried out in a prudent and safe manner. To defend against claims of negligence, teachers should take the following steps:

**4.1 Know the Law**

All teachers should become familiar with state and federal statutes regarding laboratory safety (See Appendix C). If questions arise regarding accountability under a given law, these should be addressed to the appropriate legal representative for the district.

**4.2 Maintain a Safe Laboratory Environment:**

**4.2.1 Risk Assessment-Process Operations**

1. Science educators are always responsible for understanding the hazards of the chemicals which they handle and the procedures which they perform.
2. Before any work begins, a risk assessment should be conducted.
3. Work should proceed only if it can be done safely for the people and the environment.
4. Active procedures **cannot** be left unattended. Active procedures include weighing, charging, heating, refluxing, filtration, vacuum operations, pressure operations, flowing water, open containers, etc.
5. If the potential consequences of a procedure could not be prevented even if it is supervised (attended), then the procedure must be evaluated using the risk assessment procedure.

**4.2.2 Risk Assessments**

1. The purpose of a risk assessment is:
2. to identify the hazards that exist
3. to identify the consequences and probabilities of adverse occurrences
4. to identify necessary control systems to eliminate unacceptable consequences.
5. See Appendix A for checklists.

**4.3 Keep Detailed Written Records**

Document everything related to the establishment of a safe laboratory environment. This can be done in your lesson plan book, which can be, and often is, subpoenaed in legal cases concerning laboratory injuries. Documentation could include, but is not limited to,

1. signed safety contracts.
2. results of a safety quiz, oral, written, or computer based.
3. pre-lab tests with safety questions.
4. safety rules written into a laboratory notebook prior to performing the experiment.

**Section 5: State and Federal Legislation Governing Laboratory Management and Safety**

The design, construction and operation of elementary and secondary school science classrooms and laboratories are affected by a number of federal laws and the regulations of several federal agencies. Administrators and teachers must be aware of the requirements imposed by these laws and regulations. Each numbered paragraph below concerns a law or an agency whose requirements must be met by schools. Although there are areas of overlap, these paragraphs should act as a general statement on the specific areas that are the responsibility of each agency. The abbreviation “CFR” stands for Code of Federal Regulations.

**5.1 O.C.G.A 45-22-2** The Georgia Department of Labor: Division of Safety Engineering is in charge of enforcing **O.C.G.A 45-22-2– Public Employee Hazardous Chemical Protection and Right to Know Act of 1988** (See Appendix C)The Georgia Right-To-Know Law requires each employee (faculty, staff, student workers, full time employees, part time employees and/or temporary employees) to be provided with information and training on hazardous chemicals that they may be exposed to as part of their job.  At a minimum, basic level awareness training shall be provided at the time of initial assignment to the workplace. The state of Georgia does not require that each school or district have a CHP, but it does require **a written school safety plan.** A copy of the school's safety plan must be available to all employees. In addition, a copy must be on file in the nurse's office, the Facilities and Maintenance Department, and the central office.

The **chemical hygiene plan** (CHP) is not a requirement by the State Board of Education or the state government but a requirement of Federal and State Occupational Safety and Health Administration. (OSHA) as of January 31, 1991. Furthermore, this CHP is required for all middle and secondary schools. Elementary schools that have a separate laboratory for science also require a CHP. At a minimum, a copy of the school's CHP must be available to all employees. In addition, a copy must be on file in the nurse's office, the Facilities and Maintenance Department, and the central office.

**5.2 Americans with Disabilities Act (ADA)**

Public schools are required to comply with provisions of the Americans with Disabilities Act of 1990. Students with disabilities are entitled to a level of laboratory experience appropriate to the individual student. (See Appendix C for references)

**5.3 Environmental Protection Agency (EPA)**

The Environmental Protection Agency regulates the disposal of hazardous wastes, including wastes from academic laboratories. One or more sections of the following parts of 40CFR are of interest to teachers: 261-2, 266 and 268 (See Appendix C).

**5.4 Department of Transportation (DOT)**

Whenever chemicals or hazardous wastes are transported (except between buildings of a single campus), the materials must be packaged in accordance with DOT regulations. Sections 171-77 of 49CFR contain information relevant to school science programs.

### 5.5 Emergency Planning and Community Right-to-Know Act (EPCRA)

Congress enacted EPCRA in 1986 to establish requirements for federal, state and local governments, tribes, and industry regarding emergency planning and "community right-to-know" reporting on hazardous and toxic chemicals. The community right-to-know provisions help increase the public's knowledge and access to information on chemicals at individual facilities, their uses, and releases into the environment. States and communities, working with facilities, can use the information to improve chemical safety and protect public health and the environment. This law includes the rights of students to be informed of the hazards to which they are being exposed in the laboratory.

**5.6 The Resource Conservation and Recovery Act (RCRA)** is a federal law that provides, in broad terms, the general guidelines for the waste management program envisioned by Congress. It includes a Congressional mandate directing EPA to develop a comprehensive set of regulations to implement the law. The hazardous waste program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal - in effect, from “cradle to grave.”

In any given state, the EPA or the state hazardous waste regulatory agency enforces hazardous waste laws. The EPA encourages states to assume primary responsibility for implementing a hazardous waste program through state adoption, authorization, and implementation of the regulations.

**5.7 The Occupational Safety and Health Act** The Occupational Safety and Health Act (OSHA) of 1970 helped clarify and recognize many health and safety concerns. The purpose of OSHA is to ensure that employers provide a safe and healthy working environment for employees, including all teachers—public, charter and private. Although OSHA covers employees but not students, prudent school personnel will provide a safe and healthy learning environment for students by following federal, state and local health and safety codes / regulations.

There are over 100 OSHA standards that are applicable to K-16 schools – most requiring professional development for employees. Professional development is required before an employee reports to duty rather than after an accident occurs. While “after the accident” professional development may prevent future accidents, it does nothing to prevent accidents that have occurred or provide aid in liability protection for employers or employees.

Key OSHA standards that effect schools requiring professional development for employees and a written program are:

**5.7.1 29 CFR §1910.132 Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine Personal Protective Equipment (PPE) needs and employees must be trained in use and care of PPE. Teachers must also train their students.

**5.7.2 29 CFR §1910.1030 (1991) Bloodborne Pathogens Standard** Employers are required to develop a plan to control blood borne pathogen exposure (such as HIV and Hepatitis B) and universal precautions to prevent exposure to employees. All other body fluids are covered under this standard as well.

**5.7.3 29 CFR §1910.38 Emergency Action Plan r**equires addressing of emergencies such as fire, toxic chemical spills releases, weather and weather related emergencies and others. Emergency evacuation routes and emergency action training is required for employees and, of course, students. Homeland security and many states have added requirements to address issues such as school violence and terrorism.

**5.7.4 29 CFR §1910.1450 (1990) - Occupational Exposure to Hazardous Chemicals in Laboratories Standard** OSHA defines a “Laboratory” as a facility where the “laboratory use of hazardous chemicals” occurs. It is a workplace where relatively small quantities of hazardous chemicals are used on a non-production basis.” A hazardous chemical is defined as a “chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic systems, and agents which damage the lungs, skin, eyes or mucous membranes.”

**5.7.5 General Duty Clause (GDC), Section 5(a)(1) of the William-Steiger OSH Act 29 CFR 654(a)(1)**: There is one standard that covers all hazardous conditions. This is known as the **General Duty Clause (GDC), Section 5(a)(1) of the William-Steiger OSH Act 29 CFR 654 (a)(1)**: “Each employer shall furnish to each of his (sic) employees a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees.”

OSHA does classify schools as an industry, and OSHA inspectors can issue a citation to an employer for any workplace hazard not covered by other OSHA standards. The Standard Industrial Classification (SIC) Code given to schools by OSHA is 8211.  OSHA does inspect schools. These inspections may be pre-planned, complaint-based by an employee or parent, or due to an accident.

**5.7.6 29 CFR §1910.1450 (1990) Occupational Exposure to Hazardous Chemicals in Laboratories Standard** The New Laboratory Standard with the Chemical Hygiene Plan. In May of 1990, the federal government passed an extension of the Hazard Communication Act written specifically for the research and academic laboratory. Most states also passed a version of the Laboratory Standard. Enforcement of the new Laboratory Standard began in January of 1991. The Laboratory Standard is very similar in many ways to the original law. The major difference is the requirement to have a Chemical Hygiene Plan and a Chemical Hygiene Officer. A Chemical Hygiene Plan (CHP) is a written report summarizing all safety regulations, proper laboratory procedures for handling hazardous chemicals, and training procedures. The CHP should include:

1. General laboratory rules and procedures
2. Personal protective equipment requirements
3. Spill and accident procedures
4. Chemical storage rules and procedures
5. Safety equipment requirements and inspection procedures
6. Employee safety training
7. Exposure and medical evaluations
8. Emergency evacuation plan

This regulation applies specifically to school science laboratories and must be followed as written to limit institutional and personal liability. Compliance to the requirements of this standard is mandatory. OSHA could site the school or local educational authority (LEA) for willful violation in the absence of a CHP or CHO.

**5.7.7 OSHA 29 CFR §1910.1450(b)** designates the Chief Executive Officer (CEO) of an organization as the Chemical Hygiene Officer (CHO). The Superintendent of the School district is the CHO of the School district until a designee is appointed. The Principal of a school is the CHO of the school until a designee is appointed.

**5.7.8 OSHA 29 CFR §1910.1450(b)** Regulation Defining CHO and Duties (Mandatory). **Chemical Hygiene Officer** means “an employee who is designated by the employer-and who is qualified by training or experience—to provide technical guidance in the development and implementation of the provision of the Chemical Hygiene Plan. This definition is not intended to place limitations on the position description or job classification that the designated individual shall hold within the employer’s organizational structure.” School system administrators must acknowledge that the CHO is responsible for the safety of students and staff alike. To be an effective CHO, the school administrators must provide the CHO needed time, support and sufficient resources to do a thorough job.

**5.7.9 29 CFR §1910.1450(e)(3)(vii) requires the d**esignation of personnel responsible for implementation of the Chemical Hygiene Plan including the assignment of a Chemical Hygiene Officer and, if appropriate, establishment of a Chemical Hygiene Committee.

**Section 6: Laboratory Safety Rules**

**6.1 General Rules**

1. Conduct yourself in a responsible manner at all times in the laboratory.
2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before proceeding.
3. Never work alone. No student may work in the laboratory without an instructor present.
4. When first entering a science room, do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.
5. Do not eat food, drink beverages, or chew gum in the laboratory. Do not use laboratory glassware as containers for food or beverages.
6. Perform only those experiments authorized by the instructor. Never do anything in the laboratory that is not called for in the laboratory procedures or by your instructor. Carefully follow all instructions, both written and oral. Unauthorized experiments are prohibited.
7. Be prepared for your work in the laboratory. Read all procedures thoroughly before entering the laboratory.
8. Never fool around in the laboratory. Horseplay, practical jokes, and pranks are dangerous and prohibited.
9. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the classroom area.
10. Keep aisles clear. Push your chair under the desk when not in use.
11. Know the locations and operating procedures of all safety equipment including the first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket. Know where the fire alarm and the exits are located.
12. Always work in a well-ventilated area. Use the fume hood when working with volatile substances or poisonous vapors. Never place your head into the fume hood.
13. Be alert and proceed with caution at all times in the laboratory. Notify the instructor immediately of any unsafe conditions you observe.
14. Dispose of all chemical waste properly. Never mix chemicals in sink drains. Sinks are to be used only for water and those solutions designated by the instructor. Solid chemicals, metals, matches, filter paper, and all other insoluble materials are to be disposed of in the proper waste containers, not in the sink. Check the label of all waste containers twice before adding your chemical waste to the container.
15. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions or by your instructor.
16. Keep hands away from face, eyes, mouth and body while using chemicals or preserved specimens. Wash your hands with soap and water after performing all experiments. Clean all work surfaces and apparatus at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
17. Experiments must be personally monitored at all times. You will be assigned a laboratory station at which to work. Do not wander around the room, distract other students, or interfere with the laboratory experiments of others.
18. Students are never permitted in the science storage rooms or preparation areas unless given specific permission by their instructor.
19. Know what to do if there is a fire drill during a laboratory period; containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off.
20. Handle all living organisms used in a laboratory activity in a humane manner. Preserved biological materials are to be treated with respect and disposed of properly.
21. When using knives and other sharp instruments, always carry with tips and points pointing down and away. Always cut away from your body. Never try to catch falling sharp instruments. Grasp sharp instruments only by the handles.
22. If you have a medical condition (e.g., allergies, pregnancy, etc.), check with your physician prior to working in lab.

**6.2 Clothing**

1. **Any time chemicals, heat, or glassware are used, students will wear laboratory goggles. There will be no exceptions to this rule!**
2. Contact lenses should not be worn in the laboratory unless you have permission from your instructor.
3. Dress properly during a laboratory activity. Long hair, dangling jewelry, and loose or baggy clothing are a hazard in the laboratory. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot. No sandals allowed.
4. Lab aprons have been provided for your use and should be worn during laboratory activities.

**6.3 Accidents And Injuries**

1. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.
2. If you or your lab partner are hurt, immediately yell out “Code one, Code one” to get the instructor’s attention.
3. If a chemical splashes in your eye(s) or on your skin, immediately flush with running water from the eyewash station or safety shower for at least 20 minutes. Notify the instructor immediately.
4. When mercury thermometers are broken, mercury must not be touched. Notify the instructor immediately.

**6.4 Handling Chemicals**

1. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemicals unless specifically instructed to do so. The proper technique for smelling chemical fumes will be demonstrated to you.
2. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need.
3. Never return unused chemicals to their original containers.
4. Never use mouth suction to fill a pipet. Use a rubber bulb or pipet pump.
5. When transferring reagents from one container to another, hold the containers away from your body.
6. Acids must be handled with extreme care. You will be shown the proper method for diluting strong acids. Always add acid to water, swirl or stir the solution and be careful of the heat produced, particularly with sulfuric acid.
7. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.
8. Never remove chemicals or other materials from the laboratory area.
9. Take great care when transporting acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

**6.5 Handling Glassware And Equipment**

1. Carry glass tubing, especially long pieces, in a vertical position to minimize the likelihood of breakage and injury.
2. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Place broken or waste glassware in the designated glass disposal container.
3. Inserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels or cotton gloves when inserting glass tubing into, or removing it from, a rubber stopper. If a piece of glassware becomes “frozen” in a stopper, take it to your instructor for removal.
4. Fill wash bottles only with distilled water and use only as intended, e.g., rinsing glassware and equipment, or adding water to a container.
5. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry before touching an electrical switch, plug, or outlet.
6. Examine glassware before each use. Never use chipped or cracked glassware. Never use dirty glassware.
7. Report damaged electrical equipment immediately. Look for things such as frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.
8. If you do not understand how to use a piece of equipment, ask the instructor for help.
9. Do not immerse hot glassware in cold water; it may shatter.

**6.6 Heating Substances**

1. Exercise extreme caution when using a gas burner. Take care that hair, clothing and hands are a safe distance from the flame at all times. Do not put any substance into the flame unless specifically instructed to do so. Never reach over an exposed flame. Light gas (or alcohol) burners only as instructed by the teacher.
2. Never leave a lit burner unattended. Never leave anything that is being heated or is visibly reacting unattended. Always turn the burner or hot plate off when not in use.
3. You will be instructed in the proper method of heating and boiling liquids in test tubes. Do not point the open end of a test tube being heated at yourself or anyone else.
4. Heated metals and glass remain very hot for a long time. They should be set aside to cool and picked up with caution. Use tongs or heat-protective gloves if necessary.
5. Never look into a container that is being heated.
6. Do not place hot apparatus directly on the laboratory desk. Always use an insulating pad. Allow plenty of time for hot apparatus to cool before touching it.
7. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

**THE LIFE SCIENCES:**

**ANATOMY AND PHYSIOLOGY, BIOLOGY,**

**AND**

**ENVIRONMENTAL SCIENCE**

**LABORATORIES**

Anatomy and Physiology teachers and their students face a wide range of potential hazards. This includes dangers associated with the chemicals used to preserve specimens, the use of dissection tools, and physical activities used in the study of human physiology. Effective control of such hazards involves both the recognition of each hazard and the development of control procedures.

**ANATOMY AND PHYSIOLOGY LABORATORIES**

## AP1: Required Materials for the High School Anatomy and Physiology Lab

1. Broken Glass Container
2. Sharps Disposal Box
3. Biohazard Bags
4. Household Bleach
5. Spill Kit
6. First Aid Kit
7. Fire Extinguisher
8. MSDS Notebook
9. Chemical Waste Disposal Containers

### AP2: Eye Protection

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

### AP2.1 What is your obligation?

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### AP 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress, or causes collisions
4. When dust or fumes are present
5. When using preserved specimens

### AP 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**AP 2.4 Disinfecting Goggles**

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between use of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### AP 2.5 What is the current recommendation for wearing contact lenses?

1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
5. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
6. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133, p. 16343.

**AP3: Glassware**

**AP 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**AP 3.2 General Cautions**

**AP 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**AP 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**AP 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**AP 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. When breaking tubing:
4. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
5. Scratch the glass once with a file or score.
6. Wrap the glass in a towel. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
7. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
8. Place the glass on insulating material to cool.

**AP 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**AP 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing.

**AP 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**AP 3.5 Cleaning**

1. Clean glassware immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**AP 3.6 Disposal**

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY**.
3. When handling broken glassware, wear gloves or use a dustpan and broom. Do not pick up broken glass with bare hands.

**AP 4: Microscope Handling**

1. **DO NOT ALLOW STUDENTS WITH ACTIVE EYE INFECTIONS TO USE MICROSCOPES!**
2. Provide students with alcohol wipes to clean lenses before or after use.
3. Microscopes must be carried upright, with one hand supporting the arm of the microscope and the other hand supporting the base. Nothing else should be carried at the same time.
4. Microscope must be positioned safely on the table, NOT near the edge.
5. After plugging the microscope into the electrical outlet, the cord should be draped carefully up onto the table and never allowed to dangle dangerously to the floor.
6. The coarse adjustment must NEVER be used to focus a specimen when the 40x or oil immersion lens is in place.
7. When finished with the microscope, the cord should be carefully wrapped around the microscope before returning it to the cabinet.
8. All prepared microscope glass slides are to be returned to their appropriate slide trays; wet mount preparations are to be disposed of properly.
9. Malfunctioning microscopes should be reported to the department chairperson/laboratory safety manager.

**AP 5: Dissections**

The use of preserved animal specimens in instruction should be carefully planned to provide learning that cannot otherwise be achieved. Dissection activities should enable students to develop a greater respect for life. **ALL**such activities, particularly those involving the use of vertebrates should be undertaken by students only when they are prepared and have the maturity to appreciate fully the significance of the instructional activity.

**AP 5.1 General Considerations**

1. Most biological supply houses sell specimens that are preserved in methanol or other low toxicity preservatives. When ordering new specimens for dissection, be aware that specimens preserved in formaldehyde are not permitted for use in the State of Georgia.
2. Some schools may have older specimens which are still stored in formaldehyde or formalin. Formaldehyde and formalin are listed as carcinogens by the EPA and are strong irritants. Good room ventilation is required when working with these specimens.
3. Any specimen held in a formalin solution should be soaked in a water bath in a fume hood for 24 hours and then thoroughly rinsed under running water for several minutes before use.
4. The soak solution should be placed into a hazardous waste container and appropriately labeled with the name of the contents, the amount of solution, and the date generated.
5. Facilities and Maintenance should be contacted for pick-up and disposal. Document the date of contact and the date of pick-up.
6. While not required, it is suggested that dissections should be performed **only** by those students who have obtained a permission note signed by a parent.
7. **Work surfaces should be decontaminated once per class and after any spill of materials. A 1:10 household bleach and water solution may be used for disinfection.**

**AP 5.2 Student Instruction**

1. **Students should be instructed in the safe use of dissection instruments.**
2. Scalpels and dissecting instruments should be sterilized before and after experiments.
3. Pointed dissection probes, scalpels, razor blades, scissors, and microtome knives must be used with great care, and placed in a safe position when not in use.
4. Scalpels and other sharp instruments are only to be used to make cuts in the specimen, never as a probe or a pointer.
5. Leave scalpel blades in the original package when pushing the scalpel onto the blade. Hold the blade in the package securely, keeping the cutting edge away from fingers. Use tweezers, forceps, or a hemostat to remove the blade, always pushing the blade away from the body.
6. Avoid holding the specimen in the hand during dissection. A waxed pan or similar device should be used for holding the specimen in place.
7. When cutting with a scalpel or other sharp instrument, forceps may be used to help hold the specimen. **NEVER** use fingers to hold a part of the specimen while cutting.
8. Cut down on the specimen and not up toward the body of the student or teacher.
9. Hands should be thoroughly washed after dissection activities.

**AP 5.3 Preserved Specimens**

1. When specimens are being removed from the preservative solution, rubber gloves should be worn or forceps or tongs should be used, depending on the size of the specimen.
2. Use chemical splash goggles to protect against splashes and fumes.
3. **Preserved specimens should be thoroughly washed (including the abdominal cavities of large specimens) before being handled by the students.**
4. Preservative fumes may be irritating to the eyes, nose, and throat. Adequate ventilation should be provided whenever preservative fumes are present.
5. Specimens are to be clearly labeled and stored in designated containers or cabinets when not in use.

**AP 5.4 Disposal**

1. **Body parts or scraps of the specimen should NOT to be disposed of in the sink or trash.**
2. **Body parts and tissue specimen should be placed into resealable plastic bags then placed into red biohazard bags. The bags should be labeled with the contents and the date the waste was generated.**
3. **Facilities and Maintenance should be contacted for pick up and disposal. Document the date pick-up was requested and the date it occurred.**
4. Containers designated for the disposal of sharps (scalpel blades, razor blades, needles; dissection pins, etc.) and containers designated for broken glass must be present in each laboratory. Never dispose of any sharp object in the regular trash containers.
5. All biohazardous disposable glass items (i.e., slides, cover slips, Pasteur pipets, etc.) dissecting pins. or other sharp objects must be disposed of properly in the **Biohazard Sharps Container, NOT** the regular trash or waste bags.

**AP 6: Spills**

Accidents do happen in the Anatomy and Physiology lab, and, in the event of a spill or accident, it is important that the teacher knows the correct procedures to follow.

**AP 6.1 Spills**

**A spill kit should be prepared prior to starting anatomy labs. It should include all items required to clean up a spill, including disinfectant, paper towel, gloves and plastic bags and containers for disposal.**

1. Students must report all spills to the teacher.
2. Only the teacher or laboratory safety manager should be allowed to clean up such spills.
3. If the spill is large or has caused a lot of splashing, aerosols may have been produced and the room should be evacuated for 90 minutes.

**AP 6.1.1 Liquid Spills**

1. Small (less than 1.0L) liquid spills should be covered with paper towels soaked in disinfectant (e.g. Sodium Hypochlorite with 1 % available chlorine) for at least 20 minutes.
2. The area should be cleaned with fresh paper towels soaked in disinfectant.
3. ALL paper towels should then be placed in a biohazard bag for disposal

* Make sure the bag is sealed and labeled.
* Notify Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred**.**

1. In the event of a large spill (1.0L or more):
2. Evacuate the room immediately.
3. Contact an administrator and then contact Facilities and Maintenance and provide the following information

* Your name and the name of the school
* Location of spill
* Content and approximate amount of spill
* Time of spill

**AP 6.1.2 Spills on the Body**

1. The teacher must be informed immediately.
2. Contaminated clothing should be removed and the affected area washed vigorously with soap and water.
3. Medical attention may be sought if required.
4. The incident must be documented in the first aid &/or OHSW records.
5. Contaminated clothing must be disinfected before washing.

**AP 6.1.3 Cuts and Puncture Wounds from Contaminated Sharp**

1. Immediate first aid must limit contamination to the wound and to first aid personnel.
2. Any cut or puncture wound, caused by contaminated glass or sharps, must receive immediate medical attention.

**AP 6.2 Contaminated Broken Glassware**

1. Contaminated broken glassware should never be picked up directly with the hands.
2. It should be cleaned up using aids such as brush and dustpan, forceps or cotton wool swabs.
3. Follow the procedure for liquid spills.
4. All aids must be disinfected following use

#### AP 7: Disposal and Cleanup

**AP 7.1 Disinfectants**

Disinfectants and antiseptics (disinfectants for use on living surfaces e.g. skin) vary in their ability to kill bacteria, viruses, fungi, spores and protozoa. Disinfectants should always be diluted and used according to the manufacturer's instructions. The Material Safety Data Sheet should also be consulted for specific protective equipment and ventilation requirements. The following types of disinfectants are suitable for use in schools.

**AP 7.1.1 Alcohols**

Alcohols have good activity on bacteria, and fungi but less on viruses and poor activity on spores. 70% ethanol is rapid acting and dries quickly. 90% ethanol is good for viruses. 100% ethanol is NOT an effective disinfectant. 60-70% Isopropyl Alcohol (Propan-2-ol) is also effective.

**AP 7.1.2 Chlorhexidine**

Chlorhexidine has good activity on gram-positive bacteria but less activity on gram negative bacteria, viruses and fungi and poor activity on spores. It has low toxicity and irritancy and so is a good antiseptic. 0.5% for face - 4% for other skin. It is often combined with alcohol, which may dry the skin.

**AP 7.1.3 Sodium Hypochlorite**

Household bleach has good activity on bacteria, fungi and viruses, but less activity on spores. Varying amounts of available chlorine in hypochlorite solutions are required for different purposes. They must be prepared fresh daily from the concentrated stock solution to ensure the correct level of available chlorine. 1% for spills, 0.25%for discard jars, 0.1% for cleaning benches and 0.05-0.1% for equipment and instruments.

**AP 7.1.4 Providone-Iodine**

Tincture of Iodine as 10% aqueous or alcoholic solutions is also suitable as skin disinfectant but it stains.

**AP 7.1.5 Other**

DO NOT USE quaternary Ammonia compounds as they are not effective disinfectants against many bacteria and viruses. Peracetic acid, aldehydes and phenolic disinfectants are considered too hazardous for use in schools.

**AP 7.2 General Cleanup**

All contaminated items should be decontaminated prior to reuse or disposal. Items for reuse should be immediately placed in disinfectant and soaked according to the manufacturer's instructions, prior to washing. (e.g. 25% Sodium Hypochlorite solution, soaked overnight)

**AP 7.2.1 Glassware and Sharps**

1. All biohazardous dissecting pins, scalpel blades, or other such items must be disposed of in the **Red** **Biohazard Sharps Container**, NOT in the regular trash.
2. All bio hazardous disposable glass items (i.e., slides, cover slips, Pasteur pipets, etc.) must be disposed of properly in the **Red** **Biohazard Sharps Container.**

**AP 7.2.2 Dissecting Pans**

1. All solid debris should be removed from the tray.
2. Dissecting pans should be washed with soapy water.
3. Allow the solution to sit in the pan for a minimum of 10 minutes, then rinse thoroughly and allow to air dry.

**AP 7.2.3 Dissecting Tools**

1. Scalpels, probes, and other related tools should be carefully wiped with a paper towel to remove solid debris.
2. Tools may be placed in a 5:1 ratio of water and hypochlorite solution or a similar alcohol solution to clean and sterilize them.
3. Tools should be allowed to sit in the solution for a minimum of 90 minutes; leaving them in the solution overnight is preferable.
4. If necessary, dissecting tools may be autoclaved.

**AP 8: Special Concerns**

**AP 8.1 Thermometers**

## MERCURY FILLED THERMOMETERS ARE NOT ALLOWED IN RCSS SCHOOLS.

1. Alcohol laboratory thermometers should be used in general laboratory activities.
2. For more advanced applications, a digital laboratory thermometer may be used.
3. Care should be taken to choose a digital thermometer that contains a changeable battery; some are not changeable.
4. The battery is a button cell battery and may contain 5-50 mg of mercury; it should be recycled through a battery collection program.

**AP 8.2 Using Microtomes**

Microtomes are commonly instruments used in laboratories to section tissues. These devices pose potential hazards to users during sectioning and/or the cleaning process. It is strongly recommended that teachers use prepared slides whenever possible.

**AP 8.2.1 Training**

1. Training must be documented and provided by a knowledgeable and responsible person within the laboratory before any work is completed.
2. Standard Operation Procedures should be made available to all users and posted near the point of operation.

**AP 8.2.2 Appropriate PPE**:

A lab apron, chemical splash goggles, and nitrile gloves must be worn while handling tissues to be sectioned.

**AP 8.2.3 Sharpness of Blade**

1. A microtome blade is extremely sharp and must be handled carefully.
2. The rotary handle of the microtome must always be set in the locked position when changing a paraffin block or the blade.
3. A new blade should be placed in the blade holder and clamped before the rotary wheel lock is released.
4. Wrist guards should be added where possible.
5. Once the blade is seated and secured the rotary wheel lock can be released and the knife and holder advanced to the specimen block.
6. If adjustments need to be made to the specimen, remove the blade from the housing.

**AP 8.2.4 Removal of the blade**

1. Disposable blades must always be removed using forceps or a similar instrument.
2. Do not remove the blade holder from the microtome with a blade present or transport the housing with the blade present. .
3. Dispose of used microtome blades in the Biohazard Sharps Container.
4. The Biological sharps container must be kept adjacent to the microtome to reduce the distance that a blade would be moved
5. For microtomes with reusable blades cut resistant gloves must be used when removing and sharpening the blade.

**AP 8.2.5 Microtome cleaning**

1. Before the microtome is cleaned, the rotary wheel must be locked and the blade removed from the blade holder.
2. Use caution other components of the microtome may also have sharp edges.
3. Cut resistant gloves must be worn under nitrile gloves when a microtome is being cleaned.
4. Follow manufacturer's recommendations for cleaning the microtome.
5. All use cleaning materials and solutions should be treated as hazardous waste and secured in the appropriate containers.
6. Contact Facilities and Maintenance for pick-up and disposal. Document the date the pick-up was requested and the date the pick-up occurred.

**AP 8.3 Using Centrifuges**

## AP 8.3.1 Operating Procedures

1. Check tubes for cracks/chips.
2. Use matched sets of tubes, buckets, etc.
3. Tightly seal all tubes and safety cups.
4. Ensure that rotor is locked to spindle and bucket seated.
5. Close lid during operation.
6. Allow to come to complete stop before opening.

## AP 8.3.2 Safe Operation

1. Use safety cups whenever possible.
2. Disinfect weekly and after all spills or breakages.
3. Lubricate O-rings and rotor threads weekly.
4. Do not operate the centrifuge without the rotor properly balanced.
5. Do not use rotors that have been dropped.
6. Contact your centrifuge rep for specific information.
7. If you suspect leakage occurred from the centrifuge, leave the area, do not open the centrifuge for at least 30 minutes to allow aerosols to settle, then access situation while wearing appropriate PPE and taking necessary precautions.

**AP 8.4 Human Studies**

1. **Any lab activity involving the use of bodily fluids or tissues collected from students is forbidden in RCSS laboratories.**
2. Non-invasive, nonstressful laboratory activities using students as experimental organisms are encouraged.
3. These include physiological measurements such as, pulse, heart rate, breathing rate, hearing, sight, etc.
4. These activities need to be closely supervised by the teacher due the risk of physical injury, heart palpitations, shortness of breath, overheating, fainting and death.

**AP 9: Chemical Safety in the Anatomy and Physiology Laboratory**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely

**AP 9.1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**AP 9.2 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**AP 9.2.1 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**AP 9.2.3 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration
7. Date prepared
8. Expiration or ―use by date

**AP 9.2.4 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**AP 9.3 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because a) the manufacturer no longer exists; or b) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**AP 9.4 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms
3. Chemicals should be stored in a central, secure location.
4. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern).
5. Store alphabetically within compatible groups.

**AP 9.5 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**AP 9.5.1 Chemical Waste Labeling**

1. Clearly and permanently label each container as to its contents and label as hazardous waste
2. All containers used for chemical waste should be labeled with the following:
3. HAZARDOUS WASTE
4. Chemical name (as it appears on the MSDS)
5. Accumulation start date
6. Hazard(s) associated with the chemical waste
7. Approximate amount
8. Date generated

**AP 9.5.2 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal.
2. The following waste categories should be used:

|  |  |
| --- | --- |
| * 1. Chlorinated Solvents   2. Cyanides   3. Hexavalent Chrome   4. High pH Alkaline Solutions   5. Hydrofluoric Acid   6. Low pH Acidic Solutions | 1. Nitric Acid 2. Non-Chlorinated Solvents 3. Oxidizers 4. Palladium 5. Reducing Agents 6. Sulfides |

**AP 9.5.3 Storage Guidelines**

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
4. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**AP 9.5.4 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when it occurred.

**AP 9.5.5 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**AP 9.6 Drug-Related Items**

1. **THE FOLLOWING SUBSTANCES ARE NOT ALLOWED IN RCSS LABS!**

|  |  |
| --- | --- |
| 1. **Acetaldehyde** | 1. **Histamine** |
| 1. **Adrenalin** | 1. **Nicotine** |
| 1. **Colchicine** | 1. **Testosterone** |
| 1. **Caffeine** | 1. **Thiourea** |
| 1. **Ethyl Alcohol (grain)** | 1. **Tobacco** |

**AP 10: Electrical Hazards**

**AP 10.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**AP 10.2 Electrical Safety**

**AP 10.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury.
8. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
9. They should only be recharged in a well-ventilated area with an appropriate charger.
10. Do not discard any battery in the trash.
11. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**AP 10.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**AP 10.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**AP 10.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**AP 10.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**AP 10.2.6 Power Cords**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**AP 11: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the event a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**AP 11.1 Preventing Burns and Fires**

**AP 11.1.1 When planning to heat materials or use open flames**

1. instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. make sure students know how to evacuate the classroom in the event of a large fire
3. know the location of the nearest fire extinguisher and know how to use it.
4. have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**AP 11.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. do not allow students to work with hot materials, such as very hot water.
5. do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**AP 11.1.3 When using Hot Plates**

1. do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. do not place the hot plate on paper or wooden surfaces.
3. place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. never leave the room while the hot plate is plugged in, whether or not it is in use.
5. keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**AP 11.1.4 When using open flames**

1. use only safety matches. Make sure the matches are stored in a secure place between uses.
2. closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. use tea candles that are short and wide, and cannot be knocked over in normal use.
5. place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. never leave the room while a flame is lit or other heat source is in use.

**AP 11.1.5 Bunsen Burner Safety Guidelines**

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do not leave open flames unattended and never leave the laboratory while the burner is on.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

**AP 11.2 In the event of a large, uncontainable fire**

1. evacuate the classroom immediately.
2. locate and pull the nearest fire alarm.
3. notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**AP 11.3 In the event of a small, containable fire**

1. identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**AP 11.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite. Periodically check on the location and condition of fire extinguishers.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

Biology teachers and their students face a wide range of potential hazards. In addition to chemical reagents, there are the hazards associated with the handling of organisms, classroom activities on the school grounds and outdoor study areas, and the containment of biological specimens. Effective control of such hazards involves both the recognition of each hazard and the development of control procedures.

**BIOLOGY LABORATORIES**

## 

## BIO 1: Required Materials for the High School Biology Lab

1. Broken Glass Container
2. Sharps Disposal Box
3. Biohazard Bags
4. Household Bleach
5. Fire Extinguisher
6. Spill Kit
7. First Aid Kit
8. MSDS Notebook
9. Chemical Waste Disposal Containers

### BIO 2: Eye Protection

### BIO 2.1 What is your obligation?

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### BIO 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. As a responsible teacher, you must select eyewear that provides you and your students with the most appropriate protection for the hazards of your science activities. Effective eye protection must include adequate instruction on the hazards of the particular activity and of the precautions to be followed to reduce the risk of injury. It must also include instructions and modeling of the protective equipment.

Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress (e.g., springs, wires, rubber, glass), or causes collisions
4. When dust or fumes are present (Eye protection reduces the dust or fumes reaching the eye.)
5. When using preserved specimens

### BIO 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**BIO 2.4 Disinfecting Goggles**

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes.. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### BIO 2.5 What is the current recommendation for wearing contact lenses?

* 1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
  2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
  3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
  4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
  5. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
  6. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133, p. 16343.

**BIO 3: Glassware**

**BIO 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**BIO 3.2 General Cautions**

**BIO 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**BIO 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**BIO 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**BIO 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score. Wrap the glass in a towel.
7. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
8. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner.
9. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
10. Place the glass on insulating material to cool.

**BIO.3.2.5 Bending.**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**BIO.3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**BIO 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**BIO.3.5 Cleaning**

1. Clean immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**BIO.3.6 Disposal**

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY**.
3. When handling broken glassware, wear gloves or use a dustpan and broom. Do not pick up broken glass with bare hands.

## BIO 4: Microscope Handling

1. **DO NOT ALLOW STUDENTS WITH ACTIVE EYE INFECTIONS TO USE MICROSCOPES!**
2. Provide students with alcohol wipes to clean lenses before or after use.
3. Microscopes must be carried upright, with one hand supporting the arm of the microscope and the other hand supporting the base. Nothing else should be carried at the same time.
4. Microscope must be positioned safely on the table, NOT near the edge.
5. After plugging the microscope into the electrical outlet, the cord should be draped carefully up onto the table and never allowed to dangle dangerously to the floor.
6. The coarse adjustment must NEVER be used to focus a specimen when the 40x or oil immersion lens is in place.
7. When finished with the microscope, the cord should be carefully wrapped around the microscope before returning it to the cabinet.
8. All prepared microscope glass slides are to be returned to their appropriate slide trays; wet mount preparations are to be disposed of properly.
9. Malfunctioning microscopes should be reported to the department chairperson/laboratory safety manager.

**BIO 5: Dissections**

The use of preserved animal specimens in instruction should be carefully planned to provide learning that cannot otherwise be achieved. Dissection activities should enable students to develop a greater respect for life. **ALL**such activities, particularly those involving the use of vertebrates should be undertaken by students only when they are prepared and have the maturity to appreciate fully the significance of the instructional activity.

**BIO 5.1 General Considerations**

1. Most biological supply houses sell specimens that are preserved in methanol or other low toxicity preservatives. When ordering new specimens for dissection, be aware that specimens preserved in formaldehyde are not permitted for use in the State of Georgia.
2. Some schools may have older specimens which are still stored in formaldehyde or formalin. Formaldehyde and formalin are listed as carcinogens by the EPA and are strong irritants. Good room ventilation is required when working with these specimens.
3. Any specimen held in a formalin solution should be soaked in a water bath in a fume hood for 24 hours and then thoroughly rinsed under running water for several minutes before use.
4. The soak solution should be placed into a hazardous waste container and appropriately labeled with the name of the contents, the amount of solution, and the date generated.
5. Facilities and Maintenance should be contacted for pick-up and disposal. Document the date of contact and the date of pick-up.
6. While not required, it is suggested that dissections should be performed **only** by those students who have obtained a permission note signed by a parent.
7. **Work surfaces should be decontaminated once per class and after any spill of materials. A 1:10 household bleach and water solution may be used for disinfection.**

**BIO 5.2 Student Instruction**

1. **Students should be instructed in the safe use of dissection instruments.**
2. Scalpels and dissecting instruments should be sterilized before and after experiments.
3. Pointed dissection probes, scalpels, razor blades, scissors, and microtome knives must be used with great care, and placed in a safe position when not in use.
4. Scalpels and other sharp instruments are only to be used to make cuts in the specimen, never as a probe or a pointer.
5. Leave scalpel blades in the original package when pushing the scalpel onto the blade.
6. Use tweezers, forceps, or a hemostat to remove the blade, always pushing the blade away from the body.
7. Avoid holding the specimen in the hand during dissection. A waxed pan or similar device should be used for holding the specimen in place.
8. When cutting with a scalpel or other sharp instrument, forceps may be used to help hold the specimen. **NEVER** use fingers to hold a part of the specimen while cutting.
9. Hands should be thoroughly washed after dissection activities.

**BIO 5.3 Preserved Specimens**

1. When specimens are being removed from the preservative solution, rubber gloves should be worn or forceps or tongs should be used, depending on the size of the specimen. Use chemical splash goggles to protect against splashes and fumes.
2. **Preserved specimens should be thoroughly washed (including the abdominal cavities of large specimens) before being handled by the students.**
3. Preservative fumes may be irritating to the eyes, nose, and throat. Adequate ventilation should be provided whenever preservative fumes are present.
4. When larger specimens are being dissected, the part of the specimen that is not being dissected should be kept enclosed in the plastic bag.
5. When dissecting smaller specimens, seal the bag or container after removing the specimen, so as to confine the preservative in the specimen bag.
6. Specimens are to be clearly labeled and stored in designated containers or cabinets when not in use.

**BIO 5.4 Disposal**

1. **Body parts or scraps of the specimen should NOT to be disposed of in the sink.**
2. **Body parts and tissue specimen should be placed into resealable plastic bags then placed into red biohazard bags. The bags should be labeled with the contents and the date the waste was generated.**
3. **Facilities and Maintenance should be contacted for pick up and disposal. Document the date pick-up was requested and the date it occurred.**
4. Containers designated for the disposal of sharps (scalpel blades, razor blades, needles; dissection pins, etc.) and containers designated for broken glass must be present in each laboratory. Never dispose of any sharp object in the regular trash containers.
5. All bio hazardous disposable glass items (i.e., slides, cover slips, Pasteur pipets, etc.) must be disposed of properly in the **Biohazard Sharps Container, NOT** the regular trash or waste bags.
6. Dispose of dissecting pins or other sharp objects in **Biohazard Sharps Container, NOT** inthe Waste Container, waste bags, or regular trash.

**BIO 5.5 Cleaning Dissecting Pans**

1. All solid debris should be removed from the tray.
2. Dissecting pans should be washed with soapy water.
3. Dissecting pans should be sterilized with a 5:1 ratio of water and hypochlorite solution.
4. Allow the solution to sit in the pan for a minimum of 10 minutes, then rinse thoroughly and allow to air dry.

**BIO 4.6 Cleaning Dissecting Tools**

1. Scalpels, probes, and other related tools should be carefully wiped with a paper towel to remove solid debris.
2. Place the paper towel into the waste bag containing discarded body parts and tissues.
3. Tools may be placed in a 5:1 ratio of water and hypochlorite solution or a similar alcohol solution to clean and sterilize them.
4. Tools should be allowed to sit in the solution for a minimum of 90 minutes; leaving them in the solution overnight is preferable.
5. If necessary, dissecting tools may be autoclaved.

**BIO 6: Experiments with Bacteria and Fungi**

This section pertains primarily to the use of viruses, bacteria, and other microscopic organisms. The handling of these pathogens is treated in 29CFR 1910.1030. This publication covers definitions, exposure control, specific procedures and protocols to comply with the regulations, precautions for specific pathogens, signs, labels, training, and record keeping. Proper laboratory technique is the basis for all cautions in this section.

Essential equipment for working with microorganisms includes:

1. Sterilization equipment (autoclave, heat sterilizer, or pressure cooker) for media preparation, sterilization of glassware and equipment, and decontamination of disposable material
2. Sterile transfer equipment (micropipetters with disposable tips or sterile pipets) for safe transfer of microorganisms
3. Adequate work space and equipment to prepare media
4. Proper storage facilities, including refrigeration and incubation equipment
5. Supplies for cleaning up and disinfecting work areas
6. Pipets Due to the nature of microorganisms, the use of disposable pipets, pipet tips, dishes and culture plates, etc. is recommended. If you use nondisposable glassware, take care to properly decontaminate it.
7. Special trash containers for all cultures for proper sterilization and disposal
8. Petri dishes for use with noninfectious materials

**BIO 6.1 General Considerations**

1. Disinfect work surfaces at least once a day (or after each class), and after any spill of active cultures.
2. NEVER pipette by mouth. Pipetting bulbs or pumps should always be used.
3. Wash hands with antibacterial soap when entering and prior to leaving the laboratory, and any time viable cultures are handled.
4. Wear eye protection, aprons, and gloves.
5. Cultures should be kept to the minimum size and number required to do the job.

**BIO 6.2 Incubation Temperature**

The incubation temperature should be restricted to an upper limit of 30oC to reduce the danger of isolating pathogens adapted to human body temperature.

**BIO 6.3 Culturing from the Environment**

**MICROORGANISMS MAY NOT BE CULTURED FROM THE ENVIRONMENT** **IN ANY RCSS LAB UNLESS PRIOR PERMISSION IS OBTAINED FROM DAWN PHILLIPS, ED.S.**

**BIO 6.4 Culturing Commercial Organisms**

1. **PATHOGENIC BACTERIA MAY NOTBE CULTURED IN ANY RCSS LAB.**
2. Only pure cultures of nonpathogenic microorganisms should be used in experiments.
3. Petri dishes passed around the classroom for inspection of cultures should be bound together with transparent tape.
4. Any petri dish that contains fungus should be taped shut.

### BIO 6.5 Special Concerns in the Study of Fungi and Molds

1. Only commercially prepared fungal and mold cultures are allowed in RCSS labs.
2. **MOLDS AND FUNGAL SPORES MAY NOT BE CULTURED FROM THE ENVIRONMENT** due to the risk of dangerous infections in individuals with compromised immune systems, asthma, and chronic illnesses.

**BIO 6.6 Loops**

1. Wire loops used for transferring bacteria cultures should be flamed until the *entire* wire is **red**hot before and after each transfer is made.
2. Inoculating loops must be used with care.
3. A hot loop inserted into a liquid may cause spattering. Loops should be allowed to cool before insertion into liquids.
4. The procedure may require the use of more than one loop so that as one is being used, others are cooling.
5. When a contaminated loop is inserted into a flame for sterilization, an aerosol may be generated by the boiling and volatilization of the material before the flame can kill all pathogenic microorganisms.

**BIO 6.7 Bunsen Burner Safety Guidelines**

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do not leave open flames unattended and never leave the laboratory while the burner is on.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

**BIO 6.8 Spills & First Aid**

1. **A spill kit should be prepared prior to starting microbiology labs. It should include all items required to clean up a spill, including disinfectant, paper towel, gloves and plastic bags and containers for disposal.**
2. Students must report all spills to the teacher.
3. Only the teacher or laboratory safety manager should be allowed to clean up such spills.
4. When cleaning spills disposable gloves must be worn.

**BIO 6.8.1 Liquid Spills**

1. Small (less than 1.0L) liquid spills should be covered with paper towels soaked in disinfectant (e.g. Sodium Hypochlorite with 1 % available chlorine) for at least 20 minutes.
2. The area should be cleaned with fresh paper towels soaked in disinfectant.
3. ALL paper towels should then be placed in a biohazard bag for disposal
4. Make sure the bag is sealed and labeled.
5. Notify Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred**.**
6. In the event of a large spill (1.0L or more):
7. Evacuate the room immediately.
8. Contact an administrator and then contact Facilities and Maintenance and provide the following information

* Your name
* The name of the school
* Location of spill
* Content of spill
* Amount of the spill
* Time of spill

**BIO 6.8.2 Spills on the Body**

1. The teacher must be informed immediately.
2. Contaminated clothing should be removed and the affected area washed vigorously with soap and water.
3. Medical attention may be sought if required.
4. The incident must be documented in the first aid &/or OHSW records.
5. Contaminated clothing must be disinfected before washing.

**BIO 6.9 Contaminated Broken Glassware**

1. Contaminated broken glassware should never be picked up directly with the hands.
2. It should be cleaned up using aids such as brush and dustpan, forceps or cotton wool swabs.
3. Follow the procedure for liquid spills.
4. All aids must be disinfected following use

**BIO 6.10 Sterilization**

1. Broth cultures should be sterilized by either autoclaving or adding a suitable disinfectant (SEE SECTION BIO **8.1 Disinfectants).** Once sterilized it may be poured down the sink.
2. If you are trying to sterilize soil samples or large volumes of culture, continue with the following procedure:
3. Wait one day for any resistant spores to leave the resting stage and begin to grow.
4. Sterilize a second time. Wait one day. Sterilize a third time.
5. **All resistant spores should by now be killed. The plate may be safely opened for cleaning or discarded in the regular trash.**

**BIO 6.11 Used Petri Dishes**

1. **Note: Most plastic containers and equipment, such as plastic petri dishes, are not autoclavable.**
2. Autoclaves, heat sterilizers, and pressure cookers should be run only by the teacher or professional aide or by the student aide if he/she is under the direct supervision of the teacher or professional aide. The teacher, professional aide, and student aide should be knowledgeable about the operating instructions of the pressure cooker, autoclave, or heat sterilizer.
3. Prior to disposal the Petri dishes should be taped shut with masking tape (**do not use duct tape**). Once the Petri dishes have been taped shut, they should not be opened again.
4. To sterilize plates before cleaning or disposal, follow these steps:
5. The teacher should carefully read instructions before using an autoclave or pressure cooker.

* If using a pressure cooker, make sure the safety valve is in good working order.
* Materials may be sterilized by using 15 pounds of pressure at 121°C for 20 minutes.
* Use approved eye protection and allow the pressure to return to zero before removing the cover or door.
* Open the stop cock on a pressure cooker and wait until the hissing stops before releasing any clamps. Lift the lid so it is tilted away from the teacher to protect from heat and steam.

1. Autoclave the unopened plates in the usual manner. Usually, steaming under pressure of 15 pounds per square inch for 15 to 20 minutes kills the majority of microbes.
2. If autoclaves or pressure cookers are not available or large enough an alternative is to bleach the plates.

* Saturate the plates with a 20% or "1 in 5" household bleach solution (in other words, 1 part bleach and 4 parts water). Let them sit and soak overnight in the bleach solution before disposing of them.

1. **Please note that the bleach solution is corrosive and needs to be properly disposed of after use.**

* The bleach solution should be stored in a Hazardous Waste Container that is appropriately labeled.
* Facilities and maintenance should be contacted for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

1. After the plates are removed, they should be sealed in a hazardous waste bag, labeled and dated.
2. Facilities and maintenance should be contacted for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

**BIO 7: DNA Study**

Work with deoxyribonucleic acid (DNA) is at the core of many of the hands-on activities in molecular biology and biotechnology that have been introduced into the high school biology laboratory. The study of the chemical and physical properties of DNA often involves the spooling, isolation, enzymatic digestion, gel electrophoresis, and manipulation of bacterial cells to introduce new genetic information. Many such laboratory activities can be purchased as complete kits that provide documentation and guidelines helpful to both students and teachers. These kits are especially recommended for teachers who are not familiar with standard procedures in research laboratories. Safety, as always, is a crucial part of any molecular biology experience. **Research requiring containment is prohibited by federal law.**

**BIO 7.1 Electrophoresis**

Electrophoresis, a technique which separates molecules based on their electrical charge, is frequently used in today's laboratories. **Be aware that ALL components of an electrophoresis gel require an MSDS and that students and other individuals must be informed of all risks prior to use.**

**BIO 7.1.1 Handling Electrophoresis Chambers**

Precautions to prevent electrical shock and using electrophoresis apparatus safely include:

1. Turn the power off before connecting the electrical leads.
2. Connect one lead at a time using one hand only.
3. Insure that your hands are dry while connecting the leads.
4. Keep the apparatus away from sinks or other water sources.
5. Turn off power before opening lid or reaching inside chamber.
6. Don't override safety devices.
7. Don't run electrophoresis equipment unattended.

**BIO 7.2 Electrophoresis Gels and Additives**

Many of the commonly used electrophoresis gels are harmless, but the additives can be extremely hazardous.

**BIO 7.2.1 Ethidium bromide**

Ethidium bromide is an intercalating agent commonly used as a fluorescent tag (nucleic acid stain) in molecular biology laboratories for techniques such as agarose gel electrophoresis. It is a mutagen and should be handled with caution, even when mixed in the gel.

**BIO 7.2.2. Formamide**

Formamide is also used as an RNA stabilizer in gel electrophoresis by deionizing RNA. In capillary electrophoresis, it is used for stabilizing (single) strands of denatured DNA. Also known as **methanamide**, is an amide derived from formic acid. It is a clear liquid which is miscible with water and has an ammonia-like odor. Formamide is highly corrosive on contact with skin or eyes and may be deadly if ingested. Inhalation of large amounts of formamide vapor may require medical attention. It is also a teratogen.http://en.wikipedia.org/wiki/Formamide Formamide should never be handled without proper safety attire including gloves and goggles. There is a small risk of decomposition into hydrogen cyanide and water.

**BIO 7.2.3 Acrylamide**

In recent years polyacrylamide gels have been prepared in some school laboratories to achieve the isolation of specific molecules by electrophoretic techniques. Schools are cautioned to cease this practice because acrylamide poses a potentially serious health hazard as a neurotoxin. This substance has been classified as 2B (possibly carcinogenic to humans) by the International Agency for Research on Cancer (IARC).

Because there is a serious risk of inhalation exposure during the weighing of acrylamide powder for the preparation of gels, schools should purchase only pre-poured polyacrylamide gels from laboratory supply houses. The pre-poured gel presents less health risk because the acrylamide has chemically reacted to form a solid gel. Once the gel has solidified and been rinsed, very little of the raw acrylamide remains. Gloves should be worn at all times to prevent dermal exposure to any residual acrylamide found on the gels. To avoid the hazard altogether, schools can purchase pre-poured gels made with acrylamide substitutes.

**BIO 7.2.4 TAE buffer**

TAE buffer is a [buffer solution](http://en.wikipedia.org/wiki/Buffer_solution) containing a mixture of [Tris base](http://en.wikipedia.org/wiki/Tris_base), [acetic acid](http://en.wikipedia.org/wiki/Acetic_acid) and [EDTA](http://en.wikipedia.org/wiki/EDTA).

In molecular biology EDTA is used in agarose [electrophoresis](http://en.wikipedia.org/wiki/Electrophoresis) typically for the separation of [nucleic acids](http://en.wikipedia.org/wiki/Nucleic_acids) such as [DNA](http://en.wikipedia.org/wiki/DNA) and [RNA](http://en.wikipedia.org/wiki/RNA). It is made up of [Tris-acetate](http://en.wikipedia.org/wiki/Tris-acetate) buffer, usually at pH 8.0, and [EDTA](http://en.wikipedia.org/wiki/EDTA), which sequesters divalent cations. It is extremely irritating to the skin, eyes, and the upper respiratory tract. It is easily absorbed through the skin and is a mutagen. It is harmful if swallowed or inhaled.

**BIO 7.2.5 Stains**

[Bromophenol blue](http://en.wikipedia.org/wiki/Bromophenol_blue), [Orange G](http://en.wikipedia.org/wiki/Orange_G), [xylene cyanol](http://en.wikipedia.org/wiki/Xylene_cyanol), and [Coomassie Brilliant Blue](http://en.wikipedia.org/wiki/Coomassie_Brilliant_Blue) are just 4 of the many stains commonly used in electrophoresis. ALL stains have hazards associated with them; carefully read the MSDS for each stain you use and make sure that you and all other individuals take the necessary precautions when using them.

**BIO 7.3 Electrophoresis Waste Disposal Guidance**

The following three types of wastes are commonly generated from electrophoresis methods in RCSS labs:

**BIO 7.3.1 Stock Solutions**

1. Collect all electrophoresis stock solutions in an appropriately sized container. The container cap should be closed securely when the container is not in use.
2. Label all electrophoresis stock solutions. Indicate on the label that it is a liquid waste, and check off the appropriate constituent box on the label.
3. Contact Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

**BIO 7.3.2 Electrophoresis Gels and Contaminated Non-Sharp Debris, (i.e. gloves, tips, paper towels, etc.)**

1. Collect electrophoresis gels and contaminated non-sharp debris screw-top pails with a clear plastic liner. The container lid should be closed securely when the container is not in use.
2. Label electrophoresis gels and contaminated non-sharp debris. Indicate on the label that it is a solid waste, and check off the appropriate constituent box on the label.
3. Contact Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

**BIO 7.3.3 Electrophoresis Buffer Solutions and Filtration**

Buffer solutions containing must be collected for disposal by following the directions above for disposal of stock solutions.

**BIO 73.4 Electrophoresis wastes containing acrylamide or polyacrylamide**

**Electrophoresis wastes containing acrylamide or polyacrylamide must be managed as hazardous waste.**

**BIO 7.3.4.1 Disposal of Hazardous Waste**

1. **The use of sinks for the disposal of chemicals is strictly prohibited!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site.
8. Contact Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

**BIO 7.3.4.2 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. Contact Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred.

**BIO 8: Disposal and Cleanup**

**BIO 8.1 Disinfectants**

Disinfectants and antiseptics (disinfectants for use on living surfaces e.g. skin) vary in their ability to kill bacteria, viruses, fungi, spores and protozoa. Disinfectants should always be diluted and used according to the manufacturer's instructions. The Material Safety Data Sheet should also be consulted for specific protective equipment and ventilation requirements. The following types of disinfectants are suitable for use in schools.

**BIO 8.1.1 Alcohols**

Alcohols have good activity on bacteria, and fungi but less on viruses and poor activity on spores. 70% ethanol is rapid acting and dries quickly. 90% ethanol is good for viruses. **100% ethanol is NOT an effective disinfectant**. 60-70% Isopropyl Alcohol (Propan-2-ol) is also effective.

**BIO 8.1.2 Chlorhexidine**

Chlorhexidine has good activity on gram-positive bacteria but less activity on gram negative bacteria, viruses and fungi and poor activity on spores. It has low toxicity and irritancy and so is a good antiseptic. 0.5% for face - 4% for other skin. It is often combined with alcohol, which may dry the skin.

**BIO 8.1.3 Sodium Hypochlorite**

Household bleach has good activity on bacteria, fungi and viruses, but less activity on spores. Varying amounts of available chlorine in hypochlorite solutions are required for different purposes. They must be prepared fresh daily from the concentrated stock solution to ensure the correct level of available chlorine. 1% for spills, 0.25% for discard jars, 0.1% for cleaning benches and 0.05-0.1% for equipment and instruments.

**BIO 8.1.4 Providone-Iodine**

Tincture of Iodine as 10% aqueous or alcoholic solutions is also suitable as skin disinfectant but it stains.

**BIO 8.1.5 Other**

DO NOT USE quaternary Ammonia compounds as they are not effective disinfectants against many bacteria and viruses. Peracetic acid, aldehydes and phenolic disinfectants are considered too hazardous for use in schools.

**BIO 8.2 General Cleanup**

All contaminated items should be decontaminated prior to reuse or disposal. Items for reuse should be immediately placed in disinfectant and soaked according to the manufacturer's instructions, prior to washing. (e.g. 25% Sodium Hypochlorite solution, soaked overnight)

**BIO 8.2.1 Glassware and Sharps**

1. All biohazardous dissecting pins, scalpel blades, or other such items must be disposed of in the **Red** **Biohazard Sharps Container**, NOT in the regular trash.
2. All bio hazardous disposable glass items (i.e., slides, cover slips, Pasteur pipets, etc.) must be disposed of properly in the **Red** **Biohazard Sharps Container.**

**BIO 8.2.3 Broth Cultures**

1. Broth cultures should be sterilized by either autoclaving or addition of a suitable disinfectant. (e.g. enough sodium hypochlorite to bring the culture to 1% solution, left overnight).
2. Once sterilized it may be poured down the sink.

**BIO 8.2.4 Incubator**

Following use the incubator must be thoroughly cleaned and disinfected with an appropriate disinfectant. (e.g. 0.1% sodium hypochlorite)

**BIO 9: Chromatography**

1. Chemical splash safety goggles and aprons should be worn.
2. Only water baths or hot plates with water baths (and not open-flame fires) should be used for chlorophyll extraction. Extraction may also be accomplished by leaving the plant material in the solvents overnight at room temperature.
3. Only Pyrex or comparable glass tubes should be used.
4. Dissolving and developing solvents give off toxic vapors. They must be stored in closed containers and the room
5. Solvents are highly flammable and must not be used near an open flame.
6. Avoid skin contact when spraying the developing solvents.
7. Use a fume hood when appropriate.

**BIO 10: Radiation/Radioisotopes**

**Activities involving radioactive material of any type is forbidden in RCSS laboratories.**

**BIO 11: Water Chemistry**

Water chemistry kits contain a variety of hazardous chemicals. All necessary precautions must be taken in order to avoid injury.

1. Students must wear goggles, gloves, and closed toes shoes when performing water chemistry.
2. Students should be closely supervised to make sure they are following instructions.
3. Students should be provided with a hazardous waste container in which to place rinse water and analyzed samples.
4. This container should the labeled with the name of the teacher, the contents, the approximate amount of solution, and the date the waste was generated.
5. Facilities and Maintenance should be contacted for pick-up and disposal. Document the date the request was made and the date on which the waste was picked up.

**BIO 12: Animals in the Classroom**

**BIO 12.1 Introduction**

The use of live animals in the classroom can help students understand and appreciate life processes. Before bringing animals into the classroom, teachers should check the school or school system policy. It is important to select animals that are appropriate to the instructional needs and are practical to maintain. Good safety procedures should be established for the protection of students from the hazards of classroom animals as well as to ensure the humane treatment of animals.

The humane treatment of animals in research and teaching is a sensitive issue. The Council of State Science Supervisors, the National Association of Biology Teachers, the National Science Teachers Association, the Humane Society of the United States, the Animal Welfare Institute, and the National Society for Medical Research all have established guidelines and position papers supporting the safe and humane treatment of animals used for the cause of science.

The following websites offer more information on this topic:  
[www.enc.org/csss/index.html](http://www.enc.org/csss/index.html) - Eisenhower National Clearing House

[www.nabt.org](http://www.nabt.org) - National Association of Biology Teachers  
www.nsta.org - National Science Teachers Association  
[www.hsus.org/programs/research/animals\_education.html](http://www.hsus.org/programs/research/animals_education.html)

[www.animalwelfare.com](http://www.animalwelfare.com) - Animal Welfare Institute

**BIO 12.2 Before You Bring Animals into the Classroom**

**BIO 12.2.1 Permission to Keep Live Animals on Campus**

You must complete a **Richmond County School System Permission to Keep Live Animals on Campus (**Appendix A) and submit it to the Curriculum and Instruction Department attn. Science Curriculum Department. It will help you think through some necessary planning measures such as animal enclosure options, how the enclosure will be cleaned, and weekend, holiday and summer care arrangements.

**BIO 12.2.2 Parental Notification**

You must obtain **Parental Notification Forms** (Appendix A)**.** It is not recommended that students be permitted to handle any animal(s) or be given caring or cleaning duties without prior parental/legal guardian consent.

**BIO 12.2.3 Hand Washing Education**

You must educate all students, paraprofessionals, and adult volunteers on proper hand washing. If anyone does handle an animal, they should wash their hands with hot soapy water for at least 60 seconds (instant hand sanitizers should only be used in addition to proper hand washing, NOT IN LIEU OF).

**BIO 12.2.4 Educational Purposes**

Animals in the classroom must have an educational purpose. Classroom animals should be limited to animals that are bred in captivity, and necessary to achieve the learning objectives. Wild animals can be a source of infectious agents, parasites, and are likely to bite.

**BIO 12.2.5 Healthy Animals**

Make sure all animals are healthy**.** All potential classroom animals should be examined by a veterinarian prior to being introduced to a classroom. The animals should be up to date on all vaccinations recommended by the veterinarian, and follow all of the veterinarian’s guidance on proper handling, habitat, feeding, care, and other conditions for the particular type of animal(s).

**BIO 12.2.6 Allergies**

##### Be aware of allergic reactions. Allergies and sensitivities of students should be considered before bringing any animal into the classroom, and students should be observed for signs that they are becoming sensitive to an animal (allergies can develop at any time). Please communicate with parents to determine what allergies and sensitivities are known.

**BIO 12.2.7 Special Permits**

Avoid animals requiring special permits. Some animals require a written permission from the local health department, the Georgia Department of Natural Resources, and/or the United States Department of Agriculture to be kept in a classroom setting. These include venomous and nonvenomous snakes, wild turtles, certain species of frogs, wild newts and salamanders, hogs, deer, cattle, alligators, crocodiles, caimans, wild fowl, and all domestic fowl. DO NOT attempt to keep any of the animals mentioned above.

**BIO 12.2.8 Animals Not Allowed in Richmond County Schools**

1. Farm animals excrete *E. coli* O157:H7, *Salmonella*, *Campylobacter*, and *Cryptosporidium* intermittently and in substantial numbers; therefore these animals are not appropriate unless meticulous attention to personal hygiene can be assured.
2. Mammals at high risk for transmitting rabies (e.g., bats, raccoons, skunks, foxes, and coyotes) are not appropriate as residents in the classroom.
3. Nonpsittacine birds (any bird other than parrots, parakeets, and cockatiels).
4. Inherently dangerous animals (e.g., lions, tigers, cougars, and bears).
5. Nonhuman primates (e.g., monkeys and apes).
6. Mammals at higher risk for transmitting rabies (e.g., bats, raccoons, skunks, foxes, and coyotes).
7. Aggressive or unpredictable animals, wild or domestic.
8. Stray animals with unknown health and vaccination history.
9. Venomous or toxin-producing spiders, insects, reptiles, and amphibians.

**BIO 12.3 Housing and Caring for Your Classroom Animal(s)**

**BIO 12.3.1 Habitats**

Ensure that a proper habitat can be kept for the animal(s) (free of drafts and harsh sunlight). Also consider what type of care the animal will receive over weekends, and during school breaks (paying close attention to building heat and air conditioning status during times when school is not in session).

**BIO 12.3.2 Food**

Store all animal food in rigid containers with tight fitting lids to prevent access to food by pests. Also, some animals require fresh foods that may require refrigeration, or live foods. Should this be the case, make sure you have necessary equipment before bringing the animal in to the classroom. Food and water bowls should be thoroughly scrubbed and rinsed with hot soapy water.

**BIO 12.3.3 Enclosures**

Animals should be housed in an enclosure constructed from a nonporous material that is easily cleanable. Cleaning of animal(s) enclosures should be done as often as necessary to keep the animal healthy, prevent odors from building up, and eliminate any unsanitary conditions. It should be noted that cleaning and disinfection may be necessary as often as daily, however it should be done weekly at a minimum.

**BIO 12.3.4 Sanitation**

Enclosures should be sanitized after each cleaning with a fresh bleach solution (4oz of 5.25% unscented chlorine bleach to one gallon of water) OR a quaternary ammonia solution at a dilution suggested by the manufacturer for food service uses (NEVER MIX CHEMICALS!!!). As animals can be sensitive to sanitizers, care should be taken in adequately rinsing and drying the enclosure before putting the animal back in the enclosure. Some pathogens will not be killed by the sanitizers, but may be removed by rinsing thoroughly with water (this will also remove residual amounts of sanitizers). An animal's sensitivity is not an adequate reason to avoid the use of sanitizers.

Animal enclosures must never be cleaned in plumbing fixtures used for food service, drinking water, or hand washing purposes. After cleaning the enclosure, the fixtures used to clean the enclosure should also be cleaned and sanitized.

**BIO 12.3.5 Security**

All animal(s) enclosures should be securely covered and locked if possible. This will help protect the students and animals from one another by discouraging unsupervised handling and reducing potential of escape.

**BIO 12.3.6 Aggressive Animals**

It should be noted that any animal may behave aggressively, naturally aggressive species, and animals that are unusually aggressive or those displaying odd or uncharacteristic behaviors for their species should be removed immediately. Animals capable of causing substantial injury through aggressive or defensive reflexes should also be avoided (i.e. snapping turtles, venomous snakes, poisonous frogs, large birds).

**BIO 12.3.7 Injured and Sick Animals**

Animals that are injured or in poor health should be removed from the classroom immediately and given proper care. It should be noted, however that even animals that are or appear to be in good health can still shed potential pathogens.

**BIO 12.3.8 Animal-Specific Guidelines**

**BIO 12.3.8.1 Invertebrates**

1. Invertebrate animals are often used for observation and learning activities.
2. Teachers should obtain manuals available from biological suppliers.
3. These manuals are inexpensive and serve as a complete guide to maintaining and studying the organisms in the classroom.
4. If experiments are done with fruit flies, take care in quieting them and/or killing them.
5. **ETHER AND/OR TRIETHYLAMINE (C2H5)3N MAY NOT BE USED TO ANESTHESIZE OR EUTHANIZE ANY ORGANISM IN AN RCSS LABORATORY!**
6. Place the fruit flies in a Petri dish, gently covering them with cotton, and then invert the dish for examination under the dissecting microscope.
7. Refrigerate culture jars and place “chilled” flies on a Petri dish over ice.
8. Anesthetizing kits also may be used.

* FlyNap® kits containing relatively harmless components may be purchased from biological supply companies.

1. Any anesthetic should be used in a properly ventilated room according to the supplier.

**BIO 12.3.8.2 Vertebrates (Nonhuman)**

1. Do not take vertebrates from the natural environment.
2. Most municipalities prohibit the removal of vertebrates from the natural environment because doing so upsets nature’s balance and may introduce unwanted microorganisms or diseased animals into the classroom.
3. Obtain animals from a certified disease-free source such as a biological supply house or a certified breeder.
4. When studying developing chicken embryos, do not use any embryos that are more than 18 days old.
5. Do not work with virus-infected eggs.
6. Dispose of dead embryos, which may carry pathogenic bacteria. Follow appropriate hazardous waste guidelines.
7. Do not give away or sell any animals, including baby chicks.
8. Do not release animals that are not indigenous to the area into the environment.
9. Release of indigenous animals must be approved by the State Department of Natural Resources.

**BIO 13: Plants in the School**

Plants can be used effectively to provide a living laboratory for high school science instruction. By providing experiential learning opportunities, science educators can help students to develop the kind of reasoned thinking that will result in responsible decision-making regarding human/ecosystem interaction. However, certain plants can trigger severe allergic reactions in the form of skin rashes and breathing difficulties in susceptible children. The following guidelines will help teachers determine how to best use plants as effective teaching tools.

**BIO 13.1 Poisonous Plants** **and Plants with Spines**

* 1. Teachers should confine their lesson on poisonous plants (poison ivy, poison oak or poison sumac) to pictures.
  2. Cacti and other plants with spines should not be kept in the classroom. Spines can become embedded under the skin and become infected if not removed correctly.
  3. When using an outdoor learning area, examine the site for the presence of poisonous plants. When visiting these sites, carefully monitor the children to keep them away from the poisonous plants.
  4. Children should not put any plants or plant parts in their mouths.

**BIO 13.2 Plants in the Classroom**

1. Only plants that are not hazardous to children and with which you are familiar should be used.
2. Breathing spores or pollen can cause reactions in some students. Provide face masks to susceptible students as needed.
3. When using commercial seeds treat them with care because they may have been treated with toxic fungicides.
4. Have students wear gloves when handling them.
5. Alternatively, you may obtain untreated seeds from local farm equipment stores or online at www.seedsavers.org/
6. Make sure potted plants are placed on sturdy surfaces in order to prevent pots from tipping over.
7. Do not allow students to move large potted plants.
8. Supervise children closely and
9. make sure that they never place any plant or part of a plant in the mouth.
10. make sure that they do not touch any part of their face; even 'safe' plants can have hairs, oils, and other compounds that can irritate the skin.
11. Make hand washing routine procedure after any laboratory activity even when working with plants.

**BIO 13.3 School Gardens**

Before you begin your school garden program, you will need to ensure that the soil, water, and working environment are safe for the students. Test the soil for contaminants, know what is in soil amendments, the water and plants, and develop rules for working in the garden. Talk with the students about these important issues, and let them help develop the rules to be used in the garden.

### BIO 13.3.1 Preparation

##### BIO 13.3.1.1 Manure

1. Do not use fresh or unsterilized manure. All animal manure is potentially hazardous and may contain E. coli as well as other disease-causing pathogens.
2. Use only sterilized or fully composted manure.
3. Aged manure is **not** the same as composted, and can contain disease-causing organisms.
4. For more information, contact your local county health department or cooperative extension office.

##### BIO 13.3.1.2. Lead Contamination

1. Lead is naturally present in all soils, generally in low levels, but pollution can increase lead to harmful levels.
2. If you plan to plant an edible garden in an area that may have lead-contaminated soil, first test a soil sample for lead to determine if the soil is safe.
3. This is a critical issue for schools. Areas at risk for lead contamination include those with a history of construction before 1978, where lead may have leached into the soil from paint or other materials, or a history of heavy exposure to traffic that at one time used fuel-containing lead.
4. To be on the safe side, it is **always** a good idea to test the soil for lead before beginning an edible garden project.
5. For information about lead testing, contact your local county health department or cooperative extension office.

##### BIO 13.3.2 Underground Pipes

1. Prior to developing the garden space, check with the school district or local utilities to determine if there are any underground pipes or cables that may be a potential problem.
2. If digging begins without getting an “all clear,” the chance exists of running into electrical cables, water pipes, or a gas main.

### BIO 13.3.3 Water

1. Make sure all water used in the garden – for watering plants, washing produce, and washing hands – is potable (drinkable) water.
2. Water for washing hands and produce should be **running** water to prevent recontamination.
3. Some newly developed school grounds may have two separate water systems – one for potable water and one for recycled water (used for irrigation).
4. Check with district administrators to determine if this is an issue at the school site.
5. Then make sure only potable water is used in the school garden.
6. For more information on recycled water, contact the [**WateReuse Association**](http://www.watereuse.org/?assoc) **.**

### BIO 13.3.4 Building Materials

1. Do not use railroad ties, treated lumber, or old tires for garden boundaries, raised beds or anywhere in the garden.
2. These items contain toxic chemicals that can leach into the soil and be absorbed by the plants.
3. Old railroad ties contain creosote, a carcinogen; treated lumber contains cyanide, a potent poison; and tires can leach petroleum products into the soil.
4. Contact your county cooperative extension office for more information.

### BIO 13.4 Harmful Plants

Some plants and plant parts are poisonous. Others, such as poison ivy or stinging nettle, can irritate the skin. Teach children never to taste a plant unless an expert says it is all right to eat. Refer to the List of Hazardous Plants below for more information or contact the local poison control center.

##### BIO 13.4.1 Hay Fever Plants

* Grasses
* Ragweeds
* Flowering trees, especially Alnus (Alder) and Quercus (Oaks)

##### BIO 13.4.2 Dermatitis & Skin Rashes

* Buttercup
* Cactus-like Euphorbias
* Carrots
* Crown of Thorns
* Datura
* Dill
* Fennel
* Gas Plant
* Iris
* Jimson Weed
* Lady’s-slippers
* Nettles
* Parsnips
* Poinsettia
* Poison Hemlock
* Poison Ivy
* Poison Oak
* Poison Sumac
* Rock Poppy
* Snow-on-the-Mountain

##### BIO 13.4.3 Plants That Are Harmful When Eaten

* Amaryllis
* Autumn Crocus
* Azalea
* Baneberry
* Belladonna
* Bittersweet
* Black Locust
* Bleeding Heart
* Bloodroot
* Boxwood
* Burning Bush Euonymus
* Buttercup
* Caladium
* Castor Bean
* Celastrus
* Cherry, Jerusalem
* Cherry, Wild Black
* Chokecherry
* Crocus, Autum
* Daffodil
* Daphne
* Datura
* Delphinium
* Dieffenbachia (Dumb Cane)
* Digitalis (Foxglove)
* English Ivy
* Euonymus
* False Hellebore
* Glory Lily
* Golden Chain Tree
* Holly
* Hyacinth
* Jack-in-the-pulpit
* Jequirity Pea
* Jerusalem Cherry
* Jimson Weed
* Laburnum
* Lantana
* Larkspur
* Lily-of-the-valley
* Lupine
* Marijuana
* Marsh Marigold
* Mayapple
* Mistletoe
* Monkshood
* Morning Glory
* Mountain Laurel
* Mushrooms, Death Angel (Amanita)
* Narcissus
* Nightshade
* Oleander
* Peyote
* Philodendron
* Poinsettia
* Poison Hemlock
* Pokeberry
* Potato Vines, Sprouts from Tubers, Green Tubers
* Privet
* Rhododendron
* Rhubarb Leaves
* Skunk Cabbage
* Taxus
* Water Hemlock
* Wisteria

**BIO 13.5 Disposal**

1. Exotic plants should never be released into the environment where they may compete with local plants
2. Such a release can result in an imbalance to the natural flora.
3. Native plants normally do not present a problem for the local environment.
4. Such plants should be discarded in a manner consistent with school policy and local ordinances.

**BIO 14: Greenhouse Maintenance and Operation**

For schools that have greenhouses available for biology and environmental classes, the following guidelines are intended to aid in their smooth maintenance and operation. These guidelines, which supplement applicable school regulations, apply to any individual working in the greenhouse area, student or teacher.

**BIO 14.1 Guidelines**

The following guidelines are designed to ensure that all greenhouse components are functioning at an adequate level for optimum plant growth and at a safe level for student use.

1. Check water lines, heating system, fans, and temperature control. These are usually routine procedures that can be checked by the school maintenance staff.
2. Make sure all automatic equipment is functional and accurate.
3. Clean tools after use and store them appropriately.
4. Instruct students in the proper use of, and conduct in, the greenhouse area. It is recommended that students be required to obtain the teacher’s permission to enter the greenhouse.
5. Rules which apply to the greenhouse must be clearly stated and explained to students. It is important that students understand that the rules are for the safety of both the organisms in the greenhouse and the students.
6. Students and teachers should be cautioned to handle fertilizer carefully to avoid inhaling the dust.
7. Wash fruits and vegetables before studying. Eating fruits or vegetables that have been cultivated in the greenhouse is not recommended unless special care has been maintained in the growth of such plants.
8. Inspect the greenhouse periodically to prevent the cultivation of unlawful plants such as marijuana.
9. Maintain all equipment so as not to impede the safe movement into and about the greenhouse. For example, hose lines should be properly mounted and stored to keep the floor clear.
10. Wash hands thoroughly after working in the greenhouse.
11. Make sure to maintain adequate ventilation.

**BIO 14.2 Pesticides**

1. Use organic methods of pest control when possible.
2. Make sure to maintain adequate ventilation. Ventilation is especially important when using pesticides.
3. Use the least toxic pesticides. Note signal words found on pesticide labels:

* Danger = highly toxic.
* Warning = moderately toxic.
* Caution = slightly toxic.
* No caution or warning = relatively non-toxic.

1. The safest insecticides contain pyrethrins.

**BIO 14.3 Using Pesticides**

1. Pesticides are toxic and should be used only according to instructions on container labels.
2. Pesticides can enter the body through the skin, mouth or nose. Before using pesticides, cover up exposed skin with water-repellent clothes and boots.
3. Wear a wide-brimmed hat and a full-face shield.
4. Use unlined, natural rubber gauntlet gloves.
5. Use exhaust hoods and ventilation systems when spraying.
6. Do not touch the mouth or face with hands, forearms or clothing.
7. Do not expose a drink or food container to pesticides.
8. Wash hands and face immediately after applying pesticides.

**BIO 15: Special Concerns**

**BIO 15.1 Thermometers**

## MERCURY FILLED THERMOMETERS ARE NOT ALLOWED IN RCSS SCHOOLS.

1. Alcohol laboratory thermometers should be used in general laboratory activities.
2. For more advanced applications, a digital laboratory thermometer may be used.
3. Care should be taken to choose a digital thermometer that contains a changeable battery; some are not changeable.
4. The battery is a button cell battery and may contain 5-50 mg of mercury; it should be recycled through a battery collection program.

**BIO 15.2 Using Microtomes**

Microtomes are commonly instruments used in laboratories to section tissues. These devices pose potential hazards to users during sectioning and/or the cleaning process. It is strongly recommended that teachers use prepared slides whenever possible.

**BIO 15.2.1 Training**

1. Training must be documented and provided by a knowledgeable and responsible person within the laboratory before any work is completed.
2. Standard Operation Procedures should be made available to all users and posted near the point of operation.

**BIO 15.2.2 Appropriate PPE**:

A lab apron, chemical splash goggles, and nitrile gloves must be worn while handling tissues to be sectioned.

**BIO 15.2.3 Sharpness of Blade**

1. A microtome blade is extremely sharp and must be handled carefully.
2. The rotary handle of the microtome must always be set in the locked position when changing a paraffin block or the blade.
3. A new blade should be placed in the blade holder and clamped before the rotary wheel lock is released.
4. Wrist guards should be added where possible.
5. Once the blade is seated and secured the rotary wheel lock can be released and the knife and holder advanced to the specimen block.
6. If adjustments need to be made to the specimen, remove the blade from the housing.

**BIO 15.2.4 Removal of the blade**

1. Disposable blades must always be removed using forceps or a similar instrument.
2. Do not remove the blade holder from the microtome with a blade present or transport the housing with the blade present. .
3. Dispose of used microtome blades in the Biohazard Sharps Container.
4. The Biological sharps container must be kept adjacent to the microtome to reduce the distance that a blade would be moved
5. For microtomes with reusable blades cut resistant gloves must be used when removing and sharpening the blade.

**BIO 15.2.5 Microtome cleaning**

1. Before the microtome is cleaned, the rotary wheel must be locked and the blade removed from the blade holder.
2. Use caution other components of the microtome may also have sharp edges.
3. Cut resistant gloves must be worn under nitrile gloves when a microtome is being cleaned.
4. Follow manufacturer's recommendations for cleaning the microtome.
5. All use cleaning materials and solutions should be treated as hazardous waste and secured in the appropriate containers.
6. Contact Facilities and Maintenance for pick-up and disposal. Document the date the pick-up was requested and the date the pick-up occurred.

**BIO 15.3 Using Centrifuges**

## BIO 15.3.1 Operating Procedures

1. Check tubes for cracks/chips.
2. Use matched sets of tubes, buckets, etc.
3. Tightly seal all tubes and safety cups.
4. Ensure that rotor is locked to spindle and bucket seated.
5. Close lid during operation.
6. Allow to come to complete stop before opening.

## BIO 15.3.2 Safe Operation

1. Use safety cups whenever possible.
2. Disinfect weekly and after all spills or breakages.
3. Lubricate O-rings and rotor threads weekly.
4. Do not operate the centrifuge without the rotor properly balanced.
5. Do not use rotors that have been dropped.
6. Contact your centrifuge rep for specific information.
7. If you suspect leakage occurred from the centrifuge, leave the area, do not open the centrifuge for at least 30 minutes to allow aerosols to settle, then access situation while wearing appropriate PPE and taking necessary precautions.

**BIO 15.4 Human Studies**

* 1. **Any lab activity involving the use of bodily fluids or tissues collected from students is forbidden in RCSS laboratories.**
  2. Non-invasive, nonstressful laboratory activities using students as experimental organisms are encouraged.

1. These include physiological measurements such as, pulse, heart rate, breathing rate, hearing, sight, etc.
2. These activities need to be closely supervised by the teacher due the risk of physical injury, heart palpitations, shortness of breath, overheating, fainting, and death

.

**BIO 16: Chemical Safety in the Biology Laboratory**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

**BIO 16..1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**BIO 16.2 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**BIO 16.2.1 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**BIO 16.2.2 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration or purity
7. Date prepared
8. Expiration or ―use by date

**BIO 16.2.3 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**BIO 16.2.4 Chemical Waste**

All containers used for chemical waste should be labeled with the following:

* 1. HAZARDOUS WASTE
  2. Chemical name (as it appears on the MSDS)
  3. Accumulation start date
  4. Hazard(s) associated with the chemical waste
  5. Date generated

**BIO 16.3 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**BIO 16.4 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**BIO 16.5 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**BIO 16.5.1 Chemical Waste Labeling**

1. Clearly and permanently label each container as to its contents and label as hazardous waste.
2. All containers used for chemical waste should be labeled with the following:
3. HAZARDOUS WASTE
4. Chemical name (as it appears on the MSDS)
5. Accumulation start date
6. Hazard(s) associated with the chemical waste
7. Approximate amount
8. Date generated

**BIO 16.5.2 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used:

|  |  |
| --- | --- |
| 1. Chlorinated Solvents 2. Cyanides 3. Hexavalent Chrome 4. High pH Alkaline Solutions 5. Hydrofluoric Acid 6. Low pH Acidic Solutions | 1. Nitric Acid 2. Non-Chlorinated Solvents 3. Oxidizers 4. Palladium 5. Reducing Agents 6. Sulfides |

**BIO 16.5.3 Storage Guidelines**

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
4. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**BIO 16.5.4 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when it occurred.

**BIO 16.5.6 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**BIO 16.6 Drug-Related Items**

1. **THE FOLLOWING SUBSTANCES ARE NOT ALLOWED IN RCSS LABS!**

|  |  |
| --- | --- |
| 1. **Acetaldehyde** | 1. **Histamine** |
| 1. **Adrenalin** | 1. **Nicotine** |
| 1. **Colchicine** | 1. **Testosterone** |
| 1. **Caffeine** | 1. **Thiourea** |
| 1. **Ethyl Alcohol (grain)** | 1. **Tobacco** |

**BIO 17: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the event a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**BIO 17.1 Preventing Burns and Fires**

**BIO 17.1.1 When planning to heat materials or use open flames**

1. instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. make sure students know how to evacuate the classroom in the event of a large fire
3. know the location of the nearest fire extinguisher and make sure you know how to use it.
4. have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**BIO 17.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. do not allow students to work with hot materials, such as very hot water.
5. do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**BIO 17.1.3 When using Hot Plates**

1. do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. do not place the hot plate on paper or wooden surfaces.
3. place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. never leave the room while the hot plate is plugged in, whether or not it is in use.
5. keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**BIO 17.1.4 When using open flames**

1. use only safety matches. Make sure the matches are stored in a secure place between uses.
2. closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. use tea candles that are short and wide, and cannot be knocked over in normal use.
5. place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. never leave the room while a flame is lit or other heat source is in use.

**BIO 17.2 In the event of a large, uncontainable fire**

1. evacuate the classroom immediately.
2. locate and pull the nearest fire alarm.
3. notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**BIO 17.3 In the event of a small, containable fire**

1. identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**BIO 17.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire.
2. Use a fire blanket if one is available.
3. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite.
4. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

**BIO 18: Electrical Hazards**

**BIO 18.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**BIO 18.2 Electrical Apparatus**

**BIO 18.2.1 Batteries.**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**BIO 18.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**BIO 18.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**BIO 18.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**BIO 18.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**BIO 18.2.6 Power Cords.**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**ENVIRONMENTAL SCIENCE**

**LABORATORIES**

Environmental Science teachers and their students face a wide range of potential hazards. In addition to chemical reagents, there are the hazards associated with the handling of organisms, classroom activities on the school grounds and outdoor study areas, and the containment of biological specimens. Effective control of such hazards involves both the recognition of each hazard and the development of control procedures.

## ENVSCI 1: Required Materials for the High School Environmental Science Lab

1. Broken Glass Container
2. Sharps Disposal Box
3. Biohazard Bags
4. Household Bleach
5. Fire Extinguisher
6. Spill Kit
7. First Aid Kit
8. MSDS Notebook
9. Chemical Waste Disposal Containers

### ENVSCI 2: Eye Protection

### ENVSCI 2.1 What is your obligation?

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### ENVSCI 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. As a responsible teacher, you must select eyewear that provides you and your students with the most appropriate protection for the hazards of your science activities. Effective eye protection must include adequate instruction on the hazards of the particular activity and of the precautions to be followed to reduce the risk of injury. It must also include instructions and modeling of the protective equipment.

Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress (e.g., springs, wires, rubber, glass), or causes collisions
4. When dust or fumes are present (Eye protection reduces the dust or fumes reaching the eye.)
5. When using preserved specimens

### ENVSCI 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**ENVSCI 2.4 Disinfecting Goggles**

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes.. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### ENVSCI 2.5 What is the current recommendation for wearing contact lenses?

* 1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
  2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
  3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
  4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.

1. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
2. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133 p.16343.

**ENVSCI 3: Glassware**

**ENVSCI 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**ENVSCI 3.2 General Cautions**

**ENVSCI 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**ENVSCI 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**ENVSCI 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**ENVSCI 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score.
7. Wrap the glass in a towel. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
8. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
9. Place the glass on insulating material to cool.

**ENVSCI 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**ENVSCI 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**ENVSCI 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**ENVSCI 3.5 Cleaning**

1. Clean immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**ENVSCI 3.6 Disposal**

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY.**
3. When handling broken glassware, wear gloves or use a dustpan and broom. Do not pick up broken glass with bare hands.

## ENVSCI 4: Microscope Handling

1. **DO NOT ALLOW STUDENTS WITH ACTIVE EYE INFECTIONS TO USE MICROSCOPES**!
2. Provide students with alcohol wipes to clean lenses before or after use.
3. Microscopes must be carried upright, with one hand supporting the arm of the microscope and the other hand supporting the base. Nothing else should be carried at the same time.
4. Microscope must be positioned safely on the table, NOT near the edge.
5. After plugging the microscope into the electrical outlet, the cord should be draped carefully up onto the table and never allowed to dangle dangerously to the floor.
6. The coarse adjustment must NEVER be used to focus a specimen when the 40x or oil immersion lens is in place.
7. When finished with the microscope, the cord should be carefully wrapped around the microscope before returning it to the cabinet.
8. All prepared microscope glass slides are to be returned to their appropriate slide trays; wet mount preparations are to be disposed of properly.
9. Malfunctioning microscopes should be reported to the department chairperson/laboratory safety manager.

**ENVSCI 5: Material Spills**

Accidents do happen in the Environmental Science lab, and, in the event of a spill or accident, it is important that the teacher knows the correct procedures to follow.

**ENVSCI 5.1 Spills**

1. **A spill kit should be prepared prior to starting certain environmental science labs involving chemicals, plants, and or preserved specimens. It should include all items required to clean up a spill, including disinfectant, paper towel, gloves and plastic bags and containers for disposal.**
2. Students must report all spills to the teacher.
3. Only the teacher or laboratory safety manager should be allowed to clean up such spills.
4. If the spill is large or has caused a lot of splashing, aerosols may have been produced and the room should be evacuated for 90 minutes.

**ENVSCI 5.1.1 Liquid Spills**

1. Small (less than 1.0L) liquid spills should be covered with paper towels soaked in disinfectant (e.g. Sodium Hypochlorite with 1 % available chlorine) for at least 20 minutes.
2. The area should be cleaned with fresh paper towels soaked in disinfectant.
3. ALL paper towels should then be placed in a biohazard bag for disposal
4. Make sure the bag is sealed and labeled.
5. Notify Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date it occurred.
6. In the event of a large spill (1.0L or more):
7. Evacuate the room immediately.
8. Contact an administrator and then contact Facilities and Maintenance and provide the following information

* Your name and the name of the school
* Location and time of spill
* Content and amount of spill

**ENVSCI 5.1.2 Spills on the Body**

1. The teacher must be informed immediately.
2. Contaminated clothing should be removed and the affected area washed vigorously with soap and water.
3. Medical attention may be sought if required.
4. The incident must be documented in the first aid &/or OHSW records.
5. Contaminated clothing must be disinfected before washing.

**ENVSCI 5.1.3 Contaminated Broken Glassware**

1. Contaminated broken glassware should never be picked up directly with the hands.
2. It should be cleaned up using aids such as brush and dustpan, forceps or cotton wool swabs.
3. Follow the procedure for liquid spills.
4. All aids must be disinfected following use

**ENVSCI 6: Specific Areas of Concern**

**ENVSCI 6.1 Erosion/Deposition**

**ENVSCI 6.1.1 Diatomaceous Earth**

1. **DUE TO THE POSSIBLE INHALATION OF DUST, THE USE OF DIATOMACEOUS EARTH IS NOT ALLOWED.**

**ENVSCI 6.2 Soil Sampling**

Soil samples can provide a wealth of learning opportunities for environmental science students. However, soils can contain bacteria, viruses, molds and fungi, persistent organic compound, and heavy metals, all of which are potentially hazardous. Special precautions need to be taken in order to prevent contamination and illness.

1. **DO NOT SAMPLE SOILS FROM AGRICULTURAL AREAS.**
2. **DO NOT SAMPLE SOILS FROM AREAS KNOWN TO HAVE HIGH CONCENTRATIONS OF LEAD, MERCURY, CADMIUM, AND OTHER HEAVY METALS**.
3. The Environmental Protection Division of the Georgia Department of Natural Resources and the federal Environmental Protection Agency provide up to date, online maps indicating areas of concern.
4. Students should wear gloves, goggles, and, if appropriate, a dust mask, when taking samples.
5. Students should use the appropriate tools for soil sampling (spade, shovel, and core sampler) in order to avoid injury when sampling.
6. To avoid the possibility of exposures to pathogens, soil samples should be autoclaved or microwaved.
7. Read the accompanying manual for information regarding the autoclaving of soil samples.
8. If using the microwave, samples should be 'cooked' for a minimum of 30 minutes per pound of soil on the highest possible setting.

**ENVSCI 6.3 Water Studies**

**ENVSCI 6.3.1 Stream Tables**

Stream tables can be effective learning tools. Use the following safety precautions:

1. Check the table out for leaks, including drain hoses.
2. Wipe up any spilled water immediately to avoid creating a hazard.
3. Electrical receptacles should be GFCI protected.

**ENVSCI 6.3.2 Water Chemistry**

Water chemistry kits contain a variety of hazardous chemicals. All necessary precautions must be taken in order to avoid injury.

1. Students must wear goggles, gloves, and closed toes shoes when performing water chemistry.
2. Students should be closely supervised to make sure they are following instructions.
3. Students should be provided with a hazardous waste container in which to place rinse water and analyzed samples.
4. This container should the labeled with the name of the teacher, the contents, the approximate amount of solution, and the date the waste was generated.
5. Facilities and Maintenance should be contacted for pick-up and disposal. Document the date the request was made and the date on which the waste was picked up.

**ENVSCI 7: Radiation/Radioisotopes**

**Activities involving radioactive material of any type is forbidden in RCSS laboratories.**

**ENVSCI 8: Chemical Safety in the Environmental Science Laboratory**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely,

**ENVSCI 8.1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**ENVSCI 8.2 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**ENVSCI 8.2.1 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**ENVSCI 8.2.2 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration
7. Date prepared
8. Expiration or use by date

**ENVSCI 8.2.3 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**ENVSCI 8.3 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**ENVSCI 8.4 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**ENVSCI 8.5 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**ENVSCI 8.5.1 Chemical Waste Labeling**

1. Clearly and permanently label each container as to its contents and label as hazardous waste
2. All containers used for chemical waste should be labeled with the following:
3. HAZARDOUS WASTE
4. Chemical name (as it appears on the MSDS)
5. Accumulation start date
6. Hazard(s) associated with the chemical waste
7. Approximate amount
8. Date generated

**ENVSCI 8.5.2 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used:

|  |  |
| --- | --- |
| 1. Chlorinated Solvents 2. Cyanides 3. Hexavalent Chrome 4. High pH Alkaline Solutions 5. Hydrofluoric Acid 6. Low pH Acidic Solutions | 1. Nitric Acid 2. Non-Chlorinated Solvents 3. Oxidizers 4. Palladium 5. Reducing Agents 6. Sulfides |

**ENVSCI 8.5.3 Storage Guidelines**

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
4. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**ENVSCI 8.5.4 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when it occurred.

**ENVSCI 8.5.6 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**ENVSCI 9: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the event a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**ENVSCI 9.1 Preventing Burns and Fires**

**ENVSCI 9.1.1 When planning to heat materials or use open flames**

1. instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. make sure students know how to evacuate the classroom in the event of a large fire
3. know the location of the nearest fire extinguisher know how to use it.
4. have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**ENVSCI 9.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. do not allow students to work with hot materials, such as very hot water.
5. do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**ENVSCI 9.1.3 When using Hot Plates**

1. do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. do not place the hot plate on paper or wooden surfaces.
3. place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. never leave the room while the hot plate is plugged in, whether or not it is in use.
5. keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**ENVSCI 9.1.4 When using open flames**

1. use only safety matches. Make sure the matches are stored in a secure place between uses.
2. closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. use tea candles that are short and wide, and cannot be knocked over in normal use.
5. place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. never leave the room while a flame is lit or other heat source is in use.

**ENVSCI 9.2 In the event of a large, uncontainable fire**

1. evacuate the classroom immediately.
2. locate and pull the nearest fire alarm.
3. notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**ENVSCI 9.3 In the event of a small, containable fire**

1. identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**ENVSCI 9.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available.
2. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite.
3. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

**ENVSCI 10: Electrical Hazards**

**ENVSCI 10.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Contact the school nurse or other individual with first aid certification in the event of an electrical burn.
5. Students must be warned of the high death potential present even when the voltage is low.
6. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
7. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
8. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**ENVSCI 10.2 Electrical Concerns**

**ENVSCI 10.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**ENVSCI 10.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**ENVSCI 10.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**ENVSCI 10.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**ENVSCI 10.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**ENVSCI 10.2.6 Power Cords.**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**THE PHYSICAL SCIENCES:**

**EARTH SYSTEMS, PHYSICS, PHYSICAL SCIENCE, AND CHEMISTRY LABORATORIES**

**EARTH SYSTEMS**

**LABORATORIES**

## Physical science includes the sciences of earth systems, chemistry and physics that explore the nature and characteristics of energy and nonliving matter. The boundaries between the physical and life sciences are artificial. With the advancements in science today, one field overlaps into another and covers many of the same concepts from different perspectives.

Earth Systems is an applied science based on many concepts from chemistry and physics. Because many of the activities in Earth Systems involve the application of chemistry and physics skills, teachers need to be aware of the risks involved.

## ERSYS 1: Required Materials for the High School Earth Systems Lab

1. Broken Glass Container
2. Fire Extinguisher
3. Spill Kit
4. First Aid Kit
5. MSDS Notebook
6. Chemical Waste Disposal Containers

### ERSYS 2: Eye Protection

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

### ERSYS 2.1 What is your obligation?

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### ERSYS 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

* 1. When chemicals, glassware, or a heating source is being used
  2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
  3. When an activity generates projectiles, or uses elastic materials under stress, or causes collisions
  4. When dust or fumes are present
  5. When using preserved specimens

### ERSYS 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**ERSYS** **2.4 Disinfecting Goggles**

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### ERSYS 2.5 What is the current recommendation for wearing contact lenses?

* 1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
  2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
  3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
  4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.

1. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
2. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133 p.16343.

**ERSYS 3: Glassware**

**ERSYS 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**ERSYS 3.2 General Cautions**

**ERSYS 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**ERSYS 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**ERSYS 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**ERSYS 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score. Wrap the glass in a towel.
7. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
8. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
9. Place the glass on insulating material to cool.

**ERSYS 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**ERSYS 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**ERSYS 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**ERSYS 3.5 Cleaning**

1. Clean glassware immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**ERSYS 3.6 Disposal**

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY.**
3. When handling broken glassware, wear gloves or use a dustpan and broom. Do not pick up broken glass with bare hands.

## ERSYS 4: Microscope Handling

1. **DO NOT ALLOW STUDENTS WITH ACTIVE EYE INFECTIONS TO USE MICROSCOPES!**
2. Provide students with alcohol wipes to clean lenses before or after use.
3. Microscopes must be carried upright, with one hand supporting the arm of the microscope and the other hand supporting the base. Nothing else should be carried at the same time.
4. Microscope must be positioned safely on the table, NOT near the edge.
5. After plugging the microscope into the electrical outlet, the cord should be draped carefully up onto the table and never allowed to dangle dangerously to the floor.
6. The coarse adjustment must NEVER be used to focus a specimen when the 40x or oil immersion lens is in place.
7. When finished with the microscope, the cord should be carefully wrapped around the microscope before returning it to the cabinet.
8. All prepared microscope glass slides are to be returned to their appropriate slide trays; wet mount preparations are to be disposed of properly.
9. Malfunctioning microscopes should be reported to the department chairperson/laboratory safety manager.

## ERSYS 5: Mechanical Hazards

**ERSYS 5.1 Disposal**

1. Do not flush sand, silt, clay, rocks, and other earth materials down the drain.
2. These materials are not soluble in water and may clog the drain.
3. Dispose of them in a trash can or other suitable receptacle.

**ERSYS 5.2 Force Measuring Devices**

1. Students must be careful when projecting objects (steel balls or marbles).
2. In demonstrating the flight of any projectile, students should be kept clear of the path and impact area.
3. The teacher should always pretest the projectile to determine the path it will follow and its range as well as the amount of variability to be expected.
4. Sharp-pointed objects should not be used as projectiles.
5. Use of safety goggles is mandatory.
6. A simple mechanical launcher (e.g., compressed spring, compressed air, stretched elastic) should be used.
7. It should only be "loaded" at the specific time a flight is to be observed.
8. Springs
9. Stretched or compressed springs contain mechanical potential energy.
10. A stretched spring, unexpectedly released, can pinch fingers.
11. A compressed spring, when suddenly released, can send an object at high velocity toward an observer.
12. Care should be taken to avoid unexpected release of the spring’s energy when working with dynamics carts, spring-type simple harmonic oscillators, and springs used in wave demonstrations.

**ERSYS** **5.3 Wind Generating Devices (Hair Blower, Electric Fan, etc.)**

1. Take special care in using wind generating devices.
2. As these devices are often used with water, they present a risk of electric shock.
3. No one should disconnect, connect, or operate these devices with wet hands or while standing on a wet floor.
4. Devices having metal housings should be grounded.

**ERSYS 6: Electrical Hazards**

**ERSYS 6.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**ERSYS 6.2 Electrical Apparatus**

**ERSYS 6.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**ERSYS 6.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**ERSYS 6.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**ERSYS 6.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**ERSYS 6.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**ERSYS 6.2.6 Power Cords.**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**ERSYS 7: Light Hazards**

**ERSYS 7.1 Magnesium Ribbon**

1. Students should not look directly at the flame when a magnesium ribbon is being burned. The extreme brightness can damage the eyes.

**ERSYS 7.2 Optics**

1. Avoid the use of burning candles to obtain the image produced by mirrors and lenses. Use low wattage bulbs instead of burning candles.
2. Incandescent ultraviolet lamps present a minimal danger from their ultraviolet emissions, as the energy of this radiation is very low.
3. These bulbs, however, get extremely hot when in use and must be given plenty of time to cool before handling.
4. Intense sources of visible light are usually not hazardous due to the inability of the human eye to remain focused on an intense source.

**ERSYS 7.3 Astronomy-Related Concerns**

Astronomical events such as viewing a solar eclipse are a great opportunity for learning, but safety precautions for specific events such a solar eclipse must be addressed.

1. Eyepieces of shared telescopes and binoculars should be cleaned periodically to reduce the risk of the transmission of eye infections. Never observe the sun directly through a telescope or binoculars
2. Never look directly at the sun, including during a solar eclipse. Permanent eye damage is likely to take place.
3. Properly constructed pinhole viewers are a safe way to view the sun.
4. Never view the sun directly through binoculars or telescopes. This can cause blindness.
5. Never use sunglasses or exposed film to view the sun. They do not provide appropriate protection.

**ERSYS 7.4 Ultraviolet Light**

The use of ultraviolet light for mineral study can be dangerous and should be done only as a teacher demonstration.

1. Protect eyes and skin from exposure of ultraviolet transilluminators.
2. Special glasses (such as those coated with an ultraviolet absorbing film) should be used when examining mineral samples with an ultraviolet lamp. Only special goggles clearly designated for the purpose of absorbing ultraviolet light should be used.
3. Wear long sleeve shirts and lab coat with gloves.
4. Only use a ground-fault circuit interrupter (GFCI) protected electrical receptacle for the lamp.
5. Never operate the lamp near water sources.
6. Never disassemble the lamp when plugged in – this is a high voltage power supply device.

**ERSYS 8: Special Concerns**

**ERSYS 8.1 Astronomy**

Astronomical events such as viewing a solar eclipse are a great opportunity for learning, but safety precautions for specific events such a solar eclipse must be addressed.

1. Eyepieces of shared telescopes and binoculars should be cleaned periodically to reduce the risk of the transmission of eye infections. Never observe the sun directly through a telescope or binoculars
2. Never look directly at the sun, including during a solar eclipse. Permanent eye damage is likely to take place.
3. Properly constructed pinhole viewers are a safe way to view the sun.
4. Never view the sun directly through binoculars or telescopes. This can cause blindness.
5. Never use sunglasses or exposed film to view the sun. They do not provide appropriate protection.

**ERSYS 8.2: Geology**

**ERSYS 8.2.1 Rock and Mineral Study:**

1. Use the following precautions in working with rocks and minerals in the laboratory:
2. Use appropriate personal protective equipment such as chemical splash goggles, gloves and aprons.

**ERSYS 8.2.1.1 Acid Tests**

1. 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).
2. When using 10% or 1.0M hydrochloric acid for rock and mineral identification, students should use only a very small drop of acid, and should use care so as not to get the acid on the lab table, their skin, clothes, or in their eyes, or on any other student.
3. **ROCKS AND MINERALS MUST BE RINSED OFF WITH TAP WATER IMMEDIATELY AFTER THE ACID TEST, AND BLOTTED DRY using paper towels.**
4. When dilute hydrochloric acid is applied to mineral specimens, gases often result.
5. Due to the varied composition of the minerals, it is not always possible to predict which gases will be involved.
6. Such experiments should be performed in well-ventilated areas or in the fume hood.
7. Gases should not be smelled directly.
8. Keep all table tops wiped or blotted dry.
9. Do not leave acid-covered specimens lying on the tables, and do not put acid-covered specimens back into the cardboard specimen trays.
10. If you suspect that you have acid on your hands, wash them immediately with soap and plenty of running water.
11. Report any acid spills to the instructor immediately.

**ERSYS 8.2.1.2 Tastes Tests**

1. When conducting a mineral taste test, the student should rinse the mineral in clean tap water BEFORE and AFTER the test.
2. Only taste specimens that you have good reason to suspect are HALITE on the basis of other evidence.
3. Do not taste specimens that you suspect may have hydrochloric acid on them.
4. Taste only specimens that you have personally rinsed off immediately prior to tasting.
5. Do not put any lab materials or specimens into your mouth.

**ERSYS 8.2.1.3 Hardness Tests**

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

**ERSYS 8.2.1.4 Cleavage/Fracture Tests**

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

**ERSYS 8.2.1.5 Crystallization**

1. Students can observe 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.
2. If solutions are used, be aware of the toxicity of the substances used and take adequate precautions.
3. If a molten chemical is used, care should be taken to avoid burns.

**ERSYS 8.2.1.6 Ultraviolet Light Used for Viewing Fluorescent Minerals**

1. Any radiation with a wavelength shorter than 250nm should be considered dangerous.
2. This includes the ultraviolet light (black light) used in some mineralogy laboratories.
3. Never remove the protective shield in front of a UV source.
4. 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.

**ERSYS 8.2.2 Geological Field Experience**

Geological field experiences can be exciting and academically rewarding. The following safety precautions should be addressed in preparation for the trip:

1. Secure information relative to medical conditions in preparation for the field activity from the school nurse and parents. Plan for administration of medication as necessary.
2. Make sure students wear appropriate clothing for the weather conditions.
3. Make sure students use sun sense by wearing appropriate clothing and head gear.
4. Make sure students use appropriate footwear such as boots or sneakers. Flip-flops and sandals are unacceptable.
5. Make sure students wear safety glasses or goggles.
6. Caution students against throwing or rolling rocks and boulders on the field site.
7. Make sure students do not touch or try moving rotten trees.
8. Make sure students use caution when hammering rocks.
9. Make sure students use caution when standing near the base of a cliff.

**ERSYS 8.3 Spectroscopic Analysis Using Flame Tests**

1. 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.
2. When large numbers of students are performing flame tests, the potential exists for individual acute toxicity exposure or instructor chronic toxicity exposure.

**ERSYS 8.3.1 Chemicals Often Used in Flame Tests**

**Table ERSYS 8.3.1.1**

|  |  |  |
| --- | --- | --- |
| **Health** | **Safety** | **Compound** |
| 1 | 0 | Sodium Chloride (NaC1 ) |
| 2 | 1 | Strontium Chloride (SrCl2 ) |
| 3 | 1 | Lithium Chloride (LiC1 ) |
| 3 | 1 | Copper Chloride (CuCl2 ) |
| 4 | 1 | Barium Chloride (BaC12 ) |

**ERSYS 8. .1.2 Precautions**

1. Goggles and lab aprons are required.
2. In poorly ventilated or confined laboratories, flame tests should be performed in a fume hood.
3. The general nature of an unknown compound should be ascertained before performing a flame test.
4. Students should never ingest the chemicals.
5. 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.
6. The wire and holding device should be placed on an insulated mat and allowed to cool thoroughly before handling.
7. An overloaded wire causes splattering and material can fall into the burner jets, causing blockage.
8. Unknown chemicals should not be placed in the flame.
9. It is recommended that teachers use spectrum tubes to show the properties of spectrum analysis.
10. 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.

**ERSYS 8.4: Erosion/Deposition**

**ERSYS 8.4.1 Diatomaceous Earth**

**DUE TO THE POSSIBLE INHALATION OF DUST, THE USE OF DIATOMACEOUS EARTH IS NOT ALLOWED.**

**ERSYS 8.5 Earthquakes/Volcanoes**

1. 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.

**ERSYS 8.6 Meteorology**

**ERSYS 8.6.1 Air Pressure**

1. Air under pressure can cause explosions or make objects or parts of objects move suddenly and violently.
2. Containers that are to be pressurized or evacuated must be able to withstand the differences in pressure without violently shattering.
3. Glass containers should not be subjected to differences in air pressure unless they were designed for such purposes.
4. Students should always wear protective goggles when performing air pressure experiments.
5. Magdeburg Hemispheres are often used to demonstrate the force exerted on a surface by air pressure.
6. If they are braced and pulling hard and the hemisphere gives way, they could go flying into objects behind them.
7. Do not release the vacuum inside the hemispheres while students are pulling on them.

**ERSYS 8.6.2 Barometers**

1. **MERCURY BAROMETERS ARE NEVER TO BE USED IN CLASSROOMS.**
2. Use aneroid barometers to explain air pressure readings.

**ERSYS 8.6.3 Sling Psychrometers**

**A sling psychrometer** is used to measure relative humidity in a particular area. It is composed of two **thermometers**, a **WET BULB** and a **DRY BULB**. The dry bulb is the simple thermometer while the wet bulb comes with a cotton wick. This wick needs to be moistened with water at room temperature. Both the bulbs are with a screw to a dowel which allows them to be spun in the air. It **works on the principle that evaporation is a process of cooling**. It is important to **know how to use a sling psychrometer** in order to be able to read humidity accurately without errors. While learning how to use a [sling psychrometer](http://slingpsychrometer.org/), here are a few pointers to keep in mind:

**ERSYS 8.6.3.1 Set up**

1. Use room temperature water in order to wet the cotton wick present in the wet bulb of the instrument. Distilled water is preferable.
2. The water should soak into the cotton wick with ease. If you face a problem with the soaking, you should replace the wick.
3. The barometer has to be cleaned after every use. Store it in a safe, cool place.

**ERSYS 8.6.3.2 Measurement**

1. Both the bulbs should be secure. This is very important and you should thus ensure they are stable and safe on the dowel before swinging them.
2. Swing the bulbs for about a minute. Make sure you have sufficient space to swing the instrument in order to avoid striking objects or people.
3. After a minute, note the temperature reading on both the bulbs. Do this at least twice to get the lowest reading possible. If the two readings are different, do it again.
4. If you see that the wet bulb is warmer than the dry, there is a problem with the instrument and it is most probably broken.
5. Record the difference between both the readings.
6. Check a reliable relative humidity chart and take the dry bulb temperature on the y axis.
7. The result of the difference of both the readings should be taken on the x axis and see where both the points meet. This resource chart will help you calculate the dew point
8. To find out the relative humidity, you must check the chart again but the bottom chart on the resource chart will give you the reading of relative humidity. The readings to be taken are the same as above.
9. This resource chart is the standard chart used to measure humidity and dew point and is easily available.

**ERSYS 8.6.4 Thermometers**

## MERCURY FILLED THERMOMETERS ARE NOT ALLOWED IN RCSS SCHOOLS.

1. Alcohol laboratory thermometers should be used in general laboratory activities.
2. For more advanced applications, a digital laboratory thermometer may be used.
3. Care should be taken to choose a digital thermometer that contains a changeable battery; some are not changeable.
4. The battery is a button cell battery and may contain 5-50 mg of mercury; it should be recycled through a battery collection program.

**ERSYS 9: Chemical Safety in the Earth Science Laboratory**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

**ERSYS 9.1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**ERSYS 9.2 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**ERSYS 9.2.2 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**ERSYS 9.2.3 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration or purity
7. Date prepared
8. Expiration or ―use by date

**ERSYS 9.2.4 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information
5. NFPA code

**ERSYS 9.2.5 Chemical Waste**

All containers used for chemical waste should be labeled with the following:

* 1. HAZARDOUS WASTE
  2. Chemical name (as it appears on the MSDS)
  3. Accumulation start date
  4. Hazard(s) associated with the chemical waste
  5. Date generated

**ERSYS 9.3 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**ERSYS 9.4 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**ERSYS 9.5 Chemical Waste**

According to EPA regulations, the following four characteristics define a waste as hazardous:

* Ignitability
* Corrosiveness
* Reactivity
* Toxicity

Management and disposal of laboratory waste in containers are regulated under RCRA regulations. These laboratory waste streams include used chemicals, residues from experiments, spill cleanup, expired or off-spec chemicals and other chemical waste. It is the school's responsibility to make a hazardous waste determination. This includes spent chemicals used in the lab, expired or unwanted chemicals, contaminated gloves, and any spill cleanup debris. Schools must ensure that a RCRA hazardous waste is safely accumulated and transported off-site for proper disposal. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply.

**ERSYS 9.5.1 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**ERSYS 9.5.1.1 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used.

* Nitric Acid
* Hydrofluoric Acid
* Hexavalent Chrome
* Cyanides
* Oxidizers
* Reducing Agents
* Sulfides
* Palladium
* High pH Alkaline Solutions
* Low pH Acidic Solutions
* Non-Chlorinated Solvents
* Chlorinated Solvents

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Clearly and permanently label each container as to its contents and label as hazardous waste.
4. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
5. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**ERSYS 9.5.1.2 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when pick-up occurred.

**ERSYS 9.5.2 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**ERSYS 10: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the vent a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**ERSYS 10.1 Preventing Burns and Fires**

**ERSYS 10.1.1 When planning to heat materials or use open flames**

1. Instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. Make sure students know how to evacuate the classroom in the event of a large fire
3. Know the location of the nearest fire extinguisher and know how to use it.
4. Have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**ERSYS 10.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. Make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. Do not allow students to work with hot materials, such as very hot water.
5. Do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. Do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. Handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**ERSYS 10.1.3 When Using Hot Plates**

1. Do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. Do not place the hot plate on paper or wooden surfaces.
3. Place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use.
5. Keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. Make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**ERSYS 10.1.4 When using open flames**

1. Use only safety matches. Make sure the matches are stored in a secure place between uses.
2. Closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. Closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. Use tea candles that are short and wide, and cannot be knocked over in normal use.
5. Place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. Never leave the room while a flame is lit or other heat source is in use.

**ERSYS 10.1.4 Bunsen Burner Safety Guidelines**

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do not leave open flames unattended and never leave the laboratory while the burner is on.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

**ERSYS 10.2 In the event of a large, uncontainable fire**

1. Evacuate the classroom immediately.
2. Locate and pull the nearest fire alarm.
3. Notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**ERSYS 10.3 In the event of a small, containable fire**

1. Identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use multiple purpose (ABC) or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**ERSYS 10.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite. Periodically check on the location and condition of fire extinguishers.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

**PHYSICS**

**LABORATORIES**

Experimental physics motivates teachers and students to create new techniques and apparatus and to use them to demonstrate both old and new ideas. It is impossible, therefore, to anticipate all of the specific hazards that might arise in the study of physics. While it is not desirable to eliminate creativity in the interest of safety, teachers should temper their creativity with a constant alertness to potential dangers. Common sense can go a long way toward providing a safe environment.

## PHY 1: Required Materials for the High School Physics Lab

1. Broken Glass Container
2. Fire Extinguisher
3. Spill Kit
4. First Aid Kit
5. MSDS Notebook
6. Chemical Waste Disposal Containers

### PHY 2: Eye Protection

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

### PHY 2.1 What is your obligation?

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### PHY 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress, or causes collisions
4. When dust or fumes are present
5. When using preserved specimens

### PHY 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**PHY** **2.4 Disinfecting Goggles**

* 1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes.. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
  2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
  3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### PHY 2.5 What is the current recommendation for wearing contact lenses?

* 1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
  2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
  3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
  4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
  5. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
  6. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133 p. 16343.

**PHY 3: Glassware**

**PHY** **3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**PHY 3.2 General Cautions**

**PHY 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**PHY 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**PHY 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**PHY 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score. Wrap the glass in a towel.
7. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
8. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
9. Place the glass on insulating material to cool.

**PHY 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**PHY 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**PHY 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**PHY 3.5 Cleaning**

1. Clean glassware immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**PHY 3.6 Disposal**

1. Use a dustpan and brush to pick up broken glass. Never pick up broken glass you’re your bare hands.
2. Defective glassware should be disposed of correctly.
3. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY.**

**PHY 4: Common Hazards**

**PHY 4.1 Masses and Weights**

1. Heavy masses may be used in experiments involving Atwood’s machine, free fall, Newton’s laws, and momentum.
2. Warning should be given to students to prevent hands and feet from being caught between a moving heavy mass and floor or table surfaces.
3. 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.
4. 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.
5. This will help avoid damage to the masses and also prevent the mass from rolling away.

**PHY 4.2 Jet Action**

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

**PHY 4.3 Steam**

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

**PHY 4.4 High-speed Rotation**

1. Rotators are sometimes used to demonstrate centripetal force, circular motion, and sound phenomena.
2. Any device attached to a rotator should be fastened securely and checked for tightness frequently.
3. Observers should avoid contact with moving accessories such as toothed wheels, siren discs, etc.
4. Loose clothing and long hair should be kept away from moving parts, and observers should not be in the plane of rotation.
5. The use of safety goggles should be considered in student laboratories investigating centripetal force.
6. Extremely high-speed rotation should be avoided when possible.
7. High speeds may cause some objects to fly apart unexpectedly.

**PHY 4.5 Strobe Lights**

1. A strobe light is sometimes used to illuminate a rotating object, making the object appear to be at rest.
2. If the object is a fan blade, a toothed wheel, or anything else with sharp edges, there is danger of injury from touching or inserting an object into the apparently stationary object.
3. Students should be cautioned against staring at the pulsating light for extended periods of time as this may create sensory disturbances in susceptible individuals.
4. Students prone to epileptic seizures should not participate in lab activities requiring the use of a strobe light; strobe lights are often used in clinical settings to induce seizures.

**PHY 4.6 Magnets**

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

**PHY 4.7 Tools**

1. NEVER use a dull cutting tool. It may slip and cause serious injury.
2. Cut away from yourself when using any sharp instrument.
3. Cut sheet metal only with sharp shears.
4. File the edges smooth using a file or emery cloth.
5. Rest hot soldering irons on metal stands to avoid burns and prevent fires.
6. Use pliers or clamps to hold wires and metals for soldering.
7. Do not inhale fumes from soldering paste.
8. Power Tools
9. It may be necessary for students constructing apparatus for physics experiments to use various power tools contained in a wood or metal shop.
10. In these situations the industrial arts instructor should be consulted for proper safety precautions necessary for each tool or machine.

**PHY 4.8 Projectiles**

1. Students must be careful when projecting objects (steel balls or marbles).
2. In demonstrating the flight of any projectile, students should be kept clear of the path and impact area.
3. The teacher should always pretest the projectile to determine the path it will follow and its range as well as the amount of variability to be expected.
4. Sharp-pointed objects should not be used as projectiles.
5. Use of safety goggles is mandatory.
6. A simple mechanical launcher (e.g., compressed spring, compressed air, stretched elastic) should be used.
7. It should only be "loaded" at the specific time a flight is to be observed.
8. Springs
9. Stretched or compressed springs contain mechanical potential energy.
10. A stretched spring, unexpectedly released, can pinch fingers.
11. A compressed spring, when suddenly released, can send an object at high velocity toward an observer.
12. Care should be taken to avoid unexpected release of the spring’s energy when working with dynamics carts, spring-type simple harmonic oscillators, and springs used in wave demonstrations.

**PHY 4.9 Capacitors**

1. Capacitors are used to store electric charge.
2. They may remain charged for long periods after power is turned off, and they therefore pose a serious shock/burn hazard.
3. Before working on any circuit containing a capacitor, make sure that it is discharged by shorting its terminals with an insulated wire or screwdriver.
4. Oil-filled capacitors may sometimes recharge themselves and should be kept shorted when not in use. Oil from older capacitors may be contaminated with dangerous PCBs.
5. When installing electrolytic-type capacitors in a circuit, proper polarity rules must be followed (negative to negative and positive to positive). Improper connection can result in an explosion.
6. Be on the lookout for capacitors in any apparatus with high voltage components such as oscilloscopes, TV sets, lasers, computers, and power supplies.
7. Electrostatic generators and Leyden Jars are also capacitors and can be a source of unexpected shock.

**PHY 4.10 Electrostatic Generators**.

1. Electrostatic generators used in demonstrations of static electricity produce high voltages (about 105 volts) with very low currents.
2. The danger of these generators depends on their size and capacity to produce enough current to be dangerous.
3. In many cases the shock from such devices is very quick and not harmful.
4. The startling effect, however, can be detrimental to persons with heart conditions.
5. In general, experiments that use human subjects to demonstrate the effect of electrical shock should not be attempted due to the large variation in physical and physiological factors.
6. Leyden jars -- which can be charged with electrostatic generators -- are especially dangerous because of their capacity to store a charge for long periods of time.
7. An accidental discharge through a person can be avoided by properly shorting the devices after use

**PHY 4.11 Heating Procedures**

Often it is necessary to heat liquids and solids in physics experiments and demonstrations. It is safer to use water baths and hot plates than to heat directly with open flames such as with Bunsen burners. Below are guidelines for heating and handling hot objects.

1. Any glass apparatus that is to be heated should be made of Pyrex® brand or Kimax® brand. It must be free of chips and cracks.
2. Gas burners should be kept away from the body at all times.
3. The pressure of the gas should be adjusted to allow proper ignition.
4. Too high a pressure tends to blow the flame out.
5. Do not allow gas to accumulate if ignition is delayed for any reason.
6. Never heat a closed container if there is no means of pressure relief.
7. Many substances, especially glass, remain hot for a long time after they are removed from the heat source.
8. Always check objects by bringing the back of the hand near them before attempting to pick them up without tongs, hot pads, or gloves.
9. Never set hot glassware on cold surfaces or in any other way change its temperature suddenly, because uneven contraction may cause breakage.

**PHY 4.12 Cryogenics**

1. Dry ice (solid carbon dioxide) is used in some low-friction pucks, as a source of carbon dioxide gas, and as a cooling agent.
2. A mixture of dry ice and alcohol or liquid nitrogen might also be used as low-temperature baths.
3. The temperatures of these materials are low enough to cause tissue damage from a cryogenic "burn."
4. This is not likely to occur if contact is brief, because the vapor layer formed between the cryogen and the tissue is not a good conductor of heat.
5. Follow the guidelines below to avoid a dry ice "burn."
6. Flush the skin that came into contact with the dry ice with water.
7. Water should always be readily available during cryogenic experiments.
8. In preparing a dry ice/alcohol mixture, pour the alcohol over the dry ice rather than dropping the dry ice into the alcohol to avoid spattering.
9. When storing alcohol that has been used in a dry ice/alcohol mixture, the alcohol should be returned to room temperature to allow the escape of excess dissolved gas before placing in a closed container.
10. When dry ice is used in a confined space, provide sufficient ventilation to eliminate the risk of asphyxiation.
11. This risk is caused when the more dense carbon dioxide gas released produces an oxygen-deficient layer.
12. Dry ice may produce large amounts of carbon dioxide. Students and other teachers should be warned of this risk and informed about avoiding it.
13. Cryogens should be kept in double-walled containers such as Thermos bottles or Dewars.
14. Any fluid which gets between the walls at low temperatures may become trapped and vaporize at higher temperatures, building up pressure and exploding the container.
15. The outer wall should be heavily wrapped to avoid this hazard.

**PHY 4.13**

**PHY 4.13.1 Compressed Gases**

Compressed gases can be hazardous because each cylinder contains large amounts of energy and may also have high flammability and toxicity potential. The following is a list of recommendations for storage, maintenance, and handling of compressed gas cylinders.

**PHY 4.13.1.1 Compressed Air**

1. Students in laboratories equipped with compressed air at lab stations or lecture tables should be warned of the danger of blowing dust or other debris into the eyes accidentally with compressed air.
2. High pressure air directed at glassware for drying purposes can provide enough force to knock containers from the hands.
3. The flow of air should be adjusted first to prevent this hazard.

**PHY 4.13.2 Care of Compressed Cylinders**

**PHY 4.13.2.1 Labels**

1. Make sure the contents of the compressed gas cylinder are clearly stenciled or stamped on the cylinder or on a durable label.
2. Do not identify a gas cylinder by the manufacturer’s color code.
3. Never use cylinders with missing or unreadable labels.
4. Label empty cylinders ―EMPTY‖ or ―MT‖ and date the tag; treat in the same manner that you would if it were full.

**PHY 4.13.2.2 Operations**

1. Check all cylinders for damage before use.
2. Be familiar with the properties and hazards of the gas in the cylinder before using.
3. Wear appropriate protective eyewear when handling or using compressed gases.
4. Use the proper regulator for each gas cylinder.
5. Do not tamper with or attempt to repair a gas cylinder regulator.
6. Never lubricate, modify, or force cylinder valves.
7. Open valves slowly using only wrenches or tools provided by the cylinder supplier directing the cylinder opening away from people.
8. Check for leaks around the valve and handle using a soap solution, ―snoop‖ liquid, or an electronic leak detector.
9. Close valves and relieve pressure on cylinder regulators when cylinders are not in use.

**PHY 4.13.2.3 Transport**

1. Always attach valve safety caps when storing or moving cylinders.
2. Transport cylinders with an approved cart with a safety chain; never move or roll gas cylinders by hand.

**PHY 4.13.2.4 Storage**

1. Securely attach all gas cylinders (empty or full) to a wall or laboratory bench with a clamp or chain, or secure in a metal base in an upright position.
2. Store cylinders by gas type, separating oxidizing gases from flammable gases by either 20 feet or a 30-minute firewall that is 5 feet high.
3. Store gas cylinders in cool, dry, well-ventilated areas away from incompatible materials and ignition sources.
4. Do not subject any part of a cylinder to a temperature higher than 125 °F or below 50 °F.
5. Store empty cylinders separately from full cylinders.

**PHY 4.14 Sound**

1. Usually physical science laboratory equipment and activities do not normally produce noise levels requiring use of hearing protection.
2. The OSHA Occupational Noise Standard (29 CFR 1910.95) has established a noise action level of 85 decibels (dBA) averaged over eight hours.
3. Wind tunnels, motors, engines and other laboratory equipment used in physical science laboratories have the potential to exceed the action level.
4. Science teachers should monitor sound levels and provide hearing protection for themselves and students.
5. It is advised that this be applied even below the action level.

**PHY 5: Radiation**

**PHY 5.1 Ionizing Radiation**

1. **The use of ionizing radiation sources in high school science laboratories is not allowed.**

**PHY 5.2 Non-Ionizing Radiation**

Near ultraviolet, visible light, infrared, microwave, radio waves, and low-frequency radio frequency (longwave) are all examples of non-ionizing radiation. By contrast, far ultraviolet light, X-rays, gamma-rays, and all particle radiation from radioactive decay are regarded as ionizing. Non-ionizing radiation can produce [non-mutagenic](http://en.wikipedia.org/wiki/Mutagen) effects such as inciting thermal energy in biological tissue that can lead to burns. Recently, the International Agency for Research on Cancer (IARC) from the WHO (World Health Organization) released a statement indicating that radiofrequency electromagnetic fields (including microwave and millimeter waves) are possibly carcinogenic to humans.

**PHY 5.2.1 Infrared Radiation**

1. Caution students that, beyond a limited exposure, infrared waves (heat waves) entering the eye can cause burns to the cells of the retina. Infrared lamps and the sun are concentrated sources of these waves.
2. Follow manufacturer’s instructions when using any infrared lamp.
3. The sun should never be viewed directly, especially at times when its visible light is partially obscured.
4. Lenses and sunglasses do not offer protection from this radiation.
5. Safe viewing of the sun can be done by projecting an image of it through a very small hole onto a white piece of paper about one-half meter behind the hole.

**PHY 5.2.2 Microwaves**

A microwave apparatus is often used to demonstrate various wave behaviors of electromagnetic radiation. Microwave devices designed for high school use have sufficiently low power to be free of radiation hazards when the manufacturer’s instructions are followed. Follow these guidelines:

1. RCSS policy forbids the use of microwaves in any classroom.
2. When using a microwave oven anywhere in the building
3. Check the apparatus for radiation leakage before use if there are any doubts about its safety.
4. Inspect ovens periodically to ensure they are clean and the door, hinges, vision screen, seals, and locks are secure and working properly.
5. Do not place metal objects in the heating cavity.
6. Do not permit students to stand close to an oven during operation.

**PHY 5.2.3 Radioisotopes**

The use of radioisotopes is forbidden in RCSS laboratories.

**PHY 5.2.4 Ultraviolet Radiation**

**PHY 5.2.4.1 Sources**

1. Sources of harmful ultraviolet light likely to be encountered in physics include mercury vapor lamps, electrical arcs (e.g., the carbon arc lamp), incandescent ultraviolet lamps, and the sun.
2. Mercury vapor lamps and electric arcs should not be observed without elimination of their ultraviolet emissions.
3. Incandescent ultraviolet lamps present a minimal danger from their ultraviolet emissions, as the energy of this radiation is very low.

**PHY 5.2.4.2 Personal Protection**

1. Protect eyes and skin from exposure of ultraviolet transilluminators.
2. Ultraviolet light can be absorbed in the outer layers of the eye, producing an inflammation known as conjunctivitis.
3. The effect usually appears several hours after exposure and, unless the exposure is severe, will disappear within several days.
4. Special glasses (such as those coated with an ultraviolet absorbing film) should be used when examining mineral samples with an ultraviolet lamp.
5. Only special goggles clearly designated for the purpose of absorbing ultraviolet light should be used.
6. Plastic or glass sheets which transmit poorly in the ultraviolet region offer good protection for the viewer of these sources.
7. Use black paper with caution because, while it absorbs well in the visible range, it may be highly reflective in the ultraviolet range.
8. Wear long sleeve shirts and lab coat with gloves.

**PHY 5.2.4.3 General Operating Considerations**

1. Maintain the illuminator in a room dedicated for the use of UV light.
2. Make sure the appropriate hazard warnings are posted prominently on the outside of the door.
3. The room should remain locked when not in use.
4. Only use a ground-fault circuit interrupter (GFCI) protected electrical receptacle for the lamp.
5. Never operate the lamp near water sources.
6. Never disassemble the lamp when plugged in – this is a high voltage power supply device.

**PHY 5.2.5 X-ray Radiation**

Any device that has the potential for producing X-rays is forbidden in RCSS laboratories.

**PHY 6: 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. 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.

1. 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.
2. These regulations specify safety features and classify lasers into four classes.
3. The least dangerous is Class 1, the most dangerous is Class 4.
4. **CAUTION: 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.**
5. 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.
6. 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.
7. However, because of the beam’s dazzling brightness, a long exposure can present hazards to the eyes.
8. Normal eye reflexes automatically prevent exposures longer than 0.25 second.
9. 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.

**PHY 7: Electrical Hazards**

**PHY 7.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**PHY 7.2 Electrical Apparatus**

**PHY 7.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**PHY 7.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**PHY 7.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**PHY 7.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**PHY 7.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**PHY 7.2.6 Power Cords**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

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**PHY 8: Vacuum and Pressure Hazards**

**PHY 8.1 Vacuums**

1. Full face shields should be worn whenever working with a system which could conceivably implode or explode.
2. Many popular physics demonstrations utilize a small vacuum pump to evacuate a chamber such as a bell jar, a coin-feather tube, or a collapsing metal can.
3. Under no circumstances should a standard thin-walled, flat-bottom jar be evacuated because of the likelihood of implosion.
4. If students are to be allowed to pump out a well-designed chamber, make sure it is firmly mounted so it cannot tip over and implode when under vacuum.
5. Any large evacuated chamber should be equipped with a screen shield to help provide protection following an implosion.
6. Such implosions can result from long-term stresses in glass or may result from thermal effects if heating occurs without opportunity to expand.
7. On small chambers where a screen is inconvenient or undesirable, the walls should be wrapped with tape to reduce the flying glass following an implosion.
8. When bell jars are used in demonstrations, remind students that they are specifically designed to withstand atmospheric pressure, and that one should never pump on a conventional container.

**PHY 8.2 Tubes and Implosions.**

1. Safety goggles or shields should be worn by all observers.
2. Vacuum tubes, especially large ones, present a safety hazard if the tube breaks.
3. Flying glass and electrodes can travel great distances when a tube implodes.
4. This is a particular danger when tubes such as a cathode ray tube, a TV picture tube, or a Crookes tube are used in a demonstration or experiment that removes them from a protective housing.
5. When an inoperable tube is to be discarded, it should be covered with a heavy canvas cloth and broken by striking the rear of the tube with a hammer.
6. The broken tube should then be carefully disposed of in the BROKEN GLASS CONTAINER!!!

**PHY 8.3 Vacuum Pumps.**

1. Vacuum pumps equipped with belts and pulleys must have the belt and pulley system shielded to prevent clothing and hands from getting caught.
2. This shield should also prevent injury from broken belts striking nearby observers.
3. Students should be warned to be careful of the hot motor and other parts after operation.

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## PHY 9: Rocketry

#### PHY 9.1 Local Regulations

Before beginning a model rocket program, check local school system regulations on the use of model rockets. Be sure also to check regulations about launch sites and fire codes in your area (See NFPA 1122 @ [http://www.nfpa.org](http://www.nfpa.org/) )

**PHY 9.2 Model Rocketry Safety Code**

* 1. **Construction.** In making model rockets, use only lightweight materials such as paper, wood, plastic, and rubber; use no metal as structural parts.
  2. **Engines**. Use only pre-loaded, factory-made model rocket engines in the manner recommended by the manufacturer. Do not alter or attempt to reload the engines.
  3. **Flying Conditions**. Do not launch a rocket in high winds or near buildings, power lines, tall trees, low flying aircraft, or under any conditions that might endanger people or property, such as the threat of lightning.
  4. **Jet Deflector**. The launcher must have a jet deflector device to prevent the engine exhaust from hitting the ground directly.

**PHY 9.2. Launch**

* 1. Check the stability of model rockets before their first flight, except when launching models of proven stability.
  2. Model rockets must weigh no more than 453 grams at liftoff, and the engine must contain no more than 113 grams of propellant.
  3. When conducting research activities with unproven designs or methods, try to determine their reliability through pre-launch tests.
  4. Conduct launching of unproven designs in complete isolation from persons not participating in the actual launching.
  5. Always launch rockets from a cleared area that is free of any easy-to-burn materials; use non-flammable recovery wadding.
  6. To prevent accidental eye injury, always place the launcher so the end of the rod is above eye level, or cap the end of the rod with the hand when approaching it.
  7. Never place head or body over the launching rod. When the launcher is not in use, always store it so that the launch rod is not in an upright position.
  8. Do not let anyone approach a model rocket on a launcher until making sure that either the safety interlock key has been removed or the battery has been disconnected from the launcher.
  9. Do not launch a rocket so its flight path will carry it against a target on the ground; never use an explosive warhead nor a payload that is intended to be flammable. The launching device must always be pointed within 30 degrees of vertical.
  10. The system used to launch model rockets must be remotely controlled and electrically operated, and must contain a switch that will return to "off" when released. All persons should remain at least 10 feet from any rocket that is being launched.

**PHY 9.3 Recovery**

1. Never attempt to recover a rocket from a power line or other dangerous places.
2. Always use a rocket system with model rockets that will return them safely to the ground so that they may be flown again.

**PHY 10: Chemical Safety in the Physics Laboratory**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

**PHY 10.1 Specific Chemical Hazards Associated with Physics**

**PHY 10.1.1 Carbon Dioxide**

The use of dry ice in cryogenic experiments must be accompanied by precautions against production of an oxygen-deficient atmosphere. Carbon dioxide, which is denser than air, easily collects in a non-ventilated area.

**PHY 10.1.2 Carbon Monoxide**

Do not allow carbon monoxide from incomplete combustion to collect in a closed area. Always conduct demonstrations using small internal combustion engines under a vented hood or outdoors.

**PHY 10.1.3 Explosives**

1. Making explosive compounds such as those that might be used in model rocketry is forbidden in RCSS labs.
2. Only factory-made, pre-loaded rocket engines should be used for this purpose.

**PHY 10.1.4 Mercury and Other Heavy Metals**

1. The use of free mercury, lead, cadmium, or other heavy metals is forbidden in RCSS laboratories.
2. The use of equipment containing mercury, lead, cadmium, or other heavy metals is forbidden in RCSS laboratories.
3. The use of lead, cadmium, or other heavy metal based solder is forbidden in RCSS laboratories.

**PHY 10.2 Flammable Materials**

**PHY 10.2.1 Safety Concerns**

1. Do not use flammable substances near an open flame unless the purpose is to demonstrate flammability.
2. Many flammables produce toxic fumes and should be burned only under a vented hood.
3. Large containers of flammable liquids should be opened, and liquids transferred, in a room free from open flames or electrical arcs and, preferably, under a fume hood.

**PHY 10.2.2 Storage**

Guidelines for flammable storage must follow **O.C.G.A. 25-2, O.C.G.A. 45-22-2, OSHA Standard 29 CFR 1910**, and **NFPA 45:Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

All cabinets for storage of flammable materials must be in compliance with statutes, regulations and local ordinances promulgated pursuant to **O.C.G.A. Title 25, Chapter 2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals**. In addition, all flameproof cabinets must meet the design and installation criteria set forth in the **NFPA's latest version of NFPA 30: Flammable and Combustible Liquids Code.**

1. The maximum allowable quantity for flammable liquid storage in any size lab is not to exceed 480 liters.
2. Regarding flammable liquid storage outside of approved flammable storage cabinets: there may be a maximum of 40 liters of flammable liquids in original containers and an additional 100 liters in approved safety cans not to exceed 8 liter size (**NFPA 45**).
3. NFPA specified safety cabinets MUST be used for storage of flammable liquids.
4. High schools should not be in possession of any flammable liquid that requires storage in explosion-proof refrigerators and/or freezers.
5. All flammables must be stored by compatibility.

**PHY 10.3 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**PHY 10.4 Labeling of Chemical Containers**

No unlabeled substance should be present in the laboratory at any time!

1. Use labels with good adhesive.
2. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
3. Print clearly and visibly.
4. Replace damaged, faded, or semi-attached labels.

**PHY 10.4.1 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**PHY 10.4.2 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration or purity
7. Date prepared
8. Expiration or ―use by date

**PHY 10.4.3 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**PHY 10.4.4 Chemical Waste**

All containers used for chemical waste should be labeled with the following:

* 1. HAZARDOUS WASTE
  2. Chemical name (as it appears on the MSDS)
  3. Accumulation start date
  4. Hazard(s) associated with the chemical waste
  5. Date generated

**PHY 10.5 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**PHY 10.6 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**PHY 10.7 Chemical Waste**

According to EPA regulations, the following four characteristics define a waste as hazardous:

* Ignitability
* Corrosiveness
* Reactivity
* Toxicity

Management and disposal of laboratory waste in containers are regulated under RCRA regulations. These laboratory waste streams include used chemicals, residues from experiments, spill cleanup, expired or off-spec chemicals and other chemical waste. It is the school's responsibility to make a hazardous waste determination. This includes spent chemicals used in the lab, expired or unwanted chemicals, contaminated gloves, and any spill cleanup debris. Schools must ensure that a RCRA hazardous waste is safely accumulated and transported off-site for proper disposal. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply.

**PHY 10.7.1 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**PHY 10.7.1.1 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used.

* Nitric Acid
* Hydrofluoric Acid
* Hexavalent Chrome
* Cyanides
* Oxidizers
* Reducing Agents
* Sulfides
* Palladium
* High pH Alkaline Solutions
* Low pH Acidic Solutions
* Non-Chlorinated Solvents
* Chlorinated Solvents

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Clearly and permanently label each container as to its contents and label as hazardous waste.
4. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
5. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**PHY 10.7.1.2 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when pick-up occurred.

**PHY 10.7.1.3 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**PHY 11: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the vent a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**PHY 11.1 Preventing Burns and Fires**

**PHY 11.1.1 When planning to heat materials or use open flames**

1. Instruct students on STOP DROP AND ROLL in the event clothing catches fire.
2. Make sure students know how to evacuate the classroom in the event of a large fire.
3. Know the location of the nearest fire extinguisher and know how to use it.
4. Have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**PHY 11.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. Make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. Do not allow students to work with hot materials, such as very hot water.
5. Do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. Do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. Handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**PHY 11.1.3 When using hot plates**

1. Do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. Do not place the hot plate on paper or wooden surfaces.
3. Place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use.
5. Keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. Make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**PHY 11.1.4 When using open flames**

1. Use only safety matches. Make sure the matches are stored in a secure place between uses.
2. Closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. Closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. Use tea candles that are short and wide, and cannot be knocked over in normal use.
5. Place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. Never leave the room while a flame is lit or other heat source is in use.

**PHY 11.1.5 Bunsen Burner Safety Guidelines**

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do leave the laboratory while the burner is on and do not leave open flames unattended.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

**PHY 11.2 In the event of a large, uncontainable fire**

1. Evacuate the classroom immediately.
2. Locate and pull the nearest fire alarm.
3. Notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**PHY 11.3 In the event of a small, containable fire**

1. Identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**PHY 11.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite. Periodically check on the location and condition of fire extinguishers.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

**PHYSICAL SCIENCE**

**LABORATORIES**

Safety in the physical science classroom requires knowledge of physics and chemistry hazards. It also require thorough planning, careful management, and constant monitoring of student activities. Teachers should be knowledgeable of the properties, possible hazards, and proper use and disposal of all materials used in the classroom.

## PHYSCI 1: Required Materials for the High School Physical Science Lab

* Broken Glass Container
* Fire Extinguisher
* Spill Kit
* First Aid Kit
* MSDS Notebook
* Chemical Waste Disposal Containers

### PHYSCI 2.2: Eye Protection

### PHYSCI 2.1 What is your obligation?

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### PHYSCI 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. As a responsible teacher, you must select eyewear that provides you and your students with the most appropriate protection for the hazards of your science activities. Effective eye protection must include adequate instruction on the hazards of the particular activity and of the precautions to be followed to reduce the risk of injury. It must also include instructions and modeling of the protective equipment.

Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress (e.g., springs, wires, rubber, glass), or causes collisions
4. When dust or fumes are present (Eye protection reduces the dust or fumes reaching the eye.)
5. When using preserved specimens

### PHYSCI 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**PHYSCI 2.4 Disinfecting Goggles**

* 1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes.. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
  2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
  3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### PHYSCI 2.5 What is the current recommendation for wearing contact lenses?

1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
5. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
6. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133, p.16343.

**PHYSCI 3: Glassware**

**PHYSCI 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**PHYSCI 3.2 General Cautions**

**PHYSCI 3.2.1 Broken Glass**

1. Use glassware that is without defect and has smooth edges.
2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
4. All glass tubing should be fire-polished.

**PHYSCI 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

1. nested beakers that have been jammed together.
2. stoppers that cannot be removed from bottles.
3. stopcocks that cannot be moved.

**PHYSCI 3.2.3 Hot Glass**

1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**PHYSCI 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score.
7. Wrap the glass in a towel.
8. Place the thumbs together opposite the scratch.
9. Pull and bend in one quick motion.
10. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner.
11. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
12. Place the glass on insulating material to cool.

**PHYSCI 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**PHYSCI 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**PHYSCI 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**PHYSCI 3.5 Cleaning**

1. Clean immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**PHYSCI 3.6 Disposal**

1. Defective glassware should be disposed of correctly.
2. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY.**

**PHYSCI 4: Common Hazards**

**PHYSCI 4.1 Masses and Weights**

1. Heavy masses may be used in experiments involving Atwood’s machine, free fall, Newton’s laws, and momentum.
2. Warning should be given to students to prevent hands and feet from being caught between a moving heavy mass and floor or table surfaces.
3. 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.
4. 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.
5. This will help avoid damage to the masses and also prevent the mass from rolling away.

**PHYSCI 4.2 Steam**

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

**PHYSCI 4.3 High-speed Rotation**

1. Rotators are sometimes used to demonstrate centripetal force, circular motion, and sound phenomena.
2. Any device attached to a rotator should be fastened securely and checked for tightness frequently.
3. Observers should avoid contact with moving accessories such as toothed wheels, siren discs, etc.
4. Loose clothing and long hair should be kept away from moving parts, and observers should not be in the plane of rotation.
5. The use of safety goggles should be considered in student laboratories investigating centripetal force.
6. Extremely high-speed rotation should be avoided when possible.
7. High speeds may cause some objects to fly apart unexpectedly.

**PHYSCI 4.4 Strobe Lights**

1. A strobe light is sometimes used to illuminate a rotating object, making the object appear to be at rest.
2. If the object is a fan blade, a toothed wheel, or anything else with sharp edges, there is danger of injury from touching or inserting an object into the apparently stationary object.
3. Students should be cautioned against staring at the pulsating light for extended periods of time as this may create sensory disturbances in susceptible individuals.
4. Students prone to epileptic seizures should not participate in lab activities requiring the use of a strobe light; strobe lights are often used in clinical settings to induce seizures.

**PHYSCI 4.5 Magnets**

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

**PHYSCI 4.6 Projectiles**

1. Students must be careful when projecting objects (steel balls or marbles).
2. In demonstrating the flight of any projectile, students should be kept clear of the path and impact area.
3. The teacher should always pretest the projectile to determine the path it will follow and its range as well as the amount of variability to be expected.
4. Sharp-pointed objects should not be used as projectiles.
5. Use of safety goggles is mandatory.
6. A simple mechanical launcher (e.g., compressed spring, compressed air, stretched elastic) should be used.
7. It should only be "loaded" at the specific time a flight is to be observed.
8. Springs
9. Stretched or compressed springs contain mechanical potential energy.
10. A stretched spring, unexpectedly released, can pinch fingers.
11. A compressed spring, when suddenly released, can send an object at high velocity toward an observer.
12. Care should be taken to avoid unexpected release of the spring’s energy when working with dynamics carts, spring-type simple harmonic oscillators, and springs used in wave demonstrations.

**PHYSCI 4.7 Electrostatic Generators**.

1. Electrostatic generators used in demonstrations of static electricity produce high voltages (about 105 volts) with very low currents.
2. The danger of these generators depends on their size and capacity to produce enough current to be dangerous.
3. In many cases the shock from such devices is very quick and not harmful.
4. The startling effect, however, can be detrimental to persons with heart conditions.
5. In general, experiments that use human subjects to demonstrate the effect of electrical shock should not be attempted due to the large variation in physical and physiological factors.
6. Leyden jars -- which can be charged with electrostatic generators -- are especially dangerous because of their capacity to store a charge for long periods of time.
7. An accidental discharge through a person can be avoided by properly shorting the devices after use

**PHYSCI 4.8 Heating Procedures**

Often it is necessary to heat liquids and solids in physics experiments and demonstrations. It is safer to use water baths and hot plates than to heat directly with open flames such as with Bunsen burners. Below are guidelines for heating and handling hot objects.

1. Any glass apparatus that is to be heated should be made of Pyrex® brand or Kimax® brand. It must be free of chips and cracks.
2. Gas burners should be kept away from the body at all times.
3. The pressure of the gas should be adjusted to allow proper ignition.
4. Too high a pressure tends to blow the flame out.
5. Do not allow gas to accumulate if ignition is delayed for any reason.
6. Never heat a closed container if there is no means of pressure relief.
7. Many substances, especially glass, remain hot for a long time after they are removed from the heat source.
8. Always check objects by bringing the back of the hand near them before attempting to pick them up without tongs, hot pads, or gloves.
9. Never set hot glassware on cold surfaces or in any other way change its temperature suddenly, because uneven contraction may cause breakage.

**PHYSCI 4.9 Cryogenics**

1. Dry ice (solid carbon dioxide) is used in some low-friction pucks, as a source of carbon dioxide gas, and as a cooling agent.
2. A mixture of dry ice and alcohol or liquid nitrogen might also be used as low-temperature baths.
3. The temperatures of these materials are low enough to cause tissue damage from a cryogenic "burn."
4. This is not likely to occur if contact is brief, because the vapor layer formed between the cryogen and the tissue is not a good conductor of heat.
5. Follow the guidelines below to avoid a dry ice "burn."
6. Flush the skin that came into contact with the dry ice with water.
7. Water should always be readily available during cryogenic experiments.
8. In preparing a dry ice/alcohol mixture, pour the alcohol over the dry ice rather than dropping the dry ice into the alcohol to avoid spattering.
9. When storing alcohol that has been used in a dry ice/alcohol mixture, the alcohol should be returned to room temperature to allow the escape of excess dissolved gas before placing in a closed container.
10. When dry ice is used in a confined space, provide sufficient ventilation to eliminate the risk of asphyxiation.
11. This risk is caused when the more dense carbon dioxide gas released produces an oxygen-deficient layer.
12. Dry ice may produce large amounts of carbon dioxide. Students and other teachers should be warned of this risk and informed about avoiding it.
13. Cryogens should be kept in double-walled containers such as Thermos bottles or Dewars.
14. Any fluid which gets between the walls at low temperatures may become trapped and vaporize at higher temperatures, building up pressure and exploding the container.
15. The outer wall should be heavily wrapped to avoid this hazard.

**PHYSCI 4.10 Sound**

1. Usually physical science laboratory equipment and activities do not normally produce noise levels requiring use of hearing protection.
2. The OSHA Occupational Noise Standard (29 CFR 1910.95) has established a noise action level of 85 decibels (dBA) averaged over eight hours.
3. Wind tunnels, motors, engines and other laboratory equipment used in physical science laboratories have the potential to exceed the action level.
4. Science teachers should monitor sound levels and provide hearing protection for themselves and students.
5. It is advised that this be applied even below the action level.

## PHYSCI 5: Rocketry

#### PHYSCI 5.1 Local Regulations

Before beginning a model rocket program, check local school system regulations on the use of model rockets. Be sure also to check regulations about launch sites and fire codes in your area (See NFPA 1122 @ [http://www.nfpa.org](http://www.nfpa.org/) )

**PHYSCI**  5**.2 Model Rocketry Safety Code**

1. **Construction.** In making model rockets, use only lightweight materials such as paper, wood, plastic, and rubber; use no metal as structural parts.
2. **Engines**. Use only pre-loaded, factory-made model rocket engines in the manner recommended by the manufacturer. Do not alter or attempt to reload the engines.
3. **Flying Conditions**. Do not launch a rocket in high winds or near buildings, power lines, tall trees, low flying aircraft, or under any conditions that might endanger people or property, such as the threat of lightning.
4. **Jet Deflector**. The launcher must have a jet deflector device to prevent the engine exhaust from hitting the ground directly.

**PHYSCI 5.2. Launch**

1. Check the stability of model rockets before their first flight, except when launching models of proven stability.
2. Model rockets must weigh no more than 453 grams at liftoff, and the engine must contain no more than 113 grams of propellant.
3. When conducting research activities with unproven designs or methods, try to determine their reliability through pre-launch tests.
4. Conduct launching of unproven designs in complete isolation from persons not participating in the actual launching.
5. Always launch rockets from a cleared area that is free of any easy-to-burn materials; use non-flammable recovery wadding.
6. To prevent accidental eye injury, always place the launcher so the end of the rod is above eye level, or cap the end of the rod with the hand when approaching it.
7. Never place head or body over the launching rod. When the launcher is not in use, always store it so that the launch rod is not in an upright position.
8. Do not let anyone approach a model rocket on a launcher until making sure that either the safety interlock key has been removed or the battery has been disconnected from the launcher.
9. Do not launch a rocket so its flight path will carry it against a target on the ground; never use an explosive warhead nor a payload that is intended to be flammable. The launching device must always be pointed within 30 degrees of vertical.
10. The system used to launch model rockets must be remotely controlled and electrically operated, and must contain a switch that will return to "off" when released. All persons should remain at least 10 feet from any rocket that is being launched.

**PHYSCI 5.3 Recovery**

1. Never attempt to recover a rocket from a power line or other dangerous places.
2. Always use a rocket system with model rockets that will return them safely to the ground so that they may be flown again.

**PHYSCI 6: Chemical Safety in the Physical Science Laboratory**.

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

**PHYSCI 6.1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**PHYSCI 6.2 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**PHYSCI 6.2.1 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**PHYSCI 6.2.2 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration
7. Date prepared
8. Expiration or ―use by date

**PHYSCI 6.2.3 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**PHYSCI 6.2.4 Chemical Waste**

1. All containers used for chemical waste should be labeled with the following:
2. HAZARDOUS WASTE
3. Chemical name (as it appears on the MSDS)
4. Accumulation start date
5. Hazard(s) associated with the chemical waste
6. Date generated

**PHYSCI 6.3 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**PHYSCI 6.4 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
2. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
3. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**PHYSCI 6.4.2 Chemical Waste**

According to EPA regulations, the following four characteristics define a waste as hazardous:

* Ignitability
* Corrosiveness
* Reactivity
* Toxicity

Management and disposal of laboratory waste in containers are regulated under RCRA regulations. These laboratory waste streams include used chemicals, residues from experiments, spill cleanup, expired or off-spec chemicals and other chemical waste. It is the school's responsibility to make a hazardous waste determination. This includes spent chemicals used in the lab, expired or unwanted chemicals, contaminated gloves, and any spill cleanup debris. Schools must ensure that a RCRA hazardous waste is safely accumulated and transported off-site for proper disposal. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply.

**PHYSCI 6.4.2 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**PHYSCI 6.4.2.1 Segregation and Storage of Waste**

1. Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used.

* Nitric Acid
* Hydrofluoric Acid
* Hexavalent Chrome
* Cyanides
* Oxidizers
* Reducing Agents
* Sulfides
* Palladium
* High Ph Alkaline Solutions
* Low Ph Acidic Solutions
* Non-Chlorinated Solvents
* Chlorinated Solvents

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
2. Store all waste in containers that are in good condition and are compatible with their contents. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
3. Clearly and permanently label each container as to its contents and label as hazardous waste.
4. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access. Store waste bottles away from sinks and floor drains.
5. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**PHYSCI 6.4.2.2 Disposal of Hazardous Waste**

1. **THE USE OF SINKS FOR THE DISPOSAL OF CHEMICALS IS STRICTLY PROHIBITED!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document when pick-up was requested and when pick-up occurred.

**PHYSCI 6.4.2.3 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**PHYSCI 7: Electrical Hazards**

**PHYSCI 7.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**PHYSCI 7.2 Electrical Apparatus**

**PHYSCI 7.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**PHYSCI 7.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**PHYSCI 7.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**PHYSCI 7.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**PHYSCI 7.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**PHYSCI 7.2.6 Power Cords**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**PHYSCI 8: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the vent a fire does occur, teachers need to know how to respond appropriately. the following information is provided as guidance in preventing or combatting fires in the science laboratory.

**PHYSCI 8.1 Preventing Burns and Fires**

**PHYSCI 8.1.1 When planning to heat materials or use open flames**

1. Instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. Make sure students know how to evacuate the classroom in the event of a large fire
3. Know the location of the nearest fire extinguisher and know how to use it.
4. Have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**PHYSCI 8.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. Make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. Do not allow students to work with hot materials, such as very hot water.
5. Do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. Do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. Handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**PHYSCI 8.1.3 When using Hot Plates**

1. Do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. Do not place the hot plate on paper or wooden surfaces.
3. Place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use.
5. Keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. Make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**PHYSCI 8.1.4 When using open flames**

1. Use only safety matches. Make sure the matches are stored in a secure place between uses.
2. Closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. Closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. Use tea candles that are short and wide, and cannot be knocked over in normal use.
5. Place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. Never leave the room while a flame is lit or other heat source is in use.

**PHYSCI 8.1.5 Bunsen Burner Safety Guidelines**

Bunsen burners present fire hazards. They produce an open flame and burn at a high temperature, and as a result, there is potential for an accident to occur. For the safety and convenience of everyone working in a laboratory, it is important that the following guidelines be observed.

1. Remove all papers, notebooks, combustible materials and excess chemicals from the area.
2. Tie-back any long hair, dangling jewelry, or loose clothing.
3. Inspect hose for cracks, holes, pinch points or any defect and ensure that the hose fits securely on the gas valve and the burner. Replace all hoses found to have a defect before using.
4. Notify others in the laboratory that the burner will be in use.
5. Have the sparker/lighter available before turning on the gas.
6. Utilize a sparker/lighter with extended nozzle to ignite the burner. Never use a match to ignite a burner.
7. Adjust the flame by turning the collar to regulate air flow and produce an appropriate flame for the experiment (typically a medium blue flame).
8. Do leave the laboratory while the burner is on and do not not leave open flames unattended.
9. Shut off gas when its use is complete.
10. Allow the burner to cool before handling. Ensure that the main gas valve is off before leaving the laboratory.

**PHYSCI 8.2 In the event of a large, uncontainable fire**

1. Evacuate the classroom immediately.
2. Locate and pull the nearest fire alarm.
3. Notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**PHYSCI 8.3 In the event of a small, containable fire**

1. Identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**PHYSCI 8.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite. Periodically check on the location and condition of fire extinguishers.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

.

**CHEMISTRY**

**LABORATORIES**

Chemistry laboratories are inherently dangerous places as chemicals, glassware, fire, and electrical equipment regularly interface in restricted spaces. Maintaining safe conditions in a chemistry laboratory, prep room, and storage area requires knowledge and vigilance on the part of the chemistry teacher. It requires care in ordering, storing, using, and disposing of chemicals. While chemical safety is the responsibility of everyone who uses the classroom laboratory, safe management of the chemistry laboratory and chemical stock begins with the teacher who orders and uses these products. Careful attention to the following guidelines will prevent the majority of accidents and incidents commonly seen in high school chemistry labs.

## CHM 1: Required Materials for the High School Chemistry Lab

1. Broken Glass Container
2. Fire Extinguisher
3. Safety Shower and Eye Wash
4. Fume Hood
5. Spill Kit
6. First Aid Kit
7. MSDS Notebook
8. Chemical Waste Disposal Containers

### CHM 2: Eye Protection

Teachers owe their students a duty of care. A teacher must reasonably address all foreseeable dangers inherent in any laboratory experiment or demonstration that will be performed in the science laboratory or classroom. A teacher must also instruct and ensure that students demonstrate the proper use of protective equipment.

### CHM 2.1 What is your obligation?

An important obligation of science teachers is to provide students with appropriate eye protection. **Provision and Maintenance of PPE - 29 CFR §1910.132(d) Personal Protective Equipment, General Requirements Standard** requires a hazard assessment to determine PPE needs and teachers must be trained in use and care of goggles.

### CHM 2.2 What circumstances require eye protection?

Eye protection is a must in any hazardous laboratory activity or demonstration in science. Protection of the eyes is essential in any laboratory activity. Eye protection is required (but not limited to):

1. When chemicals, glassware, or a heating source is being used
2. When working with solid materials or equipment under stress, pressure, or force that might cause fragmentation or flying particles
3. When an activity generates projectiles, or uses elastic materials under stress, or causes collisions
4. When dust or fumes are present
5. When using preserved specimens

### CHM 2.3 Choosing the best eye protection

Only safety goggles provide the level of protection needed for your laboratory activities when dealing with hazardous liquids or solids. A safety goggle fits the face surrounding the eyes; it should have a soft pliable flange, which seals around the eyes snugly to protect the eyes. In addition, safety goggles, with side shields or without side shields, provide adequate protection for laboratory activities involving use of solids such as meter sticks, projectiles, etc. Safety goggles should also be the standard for eye protection when chemicals, glassware, a heating source, or preserved specimens are being used.

**CHM** **2.4 Disinfecting Goggles**

1. When using the safety goggle cabinet, the ultraviolet light timer should be set for a minimum of ten (10) minutes. Sanitation of goggles is accomplished best by usage of a UV cabinet. Treatment with UV light will destroy the goggles over several years.
2. Hot soapy water and thorough drying between uses of shared goggles is also [recommended by the ACS](http://portal.acs.org/portal/fileFetch/C/CNBP_023457/pdf/CNBP_023457.pdf).
3. Chemical Disinfection: After student use, wash the goggles in soapy water followed by a ten (10) minute rinse in five percent bleach solution (10:1 ratio - 10 parts water to 1 part bleach). The goggles should be allowed to air dry.

### CHM 2.5 What is the current recommendation for wearing contact lenses?

1. The American Chemical Society Committee on Chemical Safety states that contact lenses can be worn in the laboratory provided that approved eye protection is worn as required of others in the laboratory.
2. The National Institute for Occupational Health and Safety (NIOSH) recommends that workers be permitted to wear contact lenses when handling hazardous chemicals provided adequate face and eye protection is worn.
3. The Council of State Science Supervisors states that contact lenses can be worn provided "specially marked, non-vented safety goggles are available to contact lens wearers".
4. The Occupational Safety and Health Administration (OSHA) believes that contact lenses do not pose additional hazards to the wearer and has determined that additional regulation addressing the use of contact lenses is unnecessary.
   1. The agency wants to make it clear, however, that contact lenses are not eye protection devices. If eye hazards are present, appropriate eye protection must be worn instead of, or in conjunction with, contact lenses."
   2. Regulations (Preamble to Final Rules) Personal Protective Equipment for General Industry (Amended Final Rule, April 1994) Section 3- III Summary and Explanation of the Final Rule 1910.133, p.16343.

**CHM 3: Glassware**

**CHM 3.1 Injuries from Glassware**

Glassware is the number one source of injury in the laboratory setting. More students are cut by damaged glassware and burned by heated glassware that are harmed by any other object or circumstance in the lab. To ensure the safety of students in the middle school laboratory, substitute plastic lab ware for glassware where possible. New plastics like polycarbonate (Lexan®) have been successfully used for laboratory containers. While not useful for heating, the plastic is clear and extremely hard and can be used for almost all water soluble compounds. Beakers, flasks, graduated cylinders, and thermometers now are available in plastic. Check with your science supply company.

**CHM 3.2 General Cautions**

**CHM 3.2.1 Broken Glass**

* 1. Use glassware that is without defect and has smooth edges.
  2. One of the most important ways to prevent glassware related injuries is to check the pieces for chips or cracks. Any damaged glassware should be disposed of in the appropriate container.
  3. Glassware should have no cracks, chips, or scratches. In particular, be wary of “star cracks” that can form on the bottom of beakers and flasks. Any glassware with such cracks should be properly disposed of immediately.
  4. All glass tubing should be fire-polished.

**CHM 3.2.2. “Frozen” Glass**

Be careful with glassware that is “frozen.” Only teachers, wearing goggles and gloves, should try to release the “frozen” glassware. If this fails, discard the glassware. Some common cases of “frozen” glassware are:

* 1. nested beakers that have been jammed together.
  2. stoppers that cannot be removed from bottles.
  3. stopcocks that cannot be moved.

**CHM 3.2.3 Hot Glass**

* 1. Use only Kimax® or Pyrex® brand glassware when heating substances. Common glass can break or shatter, causing serious injuries in the lab.
  2. Use care when working with hot glass. Hot glass looks exactly the same as room temperature glass.
  3. Do not leave hot glassware unattended, and allow ample time for the glass to cool before touching.
  4. Check the temperature of the glassware by placing your hand near, but not touching, the potentially hot glass.
  5. Have hot pads, thick gloves, or beaker tongs available for grasping hot glassware.
  6. Never set hot glassware on cold surfaces or in any way change its temperature suddenly. Even a Pyrex® or Kimax® beaker will break if cold water is poured into a hot beaker.

**CHM 3.2.4 Glass Tubing**

1. Make sure that the tubing is without chips or cracks.
2. Use the appropriate diameter tubing for the task.
3. Make sure the ends of the tubing are fire polished.
4. When breaking tubing:
5. Use gloves or towels to protect hands when breaking glass tubing. Use goggles to protect the eyes.
6. Scratch the glass once with a file or score. Wrap the glass in a towel.
7. Place the thumbs together opposite the scratch. Pull and bend in one quick motion.
8. Fire polish the broken ends: hold the glass so that the sharp end is in the top of the flame of a gas burner. Rotate the tube so all sides are heated evenly, causing the sharp edges to melt and become smooth.
9. Place the glass on insulating material to cool.

**CHM 3.2.5 Bending**

Bending glass tubing is often necessary. Follow these procedures:

1. Place a wing-top attachment on a gas burner and heat the area of the glass to be bent while holding it with one hand on each end, rotating to ensure even heating.
2. When the glass is soft and pliable, remove it from the flame and quickly bend to the desired shape.
3. Place on insulating material until cool.

**CHM 3.3 Types and Appropriate Use of Glassware**

To prevent glassware related injuries always use the correct type of glass for the task you are doing. For example, a graduated cylinder should be used to measure the volume of a liquid, not as a container in which to run chemical reactions. Likewise, a watch glass should not be used to mix chemical compounds, but as a cover over a heated reaction vessel.

**CHM 3.3.1 Proper Use**

Each type of glassware has its proper use and should be used only for its intended purpose.

1. **For measuring volume**:

|  |  |  |
| --- | --- | --- |
| pipets | burets | graduated cylinders |
| dropper pipets |  | volumetric flasks |

1. **For storing solids and liquids:**

|  |  |
| --- | --- |
| bottles | vials |

1. **For containing reactive chemicals during experiments:**

|  |  |  |
| --- | --- | --- |
| beakers | flasks | test tubes |
| crucibles | watch glasses | test plates |

1. **For transferring liquids and gases**:

|  |  |  |
| --- | --- | --- |
| glass tubing | funnels | pipets |

1. **For measuring temperature:**

|  |  |
| --- | --- |
| digital thermometers | alcohol thermometers |

**CHM 3.5 Cleaning**

1. Clean glassware immediately after use. The longer glassware sits, the harder it is to clean.
2. Use laboratory-grade detergents or liquid dishwashing detergent such as Dawn® for cleaning glassware.
3. When using brushes, make sure to use the appropriate size brush; make sure the metal part of the brush does not scratch the glass.  
   Rinse glassware with deionized water.
4. Allow glassware to air dry on paper towels, drying pads, or drying racks.

**CHM 3.6 Disposal**

1. Use a dustpan and brush to pick up broken glass. Never pick up broken glass you’re your bare hands.
2. Defective glassware should be disposed of correctly.
3. Glassware should be disposed of in a separate container from normal trash. Such container should be clearly labeled **BROKEN GLASSWARE ONLY**

**CHM 4: Special Concerns**

**CHM 4.1 Heating Procedures**

Often it is necessary to heat liquids and solids in physics experiments and demonstrations. It is safer to use water baths and hot plates than to heat directly with open flames such as with Bunsen burners. Below are guidelines for heating and handling hot objects.

1. Any glass apparatus that is to be heated should be made of Pyrex® brand or Kimax® brand. It must be free of chips and cracks.
2. Never heat a closed container if there is no means of pressure relief.
3. Many substances, especially glass, remain hot for a long time after they are removed from the heat source.
4. Always check objects by bringing the back of the hand near them before attempting to pick them up without tongs, hot pads, or gloves.
5. Never set hot glassware on cold surfaces or in any other way change its temperature suddenly, because uneven contraction may cause breakage

**CHM 4.2 Chromatography**

1. Chemical splash safety goggles and aprons should be worn.
2. Only Pyrex or comparable glass tubes should be used.
3. Dissolving and developing solvents give off toxic vapors. They must be stored in closed containers and the room
4. Solvents are highly flammable and must not be used near an open flame.
5. Avoid skin contact when spraying the developing solvents.
6. Use a fume hood when appropriate.
7. Consider the solvent and pigment mixture to be hazardous waste. Store and dispose of appropriately.

**CHM 4.3 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. When large numbers of students are performing flame tests, the potential exists for individual acute toxicity exposure or instructor chronic toxicity exposure.

**CHM 4.3.1 Chemicals Often Used in Flame Tests**

**Table CHM 4.3.1.1**

|  |  |  |
| --- | --- | --- |
| **Health** | **Safety** | **Compound** |
| 1 | 0 | Sodium Chloride (NaC1 ) |
| 2 | 1 | Strontium Chloride (SrCl2 ) |
| 3 | 1 | Lithium Chloride (LiC1 ) |
| 3 | 1 | Copper Chloride (CuCl2 ) |
| 4 | 1 | Barium Chloride (BaC12 ) |

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

**CHM 4.3.1.2 Precautions**

1. Goggles and lab aprons are required.
2. In poorly ventilated or confined laboratories, flame tests should be performed in a fume hood.
3. The general nature of an unknown compound should be ascertained before performing a flame test.
4. 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.
5. The wire and holding device should be placed on an insulated mat and allowed to cool thoroughly before handling.
6. An overloaded wire causes splattering and material can fall into the burner jets, causing blockage.
7. Unknown chemicals should not be placed in the flame.
8. It is recommended that teachers use spectrum tubes to show the properties of spectrum analysis.
9. 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.

**CHM 5: Electrical Hazards**

**CHM 5.1 Burns and Shock**

1. Many electrical devices become quite hot while in use.
2. In addition, "shorted" dry cells and batteries can produce very high temperatures.
3. Students should never grasp a recently operated device or wiring without first checking for excess heat.
4. Students must be warned of the high death potential present even when the voltage is low.
5. The severity of an electrical shock depends primarily on the amount of current to which a person is exposed.
6. Since the current is related to the resistance and voltage, these two factors, as well as the part of the body involved and the duration of the contact, determine the extent of injuries to the victim.
7. If the skin is wet or the surface broken, the resistance drops off rapidly, permitting the current to flow readily through the bloodstream and body tissues.

**CHM 5.2 Electrical Apparatus**

**CHM 5.2.1 Batteries**

1. A battery is an unregulated source of current capable of producing large currents when resistance is low.
2. When short-circuited, connecting wires can become very hot, raising the risk of burns. Short-circuited mercury batteries may even explode.
3. Chemical leakage from batteries is a potential hazard, especially in the case of wet cells that contain caustic chemicals such as sulfuric acid.
4. Certain types of batteries are rechargeable while others are not.
5. Carbon-zinc and nickel-cadmium type batteries can be recharged.
6. Do not, however, attempt to recharge a completely dead carbon-zinc battery, a leaking or corroded battery, or any battery that carries a warning against recharging.
7. Such batteries can cause damage to the charger and may explode, causing personal injury. Lead-acid batteries can be recharged but produce explosive hydrogen gas during the process.
8. They should only be recharged in a well-ventilated area with an appropriate charger.
9. Do not discard any battery in the trash.
10. Contact Facilities and Maintenance for pick-up and disposal. Document the date of the request and the date the pick-up occurred.

**CHM 5.2.2 Circuit Loads**

1. Most school laboratory electrical circuits have a maximum power rating of 1,500 watts (if fuses are 15 amp) or 2,000 watts (if fuses are 20 amp).
2. The total power load on a circuit should not exceed these values.
3. The total load is the sum of the power ratings of all apparatus plugged into that circuit.
4. The individual power rating is usually found printed on a plate somewhere on the apparatus.

**CHM 5.2.3 Extension Cords.**

1. Use extension cords only when there is no convenient way to connect equipment directly to a receptacle.
2. If an extension cord must be used, it should be checked for damage, proper grounding, and electrical capacity.
3. An extension cord should be marked with its capacity in amperes and watts and the total load should not exceed these values.
4. If the cord is unmarked, assume that it is 9 amperes or 1,125 watts.
5. If an extension cord becomes very warm to the touch, it should be disconnected and checked for proper size.
6. In general, science laboratories should be equipped with sufficient receptacles to minimize extension cord use.

**CHM 5.2.4 Fuses/Circuit Breakers**.

1. Replace blown equipment fuses with fuses of the same amperage.
2. Replace fuses with the equipment unplugged.
3. Failure to use the correct fuse can cause damage to equipment and overheating.
4. Frequent blowing of circuit fuses or tripping of circuit breakers usually indicates that the circuit is overloaded or a short exists.
5. Circuit breakers and fuses that are tripped or blown should be turned on or replaced only after the cause of the short or overload is removed from the circuit.

**CHM 5.2.5 Grounding**

1. Use grounded 3-prong plugs when available.
2. If the outlet is 2-prong, use an adapter and secure the ground wire to the cover-plate screw on the outlet.
3. Any apparatus with a metallic case or exposed metal parts should be checked to make sure that the case is grounded.
4. Such ungrounded appliances should be retrofitted with a ground wire and three-pronged plug.
5. The use of ground-fault interrupters should be considered.

**CHM 5.2.6 Power Cords**

1. Any power cord should be inspected periodically and replaced immediately if frayed or damaged.
2. Apparatus should be located to keep power cords away from student traffic paths.
3. When removing the cord from an outlet, the plug should be pulled, not the power cord.
4. Wet hands and floors present a hazard when connecting or disconnecting electrical apparatus.

**CHM 6: Fire Hazards**

Fire is a real danger in any laboratory setting, and all teachers need to be aware of how to prevent fires. In the vent a fire does occur, teachers need to know how to respond appropriately. The following information is provided as guidance in preventing or combatting fires in the science laboratory.

**CHM 6.1 Preventing Burns and Fires**

**CHM 6.1.1 When planning to heat materials or use open flames**

1. Instruct students on STOP DROP AND ROLL in the event clothing catches fire
2. Make sure students know how to evacuate the classroom in the event of a large fire
3. Know the location of the nearest fire extinguisher and know how to use it.
4. Have a bucket of sand or a fire blanket nearby in the event that the nearest fire extinguisher too far outside of the classroom.

**CHM 6.1.2 When heating materials**

1. **DO NOT USE ALCOHOL BURNERS! T**hey are extremely hazardous. Safer alternatives to alcohol burners include candles and hot plates.
2. **DO NOT USE STERNO HEATERS!**
3. Make sure that the area surrounding a heat source is clean and has no combustible materials nearby.
4. Do not allow students to work with hot materials, such as very hot water.
5. Do not use household glass. Use only borosilicate laboratory glassware, such as Kimax™ or Pyrex™ when heating substances.
6. Do not heat common household liquids, such as alcohol or oil; these are flammable and should not be heated. Heat only water or water solutions.
7. Handle all hot materials using the appropriate type of tongs or heat resistant gloves (those made of asbestos or thick silicon rubber).

**CHM 6.1.3 When using Hot Plates**

1. Do not use hotplates designed for use in home kitchens. Use only laboratory type hot plates. These are sealed against minor spills.
2. Do not place the hot plate on paper or wooden surfaces.
3. Place the hot plate in a location where a student cannot pull it off the worktop or trip over the power cord.
4. Never leave the room while the hot plate is plugged in, whether or not it is in use.
5. Keep students away from hot plates that are in use or still hot, unless you are right beside the students and have given them specific instructions.
6. Make sure that the hotplate is both unplugged and cool before handling a hotplate. You can check to see if a hot plate is still too hot by placing a few drops of water on the surface. If the water does not evaporate, it should be cool enough to touch.

**CHM 6.1.4 When using open flames**

1. Use only safety matches. Make sure the matches are stored in a secure place between uses.
2. Closely supervise students when they use matches. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
3. Closely supervise students when they use candles. Make sure students are dressed properly (baggy clothes are tucked in, long sleeves are rolled up, smocks/aprons are properly tied) and have long hair/braids tied up.
4. Use tea candles that are short and wide, and cannot be knocked over in normal use.
5. Place all candles in a “drip pan,” such as an aluminum pie plate, that is large enough to contain the candle if it is knocked over.
6. Never leave the room while a flame is lit or other heat source is in use.

**CHM 6.2 In the event of a large, uncontainable fire**

1. Evacuate the classroom immediately.
2. Locate and pull the nearest fire alarm.
3. Notify public safety and/or administration about the fire. Make sure you include the location and source (chemical, paper, petroleum) of the fire.

**CHM 6.3 In the event of a small, containable fire**

1. Identify the type of fire. The table below lists the four classes of fires and methods for extinguishing them:

|  |  |  |
| --- | --- | --- |
| **Class** | **To Fight Fires Involving** | **Method to Extinguish** |
| **A** | wood, paper, cloth | Use water or dry chemical extinguisher. |
| **B** | gasoline, alcohol, paint, oil, or other flammable liquids | Smother by using carbon dioxide or dry chemical extinguisher. |
| **C** | fires in live electrical equipment | Cut off power to electrical equipment. Use ABC or carbon dioxide fire extinguisher. |
| **D** | metals (Na, K, Mg, etc.) | Scoop dry sand onto fire. |

1. Use the appropriate method to extinguish the fire.
2. File an incident report.

**CHM 6.4 In the event a student's clothes catch fire**

1. Roll the child on the floor to smother the fire. Use a fire blanket if one is available. Do not direct a carbon dioxide (CO2) fire extinguisher at an individual because such extinguishers produce dry ice that can cause frostbite.
2. **DO NOT ATTEMPT TO ADMINISTER FIRST AID TO ANY BURNS THE CHILD MAY HAVE SUSTAINED!**  Immediately notify the school administrator, school nurse, and public safety.

**CHM 7: Physical Management of Chemical Stock**

All teachers should be familiar with the RCSS Chemical Management policy that addresses how chemicals should be properly stored, labeled, and secured, as well as who should have access to these chemicals and chemical storage locations. The following guidelines are provided for teachers in order to reduce the risk of chemical accidents and ensure that chemicals and products in their schools are stored and handled safely.

**CHM 7.1 Procurement of Chemicals**

1. Prior to ordering, determine whether the chemical is in stock.
2. Order only quantities that are necessary for the project. Remember: **"Less is better**".
3. Upon receipt of the chemical, make sure the date received and the owner’s initials are on the label.

**CHM 7.2 Chemical Inventory**

An important part of responsible chemical management is the creation of an accurate chemical inventory. A chemical inventory identifies the quantities and physical locations of, as well as the potential hazards associated with, all of the chemicals used and stored in a school. It also serves as a reference for school and emergency personnel (e.g., local fire department) in the event of an emergency. Furthermore, a chemical inventory, when used to guide necessary purchases, can reduce the costs and management needs associated with excess chemicals.

**According to the Hazard Communication standard (29 CFR 1910.1200)** and **O.C.G.A 45-22-2– Public Employee Hazardous Chemical Protection and Right to Know Act of 1988**, chemical inventories should be conducted and updated annually. The following guidelines are provided to schools and administrators by the Georgia Department of Labor and should be used for conducting a chemical inventory:

1. **Conduct pre-screening, inventory and removal while students are NOT in school.**
2. If the pre-screening establishes that it is safe to conduct an inventory, ensure that the inventory team is properly equipped with personal protective equipment and emergency response supplies as well as chemical management and safety knowledge. Ensure that chemical storage areas are properly ventilated and that potential sources of ignition are turned off.
3. Conduct an inventory of all of the chemicals and products containing chemicals (e.g., mercury thermometers) stored on-site covering all sections of the school including maintenance rooms and closets, storage sheds, greenhouses, and all classrooms.
4. Review the **RCSS Laboratory Management and Safety Manual**to ensure that chemicals are consistently being managed, stored, handled, and disposed of properly.
5. Review the **Approved Chemicals and Products List**in the**RCSS Laboratory Management and Safety Manual***.* Chemicals and products not on this list should be removed and properly disposed of or recycled according to applicable federal, state, and local laws.
6. The inventory must be updated when new chemicals or products are added to the list and when chemicals or products are used or disposed.
7. When complete, provide the following with a copy of the inventory:

**Lezettra Saunders, Ed.S., Science Instruction Coordinator (saundle@BOE.richmond.k12.ga.us)**

**Shane Bower, Assistant Director Environmental Health and Safety (BowerSh@BOE.richmond.k12.ga.us**)

1. In addition, a copy should be made available in the front office and in every chemical storage area on campus.

**CHM 7.3 Clean-outs**

1. Conduct periodic cleanouts by identifying and removing unnecessary hazardous materials and expired chemicals through appropriate recycling and/or disposal methods.
2. Chemical inventories should be conducted prior to cleaning out chemicals from schools.
3. Contact your local state agency, college or university, industry partner, or chemical supplier, or someone with technical qualifications to identify potentially dangerous situations (i.e., school staff should not move very old chemicals because of the extreme hazard they may present) and properly handle the chemicals during a chemical cleanout.

**CHM 7.4 Material Safety Data Sheets (MSDS)**

1. There must be an MSDS on file for every chemical compound in use in the lab.
2. At a minimum, MSDS information should be located in all chemical storage rooms and cabinets and in a central place within the school (away from the chemicals), as well as a central location for the school district.
3. A copy must be kept in an area that is accessible to all individuals during periods of building operations.
4. If no MSDS is available for a product because 1) the manufacturer no longer exists; or 2) the manufacturer cannot be identified from the label that material should be considered hazardous waste and disposed of in a manner consistent with federal and state regulations.

**CHM 7.5 Equipment**

1. All emergency equipment (e.g., eyewash stations and safety showers), fume hoods, and ventilation systems/exhaust fans must be inspected and tested on an annual basis.
2. Chemical fume hoods must be recalibrated annually by appropriately trained individuals to ensure proper function. Documentation of annual recalibration should be assessable to all building occupants.
3. Engage maintenance staff in these inspections if safety equipment is in need of updates or repair.
4. Protocols for the upkeep of emergency equipment and the associated maintenance records must be established and maintained by school administrators.

**CHM 7.6 Chemical Storeroom Ventilation and Temperature**

1. Rooms that are designated for use as chemical storage areas must have a functioning exhaust ventilation system that operates continuously to remove fugitive chemical vapors.
2. The local exhaust system should be ducted to the outdoors independent of the general ventilation system.
3. Each room must also have an appropriate source of transfer (or make-up) air allowing for exhaust vents to operate efficiently.
4. Such chemical storage ventilation systems must be in conformance with the applicable fire and building codes.
5. Chemical storeroom exhaust vents must be inspected annually by appropriately trained individuals to ensure proper function.
6. Chemical storerooms should be kept within 70 to 75 degrees Fahrenheit.

**CHM 7.7 Shelving**

1. Shelving must be constructed of appropriate materials that will resist corrosion resulting from leaking materials stored on or around the shelves.
2. The shelving must be able to support the weight of stored materials.
3. Guardrails should be installed along the edge of shelving to prevent accidental slippage.
4. Shelving should not be installed within a 30 inch margin from the ceiling.
5. Shelves should be appropriately labeled with the chemical type and storage code (ex: Halide Compounds, I-2).

##### CHM 7.8 Chemical Fume Hoods

Chemical fume hoods are intended to remove vapors, gases, and dusts of toxic, flammable, corrosive or otherwise dangerous materials. With the sash lowered, laboratory fume hoods can also afford workers protection from such hazards as chemical splashes or sprays and fires. However, they are not designed to withstand explosions. Before performing hazardous operations, make simple checks to determine that the hood is working (e.g., a small piece of paper held at the face of the hood will be sucked inward).

1. When work is being conducted within the hood, position the sash so that protection from splashes, flying debris, etc., is provided.
2. Normally, this is a 12-16 inch work opening.
3. Experimental procedures should be conducted well inside the hood.
4. Moving an apparatus 5-10 cm back from the front edge into the hood can reduce the vapor concentration at the face by 90%.
5. Hoods are not intended for the storage of chemicals.
6. Materials stored in them should be kept to a minimum and in a manner that will not interfere with airflow.
7. Hoods should be considered as backup safety devices that can contain and exhaust toxic, offensive, or flammable materials.
8. They should not be regarded as a means of disposing of chemicals.

**CHM 7.9 Inspections**

1. Annual inspections of classrooms, janitorial closets, and chemical store rooms and cabinets should be conducted in your school to ensure the integrity of chemicals and storage structures. Spot inspections may be performed periodically throughout the school year.
2. Engage maintenance staff in these inspections if storage shelving or locks are in need of updates or repair.
3. Create and maintain an up-to-date map of the location and storage pattern of chemical storage rooms and cabinets in your school.

**CHM 8: Chemical Storage**

**CHM 8.1 Container Labeling**

1. Each container must be labeled with the **chemical name** of the material stored within (not chemical formula solely).
2. Chemical names must be consistent with the **State of Georgia's Public Employee Hazardous Chemical Protection and Right to Know Act of 1988 (O.C.G.A 45-22-2**), **OSHA Standard 29 CFR 1910**,and **National Fire Protection Association (NFPA) 45:Standard on Fire Protection for Laboratories Using Chemicals**, in order to facilitate the identification of the chemical(s) in case of a spill.

**CHM 8.1.1 Labeling of Chemical Containers**

1. No unlabeled substance should be present in the laboratory at any time!
2. Use labels with good adhesive.
3. Use a permanent marker (waterproof and fade resistant) or laser (not inkjet) printer.
4. Print clearly and visibly.
5. Replace damaged, faded, or semi-attached labels.

**CHM 8.1.2 Commercially Packaged Chemicals**

1. Verify that the label contains the following information:
2. Chemical name (as it appears on the MSDS)
3. Name of chemical manufacturer
4. Necessary handling and hazard information
5. Add:
6. Date received
7. Date first opened
8. Expiration or ―use by date (if one is not present)

**CHM 8.1.3 Secondary Containers and Prepared Solutions**

1. When a material is transferred from the original manufacturer’s container to other vessels, these vessels are referred to as ―secondary containers.
2. Label all containers used for storage with the following:
3. Chemical name (as it appears on the MSDS)
4. Name of the chemical manufacturer or person who prepared the solution
5. Necessary handling and hazard information
6. Concentration or purity
7. Date prepared
8. Expiration or ―use by date

**CHM 8.1.4 Containers in Immediate Use**

1. These chemicals are to be used within a work shift or laboratory session.
2. Label all containers in immediate use with the following:
3. Chemical name (as it appears on the MSDS)
4. Necessary handling and hazard information

**CHM 8.1.5 Chemical Waste**

All containers used for chemical waste should be labeled with the following:

* 1. HAZARDOUS WASTE
  2. Chemical name (as it appears on the MSDS)
  3. Accumulation start date
  4. Hazard(s) associated with the chemical waste
  5. Date generated

**CHM 8.2 Proper Chemical Storage**

Guidelines for chemical storage must follow **O.C.G.A 45-22-2, O.C.G.A. 25-2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**

1. Create and maintain an up-to-date map of the location and storage pattern of chemical storage rooms and cabinets in your school.
2. Hazardous chemicals in schools should be stored in accordance with MSDS specifications
3. Chemicals should not be stored in areas that are occupied by or accessible to students, such as classrooms or restrooms; they should preferably be stored in a central, secure location.
4. Organize chemicals first by **COMPATIBILITY**—not alphabetic succession (refer to section entitled Shelf Storage Pattern). Store alphabetically within compatible groups.

**CHM 8.4 Other Considerations**

Additional consideration must be paid to toxics, peroxides, oxidants, poisons, fuming corrosives, etc. to see where they fit into the basic flammability/reactivity categories. Chemicals that belong in the same storage area but are incompatible with each other, such as acids and bases, should be separated as much as possible.

* 1. Once separated into hazard classes, chemicals may be stored alphabetically.
  2. Keep all containers well sealed to avoid vaporization and spills. Caps constructed of plastic wrap aluminum foil, corks, or glass stoppers are not adequate.
  3. Use FM or UL approved storage containers and safety cans for flammable liquids. No container of a flammable liquid may exceed a capacity of 2 gallons.
  4. Use spill trays under containers of strong reagents.
  5. Store corrosives in non-metallic or stainless steel safety cans on lowest shelves.
  6. Store containers of inorganic hydroxides and hydrofluoric acid in polyethylene containers.
  7. Segregate acids from bases and active metals such as sodium, potassium, or magnesium.
  8. Segregate acids from chemicals which could generate toxic gases upon contact such as sodium cyanide, iron sulfide, etc.
  9. Segregate oxidizing acids from inorganic acids and flammable and combustible materials.
  10. Keep oxidizers, such as bromine and sulfuric acid, away from reducing agents such as zinc, formic acid, and alkali and alkaline earth metals.
  11. Do not store liquids above eye level. All shelves should have a protective edge guard to prevent containers from sliding off shelves.
  12. Do not store containers, full or empty, in walkways.
  13. Store chemicals, particularly acids and water-reactives, in areas protected from water leaks and flooding, e.g., no storage under sinks.
  14. Always store chemicals of high acute and moderate or high chronic toxicity in unbreakable secondary containers.
  15. Nitric acid is incompatible with almost all other chemicals. It should be stored in a tub or basin in a storage cabinet.

**CHM 8.2.1 Storage Compatibility Chart**

|  |
| --- |
| Inorganics  I-1. Metals, Hydrides  I-2. Halides, Halogens, Phosphates, Sulfates, Sulfites, Thiosulfates  I-3. Amides, Nitrates (except Ammonium nitrate\*), Nitrites, Nitric acid  I-4. Carbon, Carbonates, Hydroxides, Oxides, Silicates  I-5. Carbides, Nitrides, Phosphides, Selenides, Sulfides  I-6. Chlorates, Chlorites, Hydrogen Peroxide (< 10%), Hypochlorites, Perchlorates\*, Perchloric acid\*  I-7. Arsenates\*, Cyanates\*, Cyanides\*  I-8. Borates, Chromates, Manganates, Permanganates  I-9. Acids (except Nitric acid)  I-10. Arsenic, Phosphorous\*, Phosphorous Pentoxide\*, Sulfur |
| Organics  O-1. Acids, Anhydrides\*, Peracids  O-2. Alcohols, Amides, Amines, Glycols, Imides, Imines  O-3. Ethers\*, Ethylene oxide, Halogenated hydrocarbons\*, Ketenes, Ketones  O-4. Epoxy compounds, Isocyanates\*  O-5. Azides, Hydroperoxides, Peroxides  \* Not allowed in RCSS labs. |

**CHM 8.2.2 Shelf Storage Pattern for Organics**

|  |  |  |
| --- | --- | --- |
| **ORGANIC #2**  Alcohols Imides  Amides Imines  Amines Glycols  **STORE FLAMMABLES IN A DEDICATED CABINET** | **ORGANIC #8**  Cresols  Phenol | **POISON STORAGE CABINET**  Toxic substances |
| **ORGANIC #3**  Aldehydes Esters  Hydrocarbons  **STORE FLAMMABLES IN A DEDICATED CABINET** | **ORGANIC #6**  Azides Hydroperoxides  Peroxides | **FLAMMABLE ORGANIC #1**  **Red Diamond Rating = 1**  Alcohols  Glycols. |
| **ORGANIC #4**  Ethers Ketenes  Ketones Ethylene oxide  Halogenated Hydrocarbons    **STORE FLAMMABLES IN A DEDICATED CABINET** | O**RGANIC #1**  Acids  Anhydrides  Peracids  **STORE CERTAIN**  **ORGANIC ACIDS IN ACID CABINET** | **FLAMMABLE ORGANIC #2**  **Red Diamond Rating = 2**  Alcohols  Glycols  Acetone |
| **ORGANIC #5**  Epoxides Isocyanates | **MISCELLANEOUS** | **FLAMMABLE ORGANIC #3**  **Red Diamond Rating = 3**  Methanol  Other compounds allowed only with written permission |
| **ORGANIC #7**  Nitriles Polysulfides  Sulfides Sulfoxides | **MISCELLANEOUS** | **FLAMMABLE ORGANIC #4.**  **Red Diamond Rating =4**  **Not allowed.** |

#### Note:

#### RCSS labs may NOT have Class IA, Class IB, and Class IC Flammable Organics in storage! Check the NFPA rating!

#### RCSS labs may NOT have Class IA, Class IB, and Class IC Combustible Organics in storage! Check the NFPA rating!

**CHM 8.2.2 Shelf Storage Pattern for Inorganics**

|  |  |
| --- | --- |
| **INORGANIC #10**  Arsenic Phosphorous Pentoxide  Phosphorous Sulfur | **INORGANIC #7**  Arsenates Cyanates  Cyanides  STORE AWAY FROM WATER |
| **INORGANIC #2**  Halides Sulfates  Halogens Sulfites  Phosphates Thiosulfates | **INORGANIC #5**  Carbides Selenides  Nitrides Sulfides  Phosphides |
| **INORGANIC #3**  Amides Nitrates  Azides Nitrites  EXCEPT AMMONIUM NITRATE -STORE AMMONIUM NITRATE AWAY FROM ALL OTHER SUBSTANCES | **INORGANIC #8**  Borates Manganates  Chromates Permanganates |
| **INORGANIC #1**  Hydrides Metals  STORE AWAY FROM WATER.  STORE ANY FLAMMABLE SOLIDS IN DEDICATED CABINET | **INORGANIC #6**  Chlorates Perchlorates  Chlorites Perchloric acid  Hypochlorites Peroxides  Hydrogen Peroxide |
| **INORGANIC #4**  Carbon Oxides  Carbonates Silicates  Hydroxides | **MISCELLANEOUS** |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **CHM 8.2.3 Incompatible Chemicals**  It is important to avoid storing incompatible chemicals together. In the list below, do not store chemicals in the left column together with chemicals in the right column.   |  |  |  | | --- | --- | --- | | **This chemical is . . .** |  | **incompatible with this chemical:** | | . | | | | I. acids |  | bases | | . | | | | A. nitric acid |  | metals, acetic acid sulfuric acid, sulfides, nitrites and other reducing agents, chromic acid and chromate, permanganates, flammable liquids. | | . | | | | B. oxalic acid |  | silver, mercury | | . | | | | C. sulfuric acid |  | metals, chlorates, perchlorates, permanganate, nitric acid | | . | | | | II. alkali and alkaline earth metals and their carbides, hydrides, hydroxides, oxides, peroxides |  | water, acids, halogenated organics oxidizing agents | |  | | | | . | | | | III. ammonia |  | halogens, silver, mercury, sodium hypochlorite (bleach) | | . | | | | IV. carbon, activated |  | oxidizing agents\* | | . | | | | V. hydrogen peroxide |  | metals and their salts | | . | | | | VI. inorganic azides |  | acids, heavy metals and their salts, oxidizing agents\* | | . | | | | VII. inorganic cyanides |  | acids, strong bases | | . | | | | VIII. inorganic nitrates |  | acids, metals, nitrites, sulfur | | . | | | | IX. inorganic nitrites |  | acids, oxidizing agents\* | | . | | | | X. inorganic sulfides |  | acids | | . | | | | XI. organic compounds |  | oxidizing agents\* | | . | | | | A. acetylene and monosubstituted acetylenes (R-CCH) |  | halogens, Group 11 and 12 metals and their salts | | . | | | | B. organic acyl halides |  | bases, organic hydroxy compounds | | . | | | | C. organic anhydrides |  | bases, organic hydroxy compounds | | . | | | | D. organic halogen compounds |  | aluminum metal | | . | | | | E. organic nitro compounds |  | strong bases | | . | | | | XII. phosphorus (yellow) |  | oxygen, oxidizing agents\*, strong bases | | . | | | | XIII. phosphorus pentoxide |  | water | | . | | | | XIV. powdered metals |  | acids, oxidizing agents\* | | . | | |   \* Oxidizing agents include chromates, dichromates, chromium (VI) oxide, halogens, hydrogen peroxide and peroxides, nitric acid, nitrates, perchlorates and chlorates, permanganates, and persulfates. |

**CHM 8.3 Flammable and Combustible Materials**

**CHM 8.3.1 Classification of Flammable and Combustible Materials**

|  |  |  |  |
| --- | --- | --- | --- |
| **Flammable Liquid:**A liquid having a flash point (the minimum temperature at which a liquid gives off a vapor in sufficient concentrations to ignite) below 100°F (37.8°C). There are three classes of flammable liquids: | | | |
| Class  **4** | Flashpoint | Boiling Point | NFPA 704 Red Diamond Rating |
| Class 1A (IA) | < 73°F (22.8°C) | boiling point  < 100°F (37.8°C) | 4 |
| Class 1B (IB) | < 73°F (22.8°C) | ≥ 100°F (37.8°C) | 3 |
| Class 1C (IC) | ≥ 73°F (22.8°C) and  < 100°F (37.8°C) |  | 3 |
|  | | | |
| **Combustible Liquid:** A liquid having a flash point at or above 100°F (37.8°C). There are three classes of combustible liquids: | | | |
| Class | Flashpoint | Boiling Point | NFPA 704 Red Diamond Rating |
| Class 2 (II) | ≥ 100°F (37.8°C) and  < 140°F (60.0°C) |  | 2 |
| Class 3A (IIIA) | ≥ 140°F (60.0°C) and  < 200°F (93.3°C) |  | 2 |
| Class 3B (IIIB) | ≥ 200°F (93.3°C) |  | 2 |

**CHM 8.3.2 Storage Guidelines**

#### RCSS labs may NOT have Class IA, Class IB, and Class IC Flammable Organics in storage! Check the NFPA rating!

#### RCSS labs may NOT have Class IA, Class IB, and Class IC Combustible Organics in storage! Check the NFPA rating!

1. Guidelines for flammable storage must follow **O.C.G.A. 25-2, O.C.G.A. 45-22-2, OSHA Standard 29 CFR 1910**, and **NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals** and **NFPA 30: Flammable and Combustible Liquids Code.**
2. All cabinets for storage of flammable materials must be in compliance with statutes, regulations and local ordinances promulgated pursuant to **O.C.G.A. Title 25, Chapter 2, OSHA Standard 29 CFR 1910, and NFPA 45: Standard on Fire Protection for Laboratories Using Chemicals**.
3. In addition, all flameproof cabinets must meet the design and installation criteria set forth in the **NFPA's latest version of NFPA 30: Flammable and Combustible Liquids Code.**
4. The maximum allowable quantity for flammable liquid storage in any size lab is not to exceed 480 liters.
5. Regarding flammable liquid storage outside of approved flammable storage cabinets: there may be a maximum of 40 liters of flammable liquids in original containers and an additional 100 liters in approved safety cans not to exceed 8 liter size (**NFPA 45**).
6. NFPA specified safety cabinets MUST be used for storage of flammable liquids.
7. **High schools should not be in possession of any flammable liquid that requires storage in explosion-proof refrigerators and/or freezers**.
8. All flammables must be stored by compatibility.

**CHM 8.4 Acids**

1. Acids and bases should not be stored together.
2. Acids must be stored in a cabinet that is constructed from corrosion-resistant materials (**OSHA Standard 29 CFR 1910** and **OSHA Standard 29 CFR 1200**).
3. Each acid cabinet should be vented to reduce acid vapor accumulation.
4. To properly store acids
5. Segregate acids from bases.
6. Segregate acids from reactive metals such as sodium, potassium, and magnesium.
7. Segregate oxidizing acids from organic acids, and flammable and combustible materials.
8. Segregate acids from chemicals that could generate toxic or flammable gases upon contact, such as sodium cyanide, iron sulfide and calcium carbide.
9. Store inorganic acids in corrosive or acid storage cabinets.

* Their interiors and hardware (door hinges and shelf brackets) are corrosion resistant.  Corrosive storage cabinets can be located under fume hoods or exist as separate units.
* **FLAMMABLE STORAGE CABINETS ARE NOT CORROSION RESISTANT AND MUST NOT BE USED FOR ACID STORAGE.**

1. Store acids and bases in sealed, air-impermeable containers with tight-fitting caps as opposed to loose-fitting lids or glass stoppers.

* An exception to this is mixtures that may produce gases that can pressurize the container.

1. Store nitric and in its own secondary containment tray.

* Nitric acid can combine with other acids to form nitrogen oxides and nitrosyl halide gases.

**CHM 8.5 Bases**

1. Acids and bases should not be stored together.
2. **Ammonium hydroxide is flammable and must be stored in a dedicated Flammables Cabinet.**
3. Bases in pellet or powder form should be stored on a dedicated shelf in chemical storage room.
4. Bases in liquid form should be stored in appropriate containers with proper labels and tight fitting lids. They may be stored adjacent to bases in pellet/powder form on the same shelf in the chemical storage room.

**CHM 8.4 Care of Compressed Cylinders**

**CHM 8.4.1 Labels**

1. Make sure the contents of the compressed gas cylinder are clearly stenciled or stamped on the cylinder or on a durable label.
2. Do not identify a gas cylinder by the manufacturer’s color code.
3. Never use cylinders with missing or unreadable labels.
4. Label empty cylinders ―EMPTY‖ or ―MT‖ and date the tag; treat in the same manner that you would if it were full.

**CHM 8.4.2 Operations**

1. Check all cylinders for damage before use.
2. Be familiar with the properties and hazards of the gas in the cylinder before using.
3. Wear appropriate protective eyewear when handling or using compressed gases.
4. Use the proper regulator for each gas cylinder.
5. Do not tamper with or attempt to repair a gas cylinder regulator.
6. Never lubricate, modify, or force cylinder valves.
7. Open valves slowly using only wrenches or tools provided by the cylinder supplier directing the cylinder opening away from people.
8. Check for leaks around the valve and handle using a soap solution, ―snoop‖ liquid, or an electronic leak detector.
9. Close valves and relieve pressure on cylinder regulators when cylinders are not in use.

**CHM 8.4.3 Transport**

1. Always attach valve safety caps when storing or moving cylinders.
2. Transport cylinders with an approved cart with a safety chain; never move or roll gas cylinders by hand.

**CHM 8.4.4 Storage**

1. Securely attach all gas cylinders (empty or full) to a wall or laboratory bench with a clamp or chain, or secure in a metal base in an upright position.
2. Store cylinders by gas type, separating oxidizing gases from flammable gases by either 20 feet or a 30-minute firewall that is 5 feet high.
3. Store gas cylinders in cool, dry, well-ventilated areas away from incompatible materials and ignition sources.
4. Do not subject any part of a cylinder to a temperature higher than 125 °F or below 50 °F.
5. Store empty cylinders separately from full cylinders.

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**CHM 9: Chemical Waste Storage and Disposal**

**CHM 9.1 Definition of Chemical and Hazardous Wastes**

1. Any chemical discarded or intended to be discarded is defined by the EPA as chemical waste. HAZARDOUS chemical waste as designated by the EPA or the Georgia Environmental Protection Division is waste that presents a danger to human health and/or the environment.
2. According to EPA regulations, the following four characteristics define a waste as hazardous:
3. Ignitability
4. Corrosiveness
5. Reactivity
6. Toxicity
7. Management and disposal of laboratory waste in containers are regulated under RCRA regulations.
8. These laboratory waste streams include used chemicals, residues from experiments, spill cleanup, expired or off-spec chemicals and other chemical waste.

**CHM 9.2 Regulation of Waste**

While the federal Occupational Safety and Health Administration (OSHA) does not have

jurisdiction over state and local government employees, including those in public schools, the federal Environmental Protection Agency (EPA) has the authority to enforce certain OSHA standards, such as Hazardous Waste Operations (**29 CFR 1910.1200** - see Appendix C) or relevant EPA standards in public schools.

Some chemicals purchased by schools may need to be managed as hazardous wastes and may ultimately require disposal as such. Hazardous wastes need to be managed from their initial point of generation until their ultimate point of disposal, known as “cradle to grave.” The **Resource Conservation and Recovery Act** (RCRA) gives the EPA the authority to control the generation, transportation, treatment, storage, and disposal of hazardous waste. The **Toxic Substances Control Act** (TSCA) addresses the manufacturing, processing, distribution, use, and disposal of commercial and industrial chemicals.  The **Pollution Prevention Act** (PPA) establishes pollution prevention as the national policy for controlling industrial pollution at its source.  The Department of Transportation’s Pipeline and Hazardous Materials Safety Administration regulates the transport of hazardous materials.

**CHM 9.3 Liability**

1. It is the school's responsibility to make a hazardous waste determination.
2. This includes spent chemicals used in the lab, expired or unwanted chemicals, contaminated gloves, and any spill cleanup debris.
3. Schools must ensure that a RCRA hazardous waste is safely accumulated and transported off-site for proper disposal.
4. Depending on the quantity of waste generated by a school, additional requirements for storage, handling and emergency response may apply.
5. Any school that generates hazardous wastes must notify their state environmental agency and obtain an EPA Identification (ID) Number.
6. This EPA ID Number must be put on all manifests for tracking disposal of school wastes and must be site specific for the address given.
7. School liability does not end when the wastes leave the school, and school administrators must make sure they receive a copy of the shipping manifest stating that their wastes arrived at their destination (e.g., treatment, storage, or disposal facility).

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**CHM 9.4 Proper Storage and Disposal of Chemical Waste**

The following guidelines are provided to schools and administrators and should be used for storing and disposing of hazardous waste:

**CHM 9.4.1. Segregation of Waste**

Separate waste containers are required to properly segregate waste for disposal. The following waste categories should be used.

* Chlorinated Solvents
* Cyanides
* Hexavalent Chrome
* High Ph Solutions
* Hydrofluoric Acid
* Low Ph Solutions
* Nitric Acid
* Non-Chlorinated Solvents
* Oxidizers
* Palladium
* Reducing Agents
* Sulfides

**CHM 9.4.2 Storage of Waste**

1. Chemicals that are stored for disposal off-site should be placed in suitable closed containers and should be clearly marked with the contents.
2. If the chemicals are a RCRA hazardous waste, the school must ensure that they are transported offsite for proper disposal.
3. Store all waste in containers that are in good condition and are compatible with their contents.
4. Avoid using metal containers; certain chemicals can cause the metal to corrode and the container to leak.
5. Clearly and permanently label each container as to its contents and label as hazardous waste.
6. Store waste in a designated area away from normal laboratory operations and to prevent unauthorized access.
7. Store waste bottles away from sinks and floor drains.
8. Do not completely fill waste bottles; leave several inches of space at the top of each waste container. Securely cap all waste bottles.

**CHM 9.5 Disposal of Hazardous Waste**

1. **The use of sinks for the disposal of chemicals is strictly prohibited!**
2. When rinsing glassware that contained chemical, discard the first rinse volume into the appropriate waste container.
3. Subsequent rinses can be discarded to the sink.
4. Water/air reactive wastes are restricted by waste disposal companies and must be deactivated prior to disposal.
5. This is particularly true of materials which ignite or release gases on contact with air or water.
6. Dispose of chemically contaminated paper and disposable clothing in approved solid waste containers.
7. Do not treat hazardous waste on-site. Exception: Acids may be neutralized with sodium bicarbonate in a 50-50 ratio by weight.
8. Contact Facilities and Maintenance for pick-up and disposal. Document the date pick-up was requested and the date that it occurred.

**CHM 9.6 Record Keeping**

1. Reassigned samples must be re-labeled with the new custodian's name and the date the waste was generated and stored.
2. A waste management log must be maintained and should indicate how and when the waste was generated, how and when it was isolated and stored, by whom it was generated and stored, and date and method in which it was disposed.

**CHM 10: Chemical Spills**

**CHM 10.1 RCSS Chemical Spill Response Plan**

Chemical spills and accidents need to be minimized as much as possible. If a chemical spill should occur, a quick response with a stocked chemical spill kit will help minimize potential harm to personnel, equipment and laboratory space. The majority of chemical spills can be prevented or minimized by:

1. Maintaining a neat and organized work area.
2. Performing a laboratory procedure review prior to conducting new experimental procedures.
3. Storing liquid chemicals in secondary containment bins.
4. Keeping reagent chemical containers sealed or closed at all times, except when removing contents.
5. Ordering reagent chemicals in plastic or plastic coated glass containers whenever possible.
6. Using secondary containment to store and move chemicals.

Cleanup of any spill, release or discharge is the responsibility of the school. Spill clean- up debris may be a hazardous waste subject to RCRA regulations. It is the school's responsibility to conduct a hazardous waste determination on waste generated from spill cleanup to confirm whether or not the material meets the definition of hazardous waste and must be managed in accordance with RCRA regulations.

Schools should have a chemical inventory and an emergency response plan to ensure the safety of building occupants and emergency responders. The elements of the emergency response plan should include the following topics:

1. Procedures for evacuation of the building in the case of a spill that may to result in exposure to building occupants.
2. District personnel contact numbers and emergency contact numbers.

**MAKE SURE THAT ALL EMERGENCY CONTACT NUMBERS ARE POSTED SOMEWHERE IN YOUR STORAGE AREAS, AND MAKE SURE ALL TEACHERS KNOW WHERE TO FIND THEM.**

1. Emergency procedures to contain the material in the location of the spill.
2. Contact information for remediation services
3. Procedures for proper disposal of hazardous material in compliance with federal, state, and local regulations.

**Training is MANDATORY for any personnel who might use the Chemical Spill Response Kit. The procedures noted in this manual were developed to give guidance to knowledgeable laboratory personnel, maintenance staff and custodians, public safety officers, and administrators on the safe and effective ways in which to clean-up small chemical spills. If you have any questions or concerns about the spill clean-up process, please contact Lezettra Saunders at Saundle@boe.richmond.k12.ga.us or Chad Jordan at JordaCh@boe.richmond.k12. ga.us**

**CHM 10. 2 RCSS Chemical Spill Clean-Up Procedures**

**CHM 10.2.1 General Precautions**

In the event of a solid or liquid spill, LARGE OR SMALL

1. Keep students or other individuals away from the spill. Evacuate the lab if toxic or flammable vapor is present.
2. Extinguish all flames and turn off electrical equipment that may produce a spark in order to avoid ignition of flammable vapor.
3. Attend to any students or other individuals splashed by the spill. Find out what was spilled, flush affected parts of the body with water, and get medical attention, if necessary.
4. If the spill is large or releases dangerous quantities of toxic or flammable vapors, evacuate the area and call your local fire department for advice.
5. If the floor is wet after cleanup, warn students to avoid the area to minimize the danger of slipping.

**CHM 10.2.2 Types of Spills that Can Be Handled by Laboratory Personnel**

1. In the event of a chemical spill, first decide if you are trained, knowledgeable and equipped to handle the incident.
2. Immediately evacuate the lab and notify administration and/or public safety if there is a possibility of an acute respiratory hazard present or if you need assistance to clean up the spill.
3. Never proceed to clean up a spill if you do not know the hazards associated with the chemical or if you are unsure of how to clean up the spill.
4. If anyone is injured or contaminated, immediately notify administration and/or public safety and begin decontamination measures or first aid, if trained.
5. Precautions must be taken to minimize exposure to the spilled chemical.
6. Wear the appropriate PPE when cleaning up a spill.
7. Be careful not to step in the spilled material and track it around.
8. Contact emergency personnel, your principal, and Dawn Phillips if exposure to a chemical occurs.

|  |  |
| --- | --- |
| **Chemical Class** | **Example** |
| **Weak Acids or Diluted Strong Acid Solutions (< 1.0M)**  Any acid that is dilute enough to not create fumes or gases | dilute acetic acid  dilute hydrochloric acid  0.5M sulfuric acid |
| **Weak Bases or Diluted Strong Base Solutions (<1.0M)**  Any base that is dilute enough to not emit vapors | dilute sodium hydroxide  dilute ammonium hydroxide |
| **Solid Chemical Compounds, Non-oxidative** | sodium sulfate  aluminum chloride |
| **Solid Chemical Compounds: Class 1 Oxidizers** | potassium dichromate  potassium nitrate |
| **Solid Chemical Compounds: Class 2 Oxidizers** | calcium chlorate  calcium hypochlorite (50% or less by weight) |
| **Class 1 Flammables:**  **Combustible if heated** | isopropyl alcohol  ethanol |
| **Class 2 Flammables:**  **Liquids and Solids**  **Flashpoint/Ignition between 100o  and 200oF.** | acetone  sulfur, granulated solid |

1. If the spill is fairly small, it can be cleaned up using the guidelines given below.
2. When cleaning up any spill, make sure the proper protective clothing is worn - gloves, lab coat and safety glasses or goggles. For spills of more hazardous substances or for large spills, rubber boots, a face shield or a respirator may be needed.
3. Make sure that all forms of local exhaust, i.e. fume hoods, are operating. It is normally not advisable to open the windows.
4. If broken glass is involved, do not pick it up with your gloved hands. Use the scoop or tongs to place it in the bag, then place the bag in a strong cardboard box or plastic container.
5. All spill debris and associated paper towels, glassware, gloves, and shoe covers should be placed into a polyethylene waste bag and sealed.
6. The bag should be labeled with the following information:
7. Date
8. School and Classroom Number
9. Person responsible for Clean-up
10. Content
11. Approximate Amount of Material
12. Contact Facilities and Maintenance for pick-up and disposal. Document the date that pick-up was requested and the date pick-up occurred.

**CHM 10.2.3 Types of Spills that MUST NOT Be Handled by Laboratory Personnel**

If the spill is too large for you to handle, involves more than 500 ml of any hazardous material, involves materials listed in the table below; is a threat to personnel, students or the public; involves radioactive material; involves an infectious agent; or involves a corrosive, highly toxic, or reactive chemical, call for assistance.

|  |  |
| --- | --- |
| **Chemical Class** | **Example** |
| **Strong Acids** - Any acid that is concentrated enough to fume or emit acid gases | Fuming Sulfuric Acid Red Nitric Acid |
| **Strong Bases** - Any base that is concentrated enough to emit vapors | ammonium hydroxide |
| **Poison by Inhalation** - Any chemical that readily emits vapors / gases at normal temperature and pressure that are extremely toxic by inhalation | **NOT ALLOWED IN RCSS LABS** |
| **Reactive** - Any chemical that is sensitive to air, water, shock, friction and/or temperature | dry picric acid sodium borohydride organic peroxides |
| **Mercury** - Any mercury compound | **NOT ALLOWED IN RCSS LABS** |
| **Extremely Toxic** - Any chemical that is readily absorbed through the skin and is extremely toxic at small concentrations | **NOT ALLOWED IN RCSS LABS** |
| **Solid Chemical Compounds: Class 3 Oxidizers** | potassium bromate  potassium chlorate |
| **Solid Chemical Compounds: Class 4 Oxidizers** | hydrogen peroxide (greater than 91% by weight)  perchloric acid solutions (greater than 72.5% by weight) |
| **Class 3 Flammables:**  **Easily ignitable; high risk of explosion** | methanol |
| **Class 4 Flammables** | **NOT ALLOWED IN RCSS LABS** |

**CHM 10. 2.4 Specific Clean-up Procedures**

**CHM 10.2.4.1 Solid Spills**

1. Use a plastic scoop to place the spilled material into the polyethylene bag. Care should be taken so as not to create dust or cause the contaminated powder to become airborne.
2. Broken glass contaminated with a hazardous solid requiring special disposal should be placed into a cardboard box or plastic container appropriately labeled "BROKEN GLASS" and placed with the spilled solid for disposal.
3. After the bulk of the material is cleaned up, wet a spill pad (paper towel) and wipe the area down. Place the towels into the polyethylene bag.
4. Wipe the area down with another wet paper towel. Dispose of paper towel with the waste generated from the spill clean-up.
5. All spill debris and associated paper towels, glassware, gloves, and shoe covers should be placed into a polyethylene waste bag and sealed.
6. The bag should be labeled with the following information:
7. Date
8. School and Classroom Number
9. Person responsible for Clean-up
10. Content
11. Approximate Amount of Material
12. Contact Facilities and Maintenance for pick-up and disposal. Document the date that pick-up was requested and the date pick-up occurred.

**CHM 10.2.4.1 Liquid Spills**

Liquid spills can be harder to deal with than solid spills because liquids may spread over a wider area, may emit toxic or flammable vapors and can make the floor very slippery. Liquid spills can be dealt with by absorption onto a solid absorbent, such as diatomaceous earth, or by neutralization, depending on the chemical spilled and the spill situation.

**CHM 10.2.4.1.1 Organic Solvent and Flammable Liquid Spills**

1. Alert people in the immediate area of the spill.
2. Determine chemical nature of the spill. Check the MSDS (Material Safety Data Sheet). If the material spilled is highly hazardous, treat it as a major spill, and call the 911.
3. If a volatile, toxic or flammable material is spilled, immediately warn everyone nearby to extinguish flames and turn off all electrical and spark producing equipment.
4. Wear the proper protective equipment; at a minimum, gloves and safety goggles.
5. Dike the spill by surrounding the area with absorbents, such as vermiculite or sand for organic liquids. Clean up the spill using the same materials. **Do not use paper towels, as these will increase the rate of evaporation and will cause higher concentrations of vapor, which may be toxic or flammable, to enter the air.**
6. When the liquid has been absorbed, shovel the absorbent or pillows into a container for disposal. Remember that although the liquid has been absorbed, it still has the same hazardous properties and must be disposed of appropriately.
7. Wash the surfaces with soap and water and clean up by ordinary means.
8. After cleanup, all materials used in the cleanup, including paper towels, must be disposed of as wastes and placed in the disposal bags. Double bag the waste as needed. Label the bags to indicate the chemicals inside.
9. The bag should be labeled with the following information:
10. Date
11. School and Classroom Number
12. Person responsible for Clean-up
13. Content
14. Approximate Amount of Material
15. Contact Facilities and Maintenance for pick-up and disposal. Document the date that pick-up was requested and the date pick-up occurred.

**CHM 10.2.4.1.2 Acid Spill**

1. Absorb the spill by sprinkling it with the absorbent kitty litter.
2. Neutralize an acid spill by sprinkling the absorbed liquid with sodium bicarbonate (baking soda).
3. When fizzing (evolution of CO2) stops, enough neutralizing agent has been added.
4. The spill should be swept up with a brush into a dustpan or mopped and placed into a sturdy container.
5. Add additional sodium bicarbonate to ensure that all of the acid is neutralized.
6. If broken glass is present in the spill, pick it up with tongs and rinse it in the sink before disposal in the broken glass container.
7. If the floor is wet after cleanup, warn students to avoid the area to minimize the danger of slipping.
8. After cleanup, all materials used in the cleanup, including paper towels, must be disposed of as wastes and placed in the disposal bags. Double bag the waste as needed. Label the bags to indicate the chemicals inside.
9. The bag should be labeled with the following information:
10. Date
11. School and Classroom Number
12. Person responsible for Clean-up
13. Content
14. Approximate Amount of Material
15. Contact Facilities and Maintenance for pick-up and disposal. Document the date that pick-up was requested and the date pick-up occurred.

**CHM 10.2.4.1.3 Base Spill**

1. Absorb the spill by sprinkling it with the absorbent kitty litter.
2. Neutralize base spill by sprinkling the absorbed liquid with boric acid.
3. Use pH paper to determine whether the material has been neutralized.
4. The spill should be swept up with a brush into a dustpan or mopped and placed into a sturdy container.
5. Add additional boric acid to ensure that all of the acid is neutralized.
6. If broken glass is present in the spill, pick it up with tongs and rinse it in the sink before disposal in the broken glass container.
7. If the floor is wet after cleanup, warn students to avoid the area to minimize the danger of slipping.
8. After cleanup, all materials used in the cleanup, including paper towels, must be disposed of as wastes and placed in the disposal bags. Double bag the waste as needed. Label the bags to indicate the chemicals inside.
9. The bag should be labeled with the following information:
10. Date
11. School and Classroom Number
12. Person responsible for Clean-up
13. Content
14. Approximate Amount of Material
15. Contact Facilities and Maintenance for pick-up and disposal. Document the date that pick-up was requested and the date pick-up occurred.

**APPENDICES**

**APPENDIX A: FORMS**

|  |  |  |  |
| --- | --- | --- | --- |
| **Appendix A1:**  **Richmond County School System**  **Permission to Keep Live Animals on Campus** | | | |
| **School** | | **Principal** | |
| **Name of Teacher** | **Subject** | | **Grade(s) Taught** |
| **CARE PLAN** | | | |
| **Type and quantity of animal proposed:**  **Provide a brief explanation of how the animal(s) will be used to achieve learning objectives in your classroom:** | | | |
| **Who will be the primary caretaker? (name, position)**  **Who will care for the animal over weekends and over holiday breaks?**  **Who will pay for the health care of the animal(s)?** | | | |
| **Primary Veterinarian**  **Name:**  **Clinic Address:**  **Phone:**  **Date of Examination(s):**  **If required, are the animal(s) up to date on vaccines recommended by primary veterinarian?**  **Yes or No (circle one )** | | | |
| **Will students be permitted to handle animal(s), and will students be given care or cleaning responsibilities for the animal(s)?**  **Yes or No (circle one )**  **If so, have parents signed permission slips for such activities?**  **Yes or No (circle one )**  **How will you protect the students from bites, scratches, and/or disease transmission?** | | | |
| **How will the animal(s) be fed?**  **Who will pay for the food?** | | | |
| **What type of enclosure will be used to house the animal(s)?**  **How often will the enclosure be cleaned and sanitized?**  **What type of sanitizer will be used when sanitizing the enclosure?** | | | |
| **What will be the final disposition of the animal(s)? If the animal(s) must be euthanized, how will this be accomplished?** | | | |

**Appendix A2:**

|  |  |  |  |
| --- | --- | --- | --- |
| **RICHMOND COUNTY SCHOOL SYSTEM**  **PARENTAL NOTICE FORM**  **Your student's teacher is required to notify you that your student’s classroom plans to keep classroom animals.** | | | |
| **School** | | **Principal** | |
| **Name of Teacher** | **Subject** | | **Grade(s) Taught** |
| **The specific animal(s) planned are:**  **The animal(s) for your student’s classroom may aid in achieving the following learning objectives:**  **Should you have any concerns regarding this animal (ex. student allergies, other medical sensitivities, sanitation practices, etc.) you may contact:** | | | |
| **INFORMATION BELOW TO BE COMPLETED BY A PARENT OR GUARDIAN**  **In addition to this notification, we would like to ask whether you would like your student to participate in any of the following activities (check all that apply):**   * **Handling of animal(s)** * **Providing care for animal(s)** * **Given cleaning responsibilities for animal(s)** | | | |
| **I, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acknowledge that I have been informed of plans for my student, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_’s, classroom to house animals as specified above. I have had the opportunity to express any concerns I may have about this plan. I have notified the school that my student HAS/DOES NOT HAVE allergies to the animal(s) that the teacher plans to use.**  **Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | | | |

**Appendix A3:**

**SAFETY CHECKLIST 1**

School:

Date:

Teacher(s): Room or area:

Science teachers should check their instructional areas periodically to determine whether unsafe conditions exist. Teachers who have concerns about safety conditions related to facilities, equipment, supplies, curriculum, classroom occupant load, and so on should notify their department chairpersons and school-site administrators immediately in writing for assistance in alleviating the conditions.

The following checklist may be used to determine whether a safe environment exists and to indicate possible areas of concern and danger.

|  |  |  |  |
| --- | --- | --- | --- |
| Y | N | NA |  |
|  |  |  | Good general housekeeping prevails, and aisles are clear of materials and apparatus. |
|  |  |  | Signs of the locations of first-aid and safety equipment are visible throughout the room (e.g., fire extinguishers, fire blanket, eyewash station). |
|  |  |  | Adequate storage space is provided for chemicals, materials, and apparatus. |
|  |  |  | The classroom/laboratory has no blind spots—that is, areas in which students cannot be supervised by the teacher from anywhere in the room. |
|  |  |  | There is adequate classroom/laboratory space for the various learning activities planned. |
|  | | | The following equipment or conditions are adequate: |
|  |  |  | * Counter and work space for all students to do laboratory activities at one time |
|  |  |  | * Electrical outlets |
|  |  |  | * Gas outlets |
|  |  |  | * Sinks and water faucets |
|  |  |  | * Space between laboratory stations |
|  |  |  | Ventilation for the laboratory activities planned (or a manually controlled purge system for the rapid exchange of room air) |
|  |  |  | There are ground fault circuit interrupters (GFCIs) on electrical outlets near sinks. |
|  |  |  | Cabinets and open shelves are equipped with lips or restraining wires to prevent chemical spillage or breakage of glassware during an explosion or earthquake |
|  |  |  | The room has at least two exits. |
|  |  |  | The light level is adequate (about 75 to 100 foot-candles at work surfaces). |
|  | | | Separate designated waste containers are provided for: |
|  |  |  | * Broken glass |
|  |  |  | * Spent matches, wood splints, toothpicks, and so on |
|  |  |  | * Flammable waste chemicals |
|  |  |  | * Nonflammable waste chemicals |
|  |  |  | Quantities of hazardous chemicals kept on hand are limited to the amounts needed for one school year |
|  |  |  | Proper labels and signs are kept in place on all chemicals and on the storage area. |
|  |  |  | A chemical-spill kit is available for emergency use. |
|  |  |  | Chemical containers are inspected periodically for leakage or deterioration (such as sediments and discoloration), and approved disposal procedures are followed as necessary. ¨ |
|  |  |  | Any cylinder gas is stored according to the required safety code (for example, chained or strapped in a cart or to the wall). ¨ |
|  |  |  | Splash-proof safety goggles, face shields, aprons, safety shields, and so on are available to protect the teacher and students when hazardous conditions exist. |
|  |  |  | Goggles and face-shield sterilization facilities are available. |
|  |  |  | Eyewash fountains, hand-held drench hoses, and safety showers (as necessary) are easily accessible and are flushed weekly to remove scale and rust. |
|  |  |  | Fume hoods are clean, are uncluttered, and have a streamer easily visible throughout the room when in operation; the hoods periodically to ensure adequate air flow. |
|  |  |  | All equipment is properly maintained. |
|  |  |  | All electrical equipment is three-wire grounded (except for double- insulated tools and equipment). |
|  |  |  | Electrical outlets and extension cords are kept in safe, working condition. |
|  |  |  | Electrical equipment, such as the refrigerator and aquarium aerator, is connected directly to a wall outlet and is not serviced through an extension cord. |
|  |  |  | Gas outlets and burners are maintained in safe working condition. |
|  |  |  | A fire extinguisher capable of extinguishing class A, B, and C fires is kept in working condition at all times and in a conspicuous and accessible place. |
|  |  |  | Dry sand or other appropriate means is available to extinguish class D fires. |
|  |  |  | An approved fire blanket (preferably fire-retardant-treated100 percent wool) is kept in a conspicuous and accessible place. |
|  |  |  | Flammable liquids are stored in the classroom in fireproof containers (not glass) and in quantities sufficient for only one day’s supply. ¨ |
|  |  |  | Approved fire-retardant storage cabinets (with a bottom pan to contain spills temporarily), separate from the classroom, are used for storing larger quantities of flammable, corrosive, and other dangerous chemicals. ¨ |
|  |  |  | The larger storage containers of acids and bases are stored on the lower cabinet shelves. |
|  |  |  | Flammable liquids are not kept in refrigerators, unless the refrigerators are certified as explosion-proof |
|  |  |  | Food is not kept in refrigerators that are used for storing science materials. |
|  |  |  | Ether on hand was purchased less than one year ago. |
|  |  |  | Ethers are periodically disposed of before they exceed their one-year shelf life. (See “Use and Disposal of Ethers” in chapter 7.) |
|  |  |  | Sodium is stored underneath kerosene or oil. |
|  |  |  | Incompatible chemicals are not stored adjacent to one another. (See appendix D for a list of incompatible chemicals found in high school laboratories.) |
|  |  |  | All chemical containers are dated on receipt, and a current inventory is maintained. |
|  |  |  | The material safety data sheet (MSDS) for any chemical being handled or used in school is readily available |
|  |  |  | The locations of the master electrical and gas shut-off controls are labeled and readily accessible. |
|  |  |  | Plumbing fixtures are in correct operating condition. Faucets are equipped with air gaps to prevent backflow. |
|  |  |  | Animals are cared for in an appropriate, safe, and humane environment. |
|  |  |  | Hazardous chemical waste is properly stored, handled, and disposed of. |
|  |  |  | Fire-drill and earthquake-drill procedures are posted and familiar to all teachers and students. |
|  |  |  | The school district’s emergency procedures are prominently posted. |
|  |  |  | An adequate first-aid kit, including the Red Cross Standard First Aid and Personal Safety Manual or appropriate alternate information, is provided. |
|  |  |  | The teacher is familiar with first-aid and safety measures related to science instruction as presented in this publication. |
|  |  |  | The RCSS Laboratory Safety Manual for High School is readily accessible. |

Write a summary of the survey and note actions taken to remedy inadequate conditions.

|  |
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|  |

Teacher Signature:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Department Chair Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

Principal Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

**Appendix A4:**

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| **Safety Checklists: Classrooms, Chemical, Electrical, and Refrigerators**  **Room Safety Inspection Checklist**  Room: \_\_\_\_\_\_\_\_\_\_ Inspector:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | |
| **Check for proper operation of:** | **Satisfactory** | **Unsatisfactory** | **Date Remedied** |
| Eyewash fountain |  |  |  |
| Safety Shower |  |  |  |
| Fume Hood |  |  |  |
| Ventilation |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | | |
| **Condition of:** | **Satisfactory** | **Unsatisfactory** | **Date Remedied** |
| Fire Extinguishers |  |  |  |
| Fire Blanket |  |  |  |
| First-aid kit |  |  |  |
| Spill clean-up kits |  |  |  |
| Safety goggles |  |  |  |
| Lab aprons |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | | |
| **Hazards** | **Satisfactory** | **Unsatisfactory** | **Date Remedied** |
| Exits are not blocked |  |  |  |
| Aisles are not cluttered |  |  |  |
| Chemicals are not stored in the room |  |  |  |
| Glassware is not cracked or broken |  |  |  |
| Proper waste receptacles for broken glass and other sharp objects |  |  |  |
| Chemicals are properly labeled |  |  |  |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | | | | | | | |
| **Housekeeping** | **Satisfactory** | | **Unsatisfactory** | | | | **Date Remedied** | | |
| Sinks and sink traps are clean, unblocked |  | |  | | | |  | | |
| Fume hood is clean, clear of clutter |  | |  | | | |  | | |
| Work counter tops are clean, clutter-free |  | |  | | | |  | | |
| Table tops are clean |  | |  | | | |  | | |
| No food or drink is in lab areas |  | |  | | | |  | | |
| Broken glass container is available |  | |  | | | |  | | |
| Waste containers for chemicals are available |  | |  | | | |  | | |
| **Safety Checklist for Chemical Storeroom**  Room: \_\_\_\_\_\_\_\_\_\_ Inspector:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |
| **Area of Concern** | | | | **Yes** | | **No** | | **Date Remedied** | |
| The storeroom is properly labeled. | | | |  | |  | |  | |
| The storeroom can be locked and access restricted. | | | |  | |  | |  | |
| Fire resistant cabinets for flammable liquids are available. | | | |  | |  | |  | |
| All chemical refrigerators are explosion proof and labeled No Food. | | | |  | |  | |  | |
| The shelving is secured to the wall or floor. | | | |  | |  | |  | |
| The chemical shelving has raised edges to prevent accidents. | | | |  | |  | |  | |
| Ventilation is adequate. | | | |  | |  | |  | |
| Chemicals are stored according to their chemical properties. | | | |  | |  | |  | |
| Acids (greater than 6M) are stored in corrosion-resistant cabinets. | | | |  | |  | |  | |
| Leak-proof containers are available for transporting corrosive chemicals. | | | |  | |  | |  | |
| An annually updated inventory of chemicals is available. | | | |  | |  | |  | |
| MSDS sheets are available for every chemical. | | | |  | |  | |  | |
| State Safety Manual and Chemical Hygiene plan are available. | | | |  | |  | |  | |
| Peroxide-forming chemicals are marked with the date opened and tested for peroxides every 6 months or disposed of. | | | |  | |  | |  | |
| Gas cylinders are firmly secured. | | | |  | |  | |  | |
| Waste-chemical and waste-solvent containers are capped and clearly labeled. | | | |  | |  | |  | |
| All containers of chemicals are clearly labeled with the name of the chemical, appropriate hazard warning, and name of manufacturer. | | | |  | |  | |  | |
| Reagent chemical labels contain the date mixed, name of chemical, and name of preparer. | | | |  | |  | |  | |
| All containers are free of rust and corrosion. | | | |  | |  | |  | |
| Explosion-proof lightening. | | | |  | |  | |  | |
| Grounding and bonding wires are available for spark-free transfer of flammable liquids. | | | |  | |  | |  | |
| Containers are dated when received and opened. | | | |  | |  | |  | |
| New containers are marked to show the full level. | | | |  | |  | |  | |
| Glass containers are stored in a manner to prevent breakage. | | | |  | |  | |  | |
| **Electrical Safety Inspection Checklist**  Room: \_\_\_\_\_\_\_\_\_\_ Inspector:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |
| **Situation** | | | | **Yes** | **No** | | | | **Date Remedied** |
| All circuit breakers in the panel(s) are clearly labeled. | | | |  |  | | | |  |
| The circuit breaker panel(s) are not obstructed. | | | |  |  | | | |  |
| An emergency power shut off is present | | | |  |  | | | |  |
| Ground fault interrupters are used for receptacles where water may be present. | | | |  |  | | | |  |
| Receptacles are tested annually with a ground monitor. | | | |  |  | | | |  |
| All appliances in the lab have three wire grounded cords. | | | |  |  | | | |  |
| Extension cords are not used for permanent installations. | | | |  |  | | | |  |
| Extension cords are not a tripping hazard. | | | |  |  | | | |  |
| Electric cords are not worn or frayed. | | | |  |  | | | |  |
| The circular fiber guard covering the wiring connections is present on older plugs. | | | |  |  | | | |  |
| Two-prong unpolarized plugs are inserted so that the ripple side of the cord is connected to the wider (neutral) side of the receptacle. | | | |  |  | | | |  |
| An emergency plan exists for dealing with electric shock incidents. | | | |  |  | | | |  |
| **Safety Checklist for Refrigerators and Freezers: Flammable Materials**  Room: \_\_\_\_\_\_\_\_ Inspector: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | | | | | | | | | |
| Type of refrigerated appliance: | | \_\_\_ explosion-proof refrigerator \_\_\_ domestic  \_\_\_ flammable material storage | | | | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Special Safety Design Features** | **Yes** | **No** | **Date Remedied** |
| Grounded by 3-wire cord and plug or independent ground wire |  |  |  |
| Ground wire in good condition |  |  |  |
| Door gasket seal in good condition |  |  |  |
| Static-resistant drive belt |  |  |  |
| Explosion-proof electrical enclosures, motor housing, conduit properly maintained |  |  |  |

|  |  |  |  |
| --- | --- | --- | --- |
|  | | | |
| **Storage Compartment Safety** | **Yes** | **No** | **Date Remedied** |
| Storage instructions posted on door |  |  |  |
| Containers clearly labeled |  |  |  |
| Large containers stored on low-level shelves |  |  |  |
| Containers safely sealed |  |  |  |
| Liquid storage containers have adequate vapor space, allowing for thermal expansion |  |  |  |
| Interior wall surfaces clean and free of excessive ice build-up |  |  |  |

**RICHMOND COUNTY SCHOOLS SYSTEM**

**SPECIAL REQUEST TO PURCHASE CHEMICALS**

This request form is to be completed by the school Science Department Chairperson for chemical(s) NOT found on the List of Chemicals for Use in High School Science

**SCIENCE DEPARTMENT CHAIRPERSON:**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Name Signature**

School/Facility Name for Room #**\_\_\_\_\_\_\_**

**CHEMICALS:**

|  |  |  |
| --- | --- | --- |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Chemical Name** | **Amount to be Purchased** | **Amount to be Stored** |

|  |  |  |
| --- | --- | --- |
| **PURPOSE** | | |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Chemical Name** | **Amount to be Purchased** | **Amount to be Stored** |
| **PURPOSE** | | |

**REVIEWED AND SUBMITTED BY:**

|  |  |  |  |
| --- | --- | --- | --- |
| **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | **\_\_\_\_\_\_\_\_\_\_\_** |
| **Lab Safety Manager/**  **Chemical Hygiene Officer** | **Date** | **Principal/**  **Assistant Principal** | **Date** |

**Phone Number:**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **Fax Number:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

FAX this form to 706-826-4620. The district Chemical Hygiene Officer in consultation with the science resource office committee will review the hazards and safety of the chemical. (Please allow 2 weeks from date of FAX) Upon approval or disapproval, the Principal/Assistant Principal making the request will be notified by return FAX.

**APPROVAL/ DISAPPROVAL OF REQUEST:**

Upon consultation the following decision was reached: **APPROVAL / DISAPPROVAL**

**REASON FOR DISAPPROVAL:**

*\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

**Name Signature**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Position Date**

#### Richmond County Schools System

#### High School Laboratory Safety Agreement

I, \_\_\_\_\_\_\_\_, (student’s name) have read and agree to follow all of the safety rules set forth in this agreement. I realize that I must obey these rules to ensure my own safety, and that of my fellow students and teachers. I will cooperate to the fullest extent with my teacher and fellow students to maintain a safe lab environment. I will also closely follow the oral and written instructions provided by the teacher. I am aware that any violation of this safety agreement that results in unsafe conduct in the laboratory or misbehavior on my part may result in being removed from the laboratory, detention, receiving a failing grade, and/or referral to the appropriate assistant principal.

Student Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dear Parent or Guardian:

We feel that you should be informed regarding the school’s effort to create and maintain a safe science classroom/ laboratory environment. With the cooperation of the instructors, parents, and students, a safety instruction program can eliminate, prevent, and correct possible hazards. You should be aware of the safety instructions your student will receive before engaging in any laboratory work. Please read the list of safety rules. No student will be permitted to perform laboratory activities unless this agreement is signed by both the student and parent/guardian and is on file with the teacher.

Your signature on this agreement indicates that you have read this Student Safety Agreement, are aware of the measures taken to ensure the safety of your student in the science laboratory, and will instruct your student to uphold his/her agreement to follow these rules and procedures in the laboratory.

Parent/Guardian Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_

**Appendix B1: Chemical Listings**

**APPENDIX B:**

**CHEMICALS OF INTEREST AND CONCERN**

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.
3. The EPA, CDC, and OSHA haves 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), 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.

Elements highlighted in yellow should be used sparingly and with extreme caution

Elements highlighted in red may not be ordered or used in RCCS laboratories. 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.)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Chemical Name** | **Storage Category** | **Health** | **Flammability** | **Reactivity** | **Special Hazard** |
| **The chemicals listed below are approved for use in RCSS laboratories.** | | | | | |
| Acetic Acid, >6M | 0-1 Organic Acid | 3 | 2 | 0 |  |
| Acetic acid, 0.1M | O-1 | 3 | 2 | 0 |  |
| Acetic acid, 0.349M | O-1 | 3 | 2 | 0 |  |
| Acetic acid, 0.873M | O-1 | 3 | 2 | 0 |  |
| Acetic acid, 5% (Vinegar) | O-Misc | 1 | 0 | 0 |  |
| Acetone | 0-4 Flam Cabinet | 1 | 3 | 0 |  |
| Acetone Alcohol | 0-4 Flam Cabinet | 0 | 3 | 0 |  |
| Agar-agar | O-2 Flamm Cab | 1 | 1 | 0 |  |
| Alaizarin yellow | O-Misc | 0 | 0 | 0 |  |
| Aluminum Nitrate | I-2 | 1 | 0 | 0 | **OX** |
| Aluminum ammonium sulfate | I-2 | 1 | 0 | 0 |  |
| Aluminum metal | I-1 | 1 | 0 | 0 |  |
| Aluminum potassium sulfate | I-2 | 1 | 0 | 0 |  |
| Aluminum sulfate | I-2 | 1 | 0 | 0 |  |
| Aluminum, powder | I-1 | 0 | 3 | 1 |  |
| Ammonia, household | I-4 | 2 | 0 | 0 |  |
| Ammonium Bifluoride | I-2 | 3 | 0 | 2 |  |
| Ammonium chloride | I-2 | 1 | 0 | 0 |  |
| Ammonium Hydroxide, concentrated | 1-4 Base Cabinet | 3 | 1 | 0 |  |
| Ammonium Oxalate | I-2 | 2 | 0 | 0 |  |
| Amyl Alcohol | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Barium Acetate | I-2 | 1 | 0 | 0 |  |
| Barium chloride | I-2 | 2 | 0 | 0 |  |
| Barium Hydroxide | I-4 | 1 | 0 | 0 |  |
| Barium Sulfate | I-6 | 1 | 0 | 0 |  |
| Benedict's Reagent | I-2 | 1 | 0 | 0 |  |
| Benzoic acid | O-Misc | 1 | 1 | 0 |  |
| Bismuth Trichloride | I-2 | 0 | 0 | 0 |  |
| Biuret Test Solution | 1-4 Base Cabinet | 3 | 0 | 1 |  |
| Boric acid | I-2 | 2 | 0 | 0 |  |
| Bromocresol purple solution | O-Misc | 1 | 0 | 0 |  |
| Bromothymol Blue | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 1 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 2 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 3 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 4 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 5 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 6 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 7 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 8 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 9 | O-Misc | 1 | 0 | 0 |  |
| Buffers,.pH 10 | O-Misc | 1 | 0 | 0 |  |
| Calcium carbonate | I-4 | 1 | 0 | 0 |  |
| Calcium chloride, anhydrous | I-2 | 1 | 0 | 0 |  |
| Calcium Fluoride (Fluorspar) | I-2 | 0 | 0 | 0 |  |
| Carbon dioxide, solid | Temporary in Styrofoam cooler | 1 | 0 | 1 | 0 |
| Citric acid | O-1 | 2 | 0 | 1 |  |
| Congo Red | 0-Misc | 1 | 0 | 0 |  |
| Copper (I) chloride | I-2 | 3 | 0 | 0 |  |
| Copper (II) carbonate | I-4 | 1 | 0 | 0 |  |
| Copper (II) chloride | I-2 | 3 | 0 | 1 |  |
| Copper Acetate | I-2 | 1 | 0 | 0 |  |
| Copper Bromide | I-2 | 1 | 0 | 0 |  |
| Copper Carbonate | I-4 | 1 | 0 | 0 |  |
| Copper Oxide | I-4 | 0 | 0 | 0 |  |
| Copper shot | I-1 | 1 | 0 | 0 |  |
| Copper Sulfate | I-2 | 1 | 0 | 0 |  |
| Copper sulfate pentahydrate | I-2 | 1 | 0 | 0 |  |
| Copper sulfate, 0.5M solution | I-2 | 1 | 0 | 0 |  |
| Copper sulfate, anhydrous | I-2 | 1 | 0 | 0 |  |
| Crystal Violet | 0-Misc | 2 | 1 | 1 |  |
| Crystal violet powder | O-Misc | 1 | 1 | 0 |  |
| Cupric Oxide, Red | I-4 | 1 | 0 | 0 |  |
| Dextrose Solution | O-Misc | 0 | 0 | 0 |  |
| Ethanol (ethvl alcohol) | O-2 Flamm Cab | 0 | 4 | 0 |  |
| Ethanol (ethyl alcohol) | 0-2 Flam Cabinet | 0 | 4 | 0 |  |
| Ethylene Glycol | 0-2 | 1 | 0 | 0 |  |
| Fast Green Dye | 0-Misc | 0 | 0 | 0 |  |
| Fehling's Solution - Part A | I-2 | 0 | 0 | 0 |  |
| Fehling's Solution - Part B | 1-4 Base Cabinet | 2 | 0 | 0 |  |
| Ferric Chloride | I-2 | 1 | 0 | 0 |  |
| Ferric Nitrate | I-3 | 1 | 0 | 0 |  |
| Ferric Oxide | I-4 | 0 | 0 | 0 |  |
| Ferric sulfate | I-2 | 2 | 0 | 0 |  |
| Ferrous ammonium sulfate | I-2 | 1 | 0 | 0 |  |
| Ferrous Oxide | I-4 | 2 | 0 | 0 |  |
| Ferrous sulfate | I-2 | 1 | 0 | 0 |  |
| Ferrous Sulfide | I-5 | 0 | 0 | 1 |  |
| Fluorescein (sodium hydroxide solution) | 1-4 Base Cabinet | 2 | 0 | 0 |  |
| Glucose Standard Solution | O-Misc | 0 | 0 | 0 |  |
| Glutaraldehyde (> 10%) | 0-3 | 3 | 0 | 1 |  |
| Gram's Iodine Stain | 0-Misc | 2 | 0 | 1 |  |
| Iodine potaasium iodine (Lugol's) soln | I-2 | 1 | 0 | 0 |  |
| Iodine Tincture | 1-2 Flam Cabinet | 1 | 2 | 0 |  |
| Iron (II) chloride | I-2 | 2 | 0 | 1 |  |
| Iron (III) chloride | I-2 | 2 | 0 | 1 |  |
| Iron (III) chloride | I-2 | 2 | 0 | 1 |  |
| Iron (III) oxide | I-4 | 0 | 0 | 0 |  |
| Iron Chloride (ferric chloride) | I-2 | 2 | 0 | 0 |  |
| Iron Filings | I-1 | 0 | 0 | 0 |  |
| Isopropanol (isopropyl alcohol) | O-2 Flamm Cab | 1 | 3 | 0 |  |
| Lauric acid | O-Misc Flamm Cab | 1 | 1 | 0 |  |
| lsopropanol (isopropyl alcohol) | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Magnesium chloride solution | I-2 | 1 | 0 | 0 |  |
| Magnesium oxide, light | I-2 | 0 | 0 | 0 |  |
| Manganese chloride | I-4 | 2 | 0 | 0 |  |
| Manganese Nitrate | I-3 | 1 | 0 | 0 |  |
| Marble chips | I-4 | 1 | 0 | 0 |  |
| Methylene blue | O-Misc | 1 | 3 | 0 |  |
| Methylene Chloride (dicholoroethane) | 0-4 | 2 | 1 | 0 |  |
| Milk of Magnesia Mg(OH)2 and Al(OH)3 | I Misc | 1 | 0 | 0 |  |
| Nickel Acetate | I-2 | 0 | 0 | 0 |  |
| Nickel Ammonium Sulfate | I-2 | 0 | 0 | 0 |  |
| Nickel Chloride | I-2 | 3 | 0 | 0 |  |
| Nickel Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Nickel nitrate hexhydrate | I-3 | 1 | 0 | 0 | **OX** |
| Nitric acid (>1 molar & <10 molar) | 1-9 Acid Cabinet | 3 | 0 | 0 |  |
| Nitric acid, 6M | I-9 Acid Cab | 4 | 0 | 0 | **OX** |
| Nitric Acid, concentrated | 1-9 Acid Cabinet | 4 | 0 | 0 | **OX** |
| Nitrilotriacetic Acid | 0-1 Organic Acid | 3 | 1 | 1 |  |
| Nitrobenzene | 0-3 Flam Cabinet | 3 | 2 | 1 |  |
| Nitrogen Triiodide | 0-4 Explosive | 2 | 0 | 4 |  |
| Phenol Red 0.04% soln | I-8 | 1 | 0 | 0 | **OX** |
| Phenol Red Alcohol soln 1 % | I-8 | 1 | 0 | 0 | **OX** |
| Phenolphthalein | O-Misc Flamm Cab | 1 | 1 | 0 |  |
| Potassium chloride | I-2 | 2 | 0 | 0 |  |
| Potassium chloride, 31% solution | I-2 | 1 | 0 | 0 |  |
| Potassium chloride, 3M | I-2 | 1 | 0 | 0 |  |
| Potassium chloride, 4M | I-2 | 1 | 0 | 0 |  |
| Potassium Ferricyanide | I-7 | 3 | 0 | 0 |  |
| Potassium ferrocyanide solution | I-7 | 1 | 0 | 0 |  |
| Potassium Fluoride (potassium bifluoride) | I-2 | 1 | 0 | 0 |  |
| Potassium Hydroxide | 1-4 Base Cabinet | 3 | 0 | 1 |  |
| Potassium Hydroxide (>3 molar) | 1-4 Base Cabinet | 3 | 0 | 1 |  |
| Potassium hydroxide pellets | I-4 | 3 | 0 | 1 |  |
| Potassium hydroxide, 2% soln | I-4 | 3 | 0 | 1 |  |
| Potassium iodide | I-2 | 1 | 0 | 0 |  |
| Potassium Oxalate | 2 | 4 | 0 | 0 |  |
| Potassium phosphate monobasic | I-2 | 0 | 0 | 0 |  |
| Potassium Thiocyanate | I-1 | 2 | 0 | 0 |  |
| Sodium acetate | I-2 | 1 | 0 | 0 |  |
| Sodium Bezoate (borax) | 0-3 | 1 | 0 | 0 |  |
| Sodium bicarbonate | I-4 | 1 | 0 | 0 |  |
| Sodium Bismuthate | I-7 | 2 | 0 | 0 |  |
| Sodium Bisulfite (sodium hydrogen sulfite) | I-7 | 1 | 0 | 1 |  |
| Sodium Bromate | I-6 | 1 | 1 | 1 |  |
| Sodium carbonate | I-4 | 1 | 0 | 0 |  |
| Sodium chloride | I-2 | 1 | 0 | 0 |  |
| Sodium Ferrocyanide | I-7 | 2 | 0 | 0 |  |
| Sodium Fluoride (Bifluoride) | I-2 | 3 | 0 | 0 |  |
| Sodium Hydrosulfite (sodium dithionite) | I-2 | 2 | 1 | 2 |  |
| Sodium Hydroxide (>3 molar) | 1-4 Base Cabinet | 3 | 0 | 1 |  |
| Sodium Hydroxide (Red Devil Lye) | 1-4 Base Cabinet | 3 | 0 | 1 |  |
| Sodium hydroxide pellets | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide pellets | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 0.1M | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 0.2M | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 0.3M | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 0.75M | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 1.0M | I-4 | 3 | 0 | 1 |  |
| Sodium hydroxide, 1.8M | I-4 | 3 | 0 | 1 |  |
| Sodium Hypochlorite (>4 % solution) | I-6 | 2 | 0 | 0 |  |
| Sodium iodide | I-2 | 1 | 0 | 1 |  |
| Sodium Metabifulfite | I-2 | 3 | 0 | 1 |  |
| Sodium Nitrite | I-3 | 1 | 0 | 0 |  |
| Sodium sulfate | I-2 | 1 | 0 | 0 |  |
| Sodium sulfate | I-2 | 0 | 0 | 0 |  |
| Sodium sulfite | I-2 | 2 | 0 | 1 |  |
| Sodium Thiocyanate | I-7 | 1 | 0 | 1 |  |
| Sodium thiosulfate | I-2 | 0 | 0 | 0 |  |
| Stannic Chloride | I-2 | 3 | 0 | 1 |  |
| Stannic Chloride | I-2 | 3 | 0 | 1 |  |
| Sucrose | O-Misc Flamm Cab | 1 | 1 | 0 |  |
| Sulfur | I-10 Flamm Cab | 1 | 1 | 0 |  |
| Tannie Acid | 0-1 | 1 | 1 | 0 |  |
| Tin (II) chloride | I-2 | 3 | 0 | 1 |  |
| Tin (IV) chloride | I-2 | 3 | 0 | 1 |  |
| Tin metal | I-1 | 0 | 0 | 0 |  |
| Tin metal foil | I-1 | 0 | 0 | 0 |  |
| Universal Indicator | O-Misc Flamm Cab | 2 | 3 | 2 |  |
| Universal Indicator (ethanol solution) | 0-2 Flam Cabinet | 0 | 3 | 0 |  |
| Wright's Staining Solution | 0-9 Flam Cabinet | 1 | 0 | 0 |  |
| Zinc Acetate | I-2 | 0 | 0 | 0 |  |
| Zinc metal | I-1 | 0 | 0 | 0 |  |
| Zinc oxide | I-2 | 2 | 0 | 0 |  |
| Zinc sulfate heptahydrate | I-2 | 1 | 0 | 0 |  |
| **Chemicals that Should be Used with Caution** | | | | | |
| Aluminum Chloride | I-2 | 3 | 0 | 2 |  |
| Aluminum Chloride, anhydrous | I-2 | 3 | 0 | 2 | **W** |
| Aluminum Hydroxide | 1-4 Base Cabinet | 2 | 0 | 0 |  |
| Ammonium Bichromate | I-8 | 2 | 1 | 1 | **OX** |
| Barium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Calcium Hydroxide | I-4 | 1 | 0 | 1 |  |
| Calcium Hypochlorite | I-6 | 3 | 0 | 1 | **OX** |
| Calcium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Calcium Oxide | I-4 | 3 | 0 | 1 |  |
| Cobalt Chloride | I-2 | 0 | 0 | 0 |  |
| Cobalt Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Cobalt Sulfate | I-2 | 0 | 0 | 0 |  |
| Cobalt, powder | I-1 | 1 | 1 | 0 |  |
| Copper Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Cyclohexane | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Cyclohexane, 100% | O-2 Flamm Cab | 2 | 3 | 2 |  |
| Cyclohexanol | 0-2 Flam Cabinet | 1 | 2 | 0 |  |
| Cyclohexanone | 0-4 Flam Cabinet | 0 | 2 | 0 |  |
| Cyclohexene | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Denatured Alcohol | 0-2 Flam Cabinet | 2 | 4 | 0 |  |
| Glycerin | O-2 Flamm Cab | 1 | 1 | 0 |  |
| Glycerin Jelly | O-2 Flamm Cab | 1 | 1 | 0 |  |
| Hydrochloric Acid (>5 molar) | 1-9 Acid Cabinet | 3 | 0 | 0 |  |
| Hydrochloric acid, conc | I-9 Acid Cab | 3 | 0 | 0 |  |
| Hydrochloric acid,1.0N | I-9 Acid Cab | 3 | 0 | 0 |  |
| Hydrogen peroxide, 3% | I-6 | 1 | 0 | 0 |  |
| Hydrogen Peroxide, 8% | I-6 | 3 | 0 | 1 | **OX** |
| Iron Nitrate (ferric nitrate) | I-3 | 1 | 0 | 0 | **OX** |
| Lactic Acid | 0-1 Organic Acid | 3 | 0 | 0 | **OX** |
| Lead (II) nitrate | I-3 | 2 | 0 | 2 | **OX** |
| Lead (II) nitrate solution, 1.0M | I-3 | 2 | 0 | 2 | **OX** |
| Lead (III) nitrate | I-3 | 3 | 0 | 2 | **OX** |
| Lead Acetate | I-2 | 3 | 1 | 0 |  |
| Lead Carbonate | I-4 | 3 | 0 | 0 |  |
| Lead Chloride | I-2 | 3 | 0 | 0 |  |
| Lead Nitrate | I-3 | 3 | 0 | 0 | **OX** |
| Lead Oxide | I-4 | 3 | 0 | 0 |  |
| Lead shot | I-1 | 2 | 0 | 1 |  |
| Lead Sulfate | I-2 | 3 | 0 | 0 |  |
| Lead, lump | I-1 | 1 | 0 | 0 |  |
| Lime Water (calcium hydroxide solution) | I-4 | 1 | 0 | 0 |  |
| Liquid Antacid (Aluminum hydroxide) | I-Misc | 0 | 0 | 0 |  |
| Lithium Aluminum Hydride | I-1 | 3 | 2 | 2 | **W** |
| Lithium chloride | I-2 | 1 | 0 | 0 |  |
| Lithium Fluoride | I-2 | 1 | 0 | 0 |  |
| Lithium Hydroxide | I-4 | 1 | 0 | 0 |  |
| Lithium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Lye | I-4 Base Cabinet | 3 | 0 | 1 |  |
| Magnesium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Magnesium Perchlorate (Anhydrone) | I-6 | 1 | 0 | 0 | **OX** |
| Magnesium ribbon | I-1 Flamm Cab | 0 | 1 | 0 | **W** |
| Magnesium sulfate, anhydrous | I-2 | 1 | 0 | 0 |  |
| Magnesium, turnings or ribbon | I-1 | 0 | 1 | 0 |  |
| Manganese Dioxide | I-4 | 3 | 0 | 2 | **OX** |
| Methanol | O-2 Flamm Cab | 2 | 4 | 0 |  |
| Methanol (methyl alcohol) | 0-2 Flam Cabinet | 2 | 4 | 0 |  |
| Muriatic Acid | 1-9 Acid Cabinet | 3 | 0 | 0 |  |
| Ninhydrin | 0-2 | 3 | 0 | 2 |  |
| Polyvinyl Alcohol | 0-2 | 0 | 2 | 0 |  |
| Potassium Bromate | I-6 | 1 | 0 | 0 | **OX** |
| Potassium carbonate | I-4 | 1 | 0 | 0 |  |
| Potassium Chlorate | I-6 | 2 | 0 | 0 | **OX** |
| Potassium Chromate | I-8 | 3 | 0 | 1 | **OX** |
| Potassium chromate, solid | I-8 | 3 | 0 | 1 | **OX** |
| Potassium chromate. 1.0M soln | I-8 | 3 | 0 | 1 | **OX** |
| Potassium Dichromate | I-8 | 3 | 0 | 0 '. | **OX** |
| Potassium Iodate | I-6 | 1 | 0 | 0 | **OX** |
| Potassium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Potassium Nitrite | I-3 | 1 | 0 | 0 | **OX** |
| Potassium Perchlorate | I-6 | 1 | 0 | 2 | **OX** |
| Potassium Periodate | I-6 | 1 | 0 | 2 | **OX** |
| Potassium Permanganate | I-8 | 1 | 0 | 0 | **OX** |
| Potassium permanganate solution, 0.1 M | I-8 | 2 | 0 | 2 | **OX** |
| Potassium Peroxide | I-6 | 3 | 0 | 1 | **OX** |
| Potassium Persulfate | I-5 | 1 | 0 | 0 | **OX** |
| Silver Chloride | I-2 | 1 | 0 | 0 |  |
| Silver Nitrate | I-3 | 2 | 0 | 0 | **OX** |
| Silver nitrate, 0.1 N soln | I-3 | 2 | 0 | 0 | **OX** |
| Silver nitrate, 1.0M soln | I-3 | 2 | 0 | 0 | **OX** |
| Silver nitrate, 1.0M soln | I-3 | 2 | 0 | 0 | **OX** |
| Soda Lime | 1-4 Base Cabinet | 3 | 0 | 1 | **W** |
| Sodium Borohydride | I-1 | 3 | 0 | 2 | **W** |
| Sodium Chlorate | I-6 | 1 | 0 | 2 | **OX** |
| Sodium Chromate | I-8 | 3 | 0 | 0 | **OX** |
| Sodium Cobaltinitrate | I-3 | 1 | 0 | 0 | **OX** |
| Sodium Dichromate | I-8 | 3 | 0 | 0 | **OX** |
| Sodium Nitrate | I-3 | 1 | 0 | 0 | **W** |
| Sodium Oxalate | I-2 | 4 | 0 | 0 | **OX** |
| Sodium Perborate | I-8 | 1 | 0 | 0 | **OX** |
| Sodium Perchlorate | I-6 | 2 | 0 | 2 | **OX** |
| Sulfuric Acid | 1-9 Acid Cabinet | 3 | 0 | 2 |  |
| Sulfuric acid, 0.05M | I-9 Acid Cab | 3 | 0 | 2 | **OX** |
| Sulfuric acid, conc | I-9 Acid Cab | 3 | 0 | 2 | **OX** |
| Sulfuric acid, conc | I-9 Acid Cab | 3 | 0 | 2 | **OX** |
| Zinc nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Zinc, powder | I-1, Flam Cabinet | 1 | 2 | 0 |  |
| **Chemicals Not Allowed in RCSS Laboratories** | | | | | |
| Acetaldehyde | 0-3 Flam Cabinet | 3 | 4 | 2 |  |
| Acetonitrile | 0-7 Flam Cabinet | 2 | 3 | • 0 |  |
| Acetyl Chloride | 0-4 Acid Cabinet | 3 | 3 | 2 | **W** |
| Acrolein (acrylaldehyde) | 0-3 Flam Cabinet | 4 | 3 | 3 |  |
| Acetic Acid, Glacial | 0-1 Flam Cabinet | 3 | 2 | 0 |  |
| Acetic Anhydride | 0-1 Flam Cabinet | 3 | 2 | 1 |  |
| Acrylamide | 0-3 | 2 | 2 | 2 |  |
| Acrylic Acid | 0-8 Organic Acid | 3 | 2 | 2 |  |
| Acrylonitrile | 0-7 Flam Cabinet | 4 | 3 | 2 |  |
| Adipoyl Chloride | 0-1 Organic Acid | 2 | 2 | 0 |  |
| Adrenaline (Epinephrine) | 0-2 | 3 | 0 | 0 |  |
| Ammonia, gas cylinders | Poison Gas | 3 | 1 | 0 |  |
| Ammonium Dichromate | I-8 | 2 | 1 | 1 | **OX** |
| Ammonium Metavanadate | I-8 | 3 | 0 | 0 |  |
| Ammonium Persulfate | 1-6· | 1 | 3 | 0 | **OX** |
| Ammonium Chromate | I-8 | 1 | 1 | 1 | **OX** |
| Ammonium Fluoride | I-2 | 3 | 0 | 0 |  |
| Ammonium Molybdate | I-8 | l | 0 | 0 |  |
| Ammonium nitrate | I-8 Flamm Cab SEPARATE | 3 | 0 | 0 | **OX** |
| Ammonium Perchlorate | I-6 | 1 | 0 | 4 | **OX** |
| Ammonium Sulfide | I-5 | 3 | 2 | 1 |  |
| Amyl Acetate | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Aniline | 0-2 | 3 | 2 | 0 |  |
| Aniline Hydrochloride | 0-2 | 3 | 1 | 0 |  |
| Antimony Trichloride | I-2 | 3 | 0 | 2 |  |
| Antimony, lump | I-1 | 0 | 0 | 0 |  |
| Antimony, powder | I-1 | 1 | 1 | 0 |  |
| Arsenic Oxide | I-4 | 3 | 0 | 0 |  |
| Arsenic Trioxide | I-7 | 3 | 0 | 0 |  |
| Ascarite | I-4 | 3 | 0 | 2 |  |
| Barium Carbonate | I-4 | 1 | 0 | 0 |  |
| Barium Chromate | I-8 | 2 | 0 | 1 | **OX** |
| Barium Peroxide | I-6 | 1 | 0 | 0 | **OX** |
| Benzaldehyde | 0-3 Flam Cabinet | 2 | 2 | 0 |  |
| Benzene | 0-3 Flam Cabinet | 2 | 3 | 0 |  |
| Benzidine | 0-2 | 1 | 0 | 0 |  |
| Benzonitrile . | 0-7 Flam Cabinet | 2 | 2 | 1 |  |
| Benzoyl Chloride | 0-3 Flam Cabinet | 3 | 2 | 2 | **W** |
| Benzoyl Peroxide | 0-6 | 1 | 0 | 3 |  |
| Benzyl Alcohol | 0-2 Flam Cabinet | 0 | 1 | 0 |  |
| Beryllium | I-1 | 3 | 1 | 0 |  |
| Bouin's Solution | 0-8 Organic Acid | 2 | 1 | 0 |  |
| Bromine Water | 1-2 Acid Cabinet | 3 | 0 | 0 | **OX** |
| Bromine, concentrated | 1-2 Acid Cabinet | 3 | 0 | 0 | **OX** |
| Bromobenzene | 0-4 Flam Cabinet | 2 | 2 | 0 |  |
| Bromobutane | 0-4 Flam Cabinet | 2 | 3 | 0 |  |
| Bromoform | 0-4 | 3 | 0 | 1 |  |
| Butanol, 1- (n-butyl alcohol) | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Butanol, 2- (sec-butyl alcohol) | 0-2 Flam Cabinet | 1 | 3 | 1 |  |
| Butanol, 3- (tert-butyl alcohol) | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Butoxyethanol | 0-2 Flam Cabinet | 0 | 0 | 0 |  |
| Butyl Acetate | 0-3 Flam Cabinet | 0 | 3 | 0 |  |
| Butyraldehyde | 0-3 Flam Cabinet | 3 | 3 | 2 |  |
| Butyric Acid | 0-1 Acid Cabinet | 3 | 2 | 0 |  |
| Cadmium Chloride | I-2 | 4 | 0 | 0 |  |
| Cadmium Nitrate | I-3 | 2 | 0 | 0 | **OX** |
| Cadmium, powder | I-1 | 3 | 0 | 0 |  |
| Caffeine | 0-2 | 0 | 0 | 0 |  |
| Calcium Carbide | I-5 | 3 | 3 | 2 | **W** |
| Calcium Phosphide | I-5 | 4 | 3 | 3 | **W** |
| Calcium Sulfide | I-5 | 0 | 1 | 0 |  |
| Calcium, metal | I-1 | 3 | 1 | 2 | **W** |
| Calomel (Mercurous Chloride) | I-2 | 3 | 0 | 0 |  |
| Camoy's Fixative Solution | 0-4 Flam Cabinet | 2 | 4 | 0 |  |
| Camphor | 0-4 | 1 | 1 | 0 |  |
| Carbal Fuchsin Solution | 0-8 Flam Cabinet | 2 | 1 | 0 |  |
| Carbon Disulfide | 1-5 Flam Cabinet | 3 | 4 | 0 |  |
| Carbon Tetrachloride | 0-4 | 3 | 0 | 0 |  |
| Catechol | 0-8 | 3 | 1 | 0 |  |
| Ceric Ammonium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Chloral Hydrate | 0-2 | 2 | 0 | 0 |  |
| Chloretone | 0-4 | 3 | 1 | 0 |  |
| Chlorine water | 1-2 Acid Cabinet | 3 | 0 | 0 |  |
| Chlorine, gas cylinders | Poison Gas | 4 | 0 | 0 | **OX** |
| Chlorobenzene | 0-4 Flam Cabinet | 2 | 3 | 0 |  |
| Chloroethanol | 0-4 Flam Cabinet | 4 | 2 | 0 |  |
| Chloroform | 0-4 | 2 | 0 | 0 |  |
| Chlorophenol, p- | 0-4 | 2 | 0 | 0 |  |
| Chloroprene | 0-4 Flam Cabinet | 3 | 3 | 0 |  |
| Chlorosulfonic Acid | 0-1 Acid Cabinet | 4 | 0 | 2 | **W.OX** |
| Chromic Acid | 1-8 Acid Cabinet | 3 | 0 | 1 | **OX** |
| Chromium Nitrate | I-3 | 1 | 0 | 0 | **OX** |
| Chromium Trioxide | I-4 | 3 | 0 | 2 | **OX** |
| Colchicine | 0-2 | 3 | 1 | 0 |  |
| Collodion | 0-4 Flam Cabinet | 1 | 4 | 0 |  |
| Copper Cyanide | I-7 | 3 | 0 | 0 |  |
| Copper Sulfide | I-5 | 3 | 1 | 1 |  |
| Corrosive Sublimate (Mercury Bifluoride) | I-2 | 3 | 0 | 0 |  |
| Creosote | 0-8 Flam Cabinet | 2 | 2 | 0 |  |
| Cresol | 0-8 Organic Acid | 3 | 2 | 0 |  |
| Cumene | 0-4 Flam Cabinet | 2 | 3 | 1 |  |
| Cyanogen Bromide | 0-4 | 4 | 0 | 1 |  |
| Dichlorobenzene, p- | 0-4 | 2 | 2 | 0 |  |
| Dichloroethane, 1,2- (ethylene dichloride) | 0-4 Flam Cabinet | 1 | 4 | 0 |  |
| Diethylamine | 0-2 Flam Cabinet | 3 | 3 | 0 |  |
| Dimethyl Aniline | 0-2 Flam Cabinet | 3 | 2 | 0 |  |
| Dimethyl Sulfoxide | 0-7 | 1 | 1 | 0 |  |
| Dinitrophenol, 2,4- | 0-4 | 3 | 3 | 1 |  |
| Dinitrophenyl Hydrazine, 2,4- | 0-4 | 1 | 2 | 2 |  |
| Dioxane, 1,4- | 0-4 Flam Cabinet | 2 | 3 | 1 |  |
| Diphenylamine | 0-2 | 1 | 0 | 0 |  |
| Estrone | 0-2 | 0 | 0 | 0 |  |
| Ethidium Bromide | 0-2 | 3 | 0 | 0 |  |
| Ethyl Acetate | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Ethyl Carbamate (urethane) | 0-2 Flam Cabinet | 2 | 2 | 0 |  |
| Ethyl Chloride | 0-4 Flam Cabinet | 2 | 4 | 0 |  |
| Ethyl Ether (diethyl ether or anhydrous ether) | 0-4 Flam Cabinet | 1 | 4 | 1 |  |
| Ethyl Iodide | 0-2 Flam Cabinet | 3 | 1 | 1 |  |
| Ethyl Nitrate | 0-4 Explosive | 3 | 4 | 4 |  |
| Ethylenediamine | 0-2 Flam Cabinet | 3 | 2 | 0 |  |
| Ethyleneimine | 0-2 Flam Cabinet | 4 | 3 | 3 |  |
| Formaldehyde (37% Solution) | 0-3 | 3 | 2 | 0 |  |
| Formalin, buffered, (<10% solution) | 0-3 | 2 | 2 | 0 |  |
| Formic Acid | 0-1 Organic Acid | 3 | 2 | 0 |  |
| Furfural | 0-3 Flam Cabinet | 3 | 2 | 0 |  |
| Gasoline | 0-4 Flam Cabinet | 3 | 4 | 2 |  |
| Giemsa Stain | 0-2 Flam Cabinet | 0 | 2 | 0 |  |
| Gunpowder | 1-4 Flam Cabinet | 0 | 4 | 3 |  |
| Hayem Diluting Fluid | I-2 | 3 | 0 | 0 |  |
| Heptane | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Hexamethylenediamine ( 1,6-hexanediamine) | 0-2 Base Cabinet | 2 | 0 | 0 |  |
| Hexane | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Hexanes | 0-3 Flam Cabinet | 1 | 2 | 0 |  |
| Hydrazine | 0-2 Flam Cabinet | 3 | 3 | 3 |  |
| Hydrazine Sulfate | 0-2 | 3 | 0 | 1 |  |
| Hydriodic Acid | 1-9 Acid Cabinet | 3 | 0 | 0 |  |
| Hydrobromic Acid | 1-9 Acid Cabinet | 3 | 0 | 0 |  |
| Hydrofluoric Acid | 1-9 Acid Cabinet | 4 | 0 | 0 |  |
| Hydrogen Peroxide, >29% | I-6 | 3 | 0 | 1 | **OX** |
| Hydrogen Sulfide, gas cylinders | Poison Gas | 4 | 4 | 0 |  |
| Hydrogen, gas cylinders | Flam Gas | 0 | 4 | 0 |  |
| Hydroquinone | 0-2 | 2 | 0 | 0 |  |
| Immersion Oil (very old) | 0-2 | 0 | 0 | 0 |  |
| Iodine | I-2 | 3 | 0 | 0 |  |
| Iron (III) hydroxide | I-4 | 3 | 0 | 2 | **CORR** |
| Isobutanol | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Isopentyl Alcohol (isoamyl alcohol) | 0-2 Flam Cabinet | 1 | 2 | 0 |  |
| Isopropyl Ether | 0-4 Flam Cabinet | 2 | 3 | 1 |  |
| Kerosene | 0-3 | 0 | 1 | 0 |  |
| Lauroyl Peroxide | 0-6 | 1 | 2 | 3 |  |
| Lead Chromate | I-8 | 3 | 0 | 0 | **OX** |
| Lead Dioxide | I-4 | 3 | 0 | 0 | **OX** |
| Lead Iodide | I-2 | 3 | 0 | 0 |  |
| Lead Monoxide (Litharge) | I-4 | 3 | 0 | 0 |  |
| Lead, powder | I-1 | 2 | 1 | 0 |  |
| Lithium, Metal | I-1 | 3 | 2 | ·2 | **W** |
| Magnesium, powder | I-1 | 0 | 1 | 1 | **W** |
| Malonic Acid | 0-1 Organic Acid | 1 | 1 | 1 |  |
| Mercaptoethanol | 0-2 Flam Cabinet | 3 | 2 | 1 |  |
| Mercuric Chloride | I-2 | 3 | 0 | 0 |  |
| Mercuric Iodide | I-2 | 2 | 0 | 0 |  |
| Mercuric Nitrate | I-3 | 3 | 0 | 0 | **OX** |
| Mercuric Sulfate | I-2 | 3 | 0 | 0 |  |
| Mercuric Sulfide | I-5 | 3 | 0 | 1 |  |
| Mercurochrome | 0-2 | 3 | 0 | 0 |  |
| Mercurous Chloride | I-2 | 2 | 0 | 0 |  |
| Mercurous Nitrate | I-3 | 3 | 0 | 0 | **OX** |
| Mercurous Sulfate | I-2 | 3 | 0 | 0 |  |
| Mercury Thermometers | I-1 Separate | 2 | 0 | 0 |  |
| Mercury, liquid | I-1 | 2 | 0 | 0 |  |
| Methyl Methacrylate | 0-3 Flam Cabinet | 2 | 3 | 2 |  |
| Methyl Ethyl Ketone | 0-4 Flam Cabinet | 1 | 3 | 0 |  |
| Methyl Iodide (lodomethane) | 0-4 Flam Cabinet | 3 | 0 | 1 |  |
| Methyl Isobutyl Ketone | 0-4 Flam Cabinet | 2 | 3 | 1 |  |
| Methyl Isocyanate | 0-5 Flam Cabinet |  | 3 | 1 |  |
| Methyl lsopropyl Ketone | 0-4 Flam Cabinet | 1 | 3 | 0 |  |
| Methyl Orange | 0-9 | 2 | 0 | 0 |  |
| Methyl Red | O-Misc | 1 | 3 | 0 |  |
| Methylamine | 0-2 Flam Cabinet | 3 | 4 | 0 |  |
| Millon's Reagent | I-9 Acid Cabinet | 3 | 0 | 0 | **OX** |
| Molisch Reagent | 0-2 Flam Cabinet | 1 | 3 | 0 |  |
| Molybdenum, dust | I-1 | 0 | 1 | 0 |  |
| Naphthalene | 0-3 | 2 | 2 | 0 |  |
| Naphthol, 1- | 0-8 | 1 | 1 | 0 |  |
| Naphthol, 2- | 0-8 | 1 | 1 | 0 |  |
| Naphthylamine, a- | 0-2 Flam Cabinet | 2 | 1 | 0 |  |
| Nessler's Reagent | I-4 | 3 | 0 | 0 |  |
| Nickel Oxide | I-4 | 1 | 0 | 0 |  |
| Nickel Sulfate | I-2 | 0 | 0 | 0 |  |
| Nickel, dust | I-1 | 1 | 0 | 0 |  |
| Nicotine | 0-2 | 4 | l | 0 |  |
| Nitroglycerin | 0-4 Explosive | 3 | 1 | 2 |  |
| Nitrophenol, 3- | 0-8 | 3 | 0 | 0 |  |
| Nitrophenol, 4- | 0-8 | 3 | 0 | 0 |  |
| Octanol, 2- | 0-2 Flam Cabinet | 1 | 2 | 0 |  |
| Osmium Tetraoxide (Osmic Acid) | I-4 | 3 | 0 | 0 |  |
| Oxalic Acid | I-1 | 3 | 1 | 0 |  |
| Paraformaldehyde | 0-3 | 3 | 1 | 0 |  |
| Paraldehyde | 0-3 Flam Cabinet | 2 | 3 | 1 |  |
| Pentachlorophenol | 0-4 | 3 | 0 | 0 |  |
| Pentane | 0-3 Flam Cabinet | 1 | 4 | 0 |  |
| Perchloric Acid | 1-9 Acid Cabinet | 3 | 0 | 3 | **OX** |
| Perchloroethylene | 0-4 | 2 | 0 | 0 |  |
| Petroleum Ether | 0-3 Flam Cabinet | 1 | 4 | 0 |  |
| Phenanthroline | 0-2 | 2 | 1 | 0 |  |
| Phenol | 0-8 | 4 | 2 | 0 |  |
| Phenylthiocarbamide | 0-2 | 2 | 0 | 0 |  |
| Phosphoric Acid | 1-9 | 3 | 0 | 0 |  |
| Phosphorus Pentasulfide | 1-5 | 2 | 1 | 2 | **W** |
| Phosphorus Pentoxide | 1-10 | 3 | 0 | 2 | **W** |
| Phosphorus, Red | 1-10 Flam Cabinet | 1 | 1 | 1 |  |
| Phosphorus, Yellow or White | 1-10 Flam Cabinet | 4 | 4 | 2 |  |
| Physostigmine | 0-2 | 0 | 0 | 0 |  |
| Picric Acid, Trinitrophenol | 0-8 Organic Acid | 3 | 4 | 4 |  |
| Polyurethane Foam -Part B | 0-5 | 2 | 1 | 1 |  |
| Potassium biphthalate | I-2 | 0 | 0 | 0 |  |
| Potassium Cyanide | I-7 | 3 | 0 | 0 |  |
| Potassium Sulfide | I-7 | 3 | 1 | 0 |  |
| Potassium, metal | I-6 | 3 | 3 | 2 | **W** |
| Propanol, n- | 0-2 Flam Cabinet | 2 | 3 | 2 |  |
| Propionic Acid | 0-1 Organic Acid | 3 | 2 | 0 |  |
| Pyridine | 0-2 Flam Cabinet | 3 | 3 | 0 |  |
| Pyrogallol | 0-8 | 3 | 0 | 0 |  |
| Resorcinol | 0-8 | 3 | 1 | 0 |  |
| Rubber Cement Solvent | 0-3 Flam Cabinet | 0 | 3 | 0 |  |
| Rubber Cement Thinner | 0-3 Flam Cabinet | 0 | 3 | 0 |  |
| Sebacoyl Chloride | 0-1 Organic Acid | 3 | 1 | 1 |  |
| Sebacoyl Chloride/Hexane Solution | 0-3 Flam Cabinet | 3 | 3 | 1 |  |
| Selenium | I-1 | 1 | 0 | 0 |  |
| Silver Acetate | I-2 | 1 | 0 | 0 |  |
| Silver Cyanide | I-7 | 3 | 0 | 0 |  |
| Silver Oxide | I-4 | 1 | 0 | 0 |  |
| Sodium Arsenate | 7 | 3 | 0 | 0 |  |
| Sodium Arsenite | 7 | 3 | 0 | 0 |  |
| Sodium Azide | 3 | 3 | 0 | 3 |  |
| Sodium Cyanide | I-7 | 3 | 0 | 0 |  |
| Sand, washed (Silicon dioxide) | I-Misc | 1 | 0 | 1 |  |
| Sodium Nitroferricyanide | I-7 | 3 | 0 | 0 | **OX** |
| Sodium Peroxide | I-6 | 3 | 0 | 1 | **OX** |
| Sodium Sulfide | I-5 | 3 | 1 | 1 |  |
| Sodium, metal lump | I-1 | 3 | 3 | 2 | **W** |
| Sodium, metal, small chips | I-1 | 3 | 3 | 2 | **W** |
| Stannous Chloride | I-2 | 3 | 0 | 1 |  |
| Strontium | I-1 | 2 | 2 | 2 | **W** |
| Strontium chloride hexahydrate | I-2 | 2 | 0 | 0 |  |
| Strontium Hydroxide Solution | 1-4 Base Cabinet | 2 | 0 | 1 |  |
| Strontium Nitrate | 3-Jan | 1 | 0 | 0 | **OX** |
| Strychnine | 0-2 | 3 | 0 | 0 |  |
| Styrene, monomer | 0-3 Flam Cabinet | 2 | 3 | 0 |  |
| Sulfamic Acid | 1-9 Acid Cabinet | 1 | 0 | 0 |  |
| Sulfur Dioxide, gas cylinder | Poison Gas | 3 | 0 | 0 |  |
| Sulfuric Acid, fuming | I-9 Acid Cab | 3 | 0 | 2 | **OX** |
| Testosterone | 0-2 | 0 | 0 | 0 |  |
| Testosterone Proprionate | 0-2 | 0 | 0 | 0 |  |
| Tetrahydrofuran | 0-4 Flam Cabinet | 2 | 3 | 1 |  |
| Thallium | 1-Jan | 2 | 0 | 0 |  |
| Thionyl Chloride | 1-6 Acid Cabinet | 4 | 0 | 2 |  |
| Thiourea | 0-2 | 1 | 0 | 0 |  |
| Thorium Nitrate | 1-3 Radioactive | 1 | 0 | 0 |  |
| Tin, powder | I-1 | 0 | 1 | 0 |  |
| Titanium Tetrachloride | I-2 | 3 | 0 | 2 |  |
| Titanium Trichloride | I-2 | 3 | 0 | 1 |  |
| Toluene | 0-3 Flam Cabinet | 2 | 3 | 0 |  |
| Trichloroacetic Acid | 0-1 Organic Acid | 3 | 0 | 0 |  |
| Trichloroethane | 0-4 | 2 | 1 | 1 |  |
| Trichloroethylene | 0-4 | 2 | 1 | 0 |  |
| Triethyl Phosphate | 0-5 | 0 | 1 | 1 |  |
| Triethylamine | 0-2 Flam Cabinet | 3 | 3 | 0 |  |
| Trinitrobenzene | 0-3 Explosive | 2 | 4 | 4 |  |
| Trinitrotoluene (TNT) | 0-3 Explosive | 2 | 4 | 4 |  |
| Turpentine | 0-3 Flam Cabinet | 1 | 3 | 0 |  |
| Uranium | 1-1 Radioactive | 1 | 4 | 3 |  |
| Uranyl Acetate | 1-2 Radioactive | 1 | 0 | 0 |  |
| Uranyl Nitrate | 1-3 Radioactive | 1 | 0 | 0 |  |
| Vanadium Pentoxide | I-4 | 3 | 0 | 1 |  |
| Wood's Metal | I-1 | 0 | 0 | 0 |  |
| Xylene | 0-3 Flam Cabinet | 2 | 3 | 0 |  |

### Appendix B2: Oxidizers

### NFPA Class 1 Oxidizers

### Class 1 Oxidizers slightly increase the burning rate of combustible materials.

**They do not cause spontaneous ignition when they come in contact with them.**

**Examples of NFPA Class 1 oxidizers include:**

aluminum nitrate

ammonium persulfate

barium peroxide

hydrogen peroxide solutions

(8% to 27.5% by weight)

magnesium nitrate

nitric acid (40% concentration or less)

perchloric acid solutions

(less than 50% by weight)

potassium dichromate

potassium nitrate

silver nitrate

sodium dichloroisocyanurate dihydrate

sodium dichromate

sodium nitrate

sodium nitrite

sodium perborate (and its monohydrate)

sodium persulfate

strontium nitrate

strontium peroxide

trichloroisocyanuric acid

zinc peroxide

### NFPA Class 2 Oxidizers

### Class 2 Oxidizers increase the burning rate of combustible materials moderately with which they come in contact.

**They may cause spontaneous ignition when in contact with a combustible material.**

**Examples of NFPA Class 2 oxidizers include:**

calcium chlorate

calcium hypochlorite

(50% or less by weight)

chromic acid (chromium trioxide)

1,3-dichloro-5,5-dimethylhydantoin

hydrogen peroxide

(27.5 to 52% by weight)

magnesium perchlorate

nitric acid

(concentration greater than 40% but less than 86%)

potassium permanganate

sodium permanganate

sodium chlorite (40% or less by weight)

sodium perchlorate (and its monohydrate)

sodium peroxide

### NFPA Class 3 Oxidizers

### Class 3 Oxidizers severely increase the burning rate of combustible materials with which they come in contact.

**They will cause sustained and vigorous decomposition if contaminated with a combustible material or if exposed to sufficient heat.**

**Examples of NFPA Class 3 oxidizers include:**

ammonium dichromate

hydrogen peroxide (52 to 91% by weight)

nitric acid, fuming

(concentration greater than 86%)

perchloric acid solutions

(60 to 72% by weight)

potassium bromate

potassium chlorate

potassium dichloroisocyanurate

sodium chlorate

sodium chlorite

(greater than 40% by weight)

sodium dichloroisocyanurate

### NFPA Class 4 Oxidizers

### Class 4 Oxidizers

* **can explode when in contact with certain contaminants.**
* **can explode if exposed to slight heat, shock, or friction.**
* **will increase the burning rate of combustibles.**
* **can cause combustibles to ignite spontaneously.**

**Examples of NFPA Class 4 oxidizers include:**

ammonium perchlorate

(particle size greater than 15 microns)

ammonium permanganate

hydrogen peroxide (greater than 91% by weight)

perchloric acid solutions

(greater than 72.5% by weight)

tetranitromethane

**Appendix B3: Flammable and Combustible Compounds**

**Class 1A (IA)**

Acetaldehyde

Ammonium perchlorate

Collodoin

Cyanogen

Deuterium

Dimethyl sulphine

Dimethylamine

Ethyl chloride

Ethyl ether

Ethyl mercaptan

Ethylamine

Furan

Hydrogen cyanide

Isopentane

Isopropylamine

*l*‐ butylene

Methyl formate

Methyl mercaptan

Methylamine

Methylene chloride

*n*‐pentane

Propylene oxide

*t*‐butylamine

*t*‐buyl hydroperoxide

Trimethylamine

**Class 1B (IB)**

1,1‐dichloroethane

1,1‐dimethylhydrazine

1,2‐dichloroethylene

1,2‐dichloropropane

1‐pentanethiol

1‐propanethiol

2‐butanone (MEK)

2‐pentanone

Acetal

Acetone

Acetonitrile

Acetyl chloride

Acrolein

Acrylonitrile

Allyl alcohol

Allyl chloride

Benzene

*beta*‐chloroprene

*bis*‐chloromethyl ether

Butylaldehyde

Carbon disulfide

Chloromethyl

Crotonaldehyde

Cyclohexane

Cyclohexene

Cyclopentane

Diethyl ketone

Diethylamine

Diisoproplyamine

Dioxane

Ethyl acetate

Ethyl acrylate

Ethyl alcohol, >60%

Ethyl benzene

Ethyl bromide

Ethyl chloroformate

Ethyl formate

Ethylene dichloride

Ethyleneimine

Gasoline

Hexone

Iron pentacarbonyl

Isobutyl alcohol

Isobutyronitrile

Isopropyl acetate

Isopropyl alcohol

Isopropyl ether

Methoxycyclohexane

Methyl acetate

Methyl acrylate

Methyl acrylonitrile

Methyl alcohol

Methyl chloroformate

methyl ether

Methyl ethyl ketone (MEK)

Methyl hydrazine

Methyl isobutyl ketone (MIK)

Methyl isocyanate

Methyl methacrylate

Methyl propyl ketone (MPK)

Methylal *o,m,p*‐xylene

Naphtha

*n*‐butyl acetate

*n*‐butyl mercaptan

*n*‐butylamine

*n*‐butyronitrile

*n*‐heptane

*n*‐hexane

*n*‐hexanethiol

Nickel carbonyl

*n*‐propyl acetate

*n*‐propyl alcohol

*n*‐propyl nitrate

*n*‐valeraldehyde

Pentaborane

Piperidine

Propargyl alcohol

Propionitrile

Propylene dichloride

Propylene imine

Pyridine

*tert*‐butyl alcohol

Tetrahydrofuran (THF)

Toluene

Triethylamine (TEA)

Vinyl acetate

**Class 1C (IC)**

1,3‐dichloropropene

1‐nitropropane

2‐hexanone

2‐isopropoxyethanol

2‐nitropropane

Amyl acetate

Amyl alcohol

Chlorobenzene

Chlorostyrene

Cumene

Cyclohexylamine

Cyclopentadiene

Dicyclopentadiene

Diethyl carbonate

Epichlorohydrin

Ethyl alcohol, 20‐60%

Ethyl silicate

Ethylene diamine

Hydrazine

Isoamyl acetate

Isoamyl alcohol (2%)

Isopropyl glycidyl ether

Mesityl oxide

Methoxyflurane

Methyl butyl ketone

Methyl isoamyl ketone

Morpholine

*n*‐butyl acetate

*n*‐butyl alcohol

*n*‐ethylmorpholine

Nickel tetracarbonyl

Nitroethane

Nitromethane ether

*n*‐octane

Nonane

*o*‐chlorotoluene

Propylene glycol monomethyl

*sec*‐butyl alcohol

Styrene

Trimethyl phosphite

Turpentine

**Class 2 (II)**

1,1‐dichloro‐1‐nitroethane

1,2‐diehtylbenzene

1,3,5‐trimethylbenzene

10% 5‐methyl‐3‐heptanone

1‐heptanethiol

1‐octanethiol

2‐diethylaminoethanol Isoamyl alcohol (1°)

2‐ethoxyethanol (EGMEA)

2‐ethoxyethyl acetate

Acetic acid, glacial

Acetic anhydride

Acrylic acid

Allyl glycidyl ether

Benzenethiol

Butyl acrylate

Chlorostyrene

Cyclohexanethiol

Demeton Formalin, 37% (methanol, 15%)

Diacetone alcohol

Dichloroethyl ether

Diisobutyl ketone

Dimethyl formamide

Dipropyl ketone

Ethyl alcohol,

Ethyl butyl ketone

Ethylene chlorohydrin

Ethylglycol acetate

Ethylidene norbornene

Formic acid

Kerosene

Methyl (*n*‐amyl) ketone

Methyl “cellusolve” (EGME)

Methyl “cellusolve” acetate

Methyl isobutyl carbinol

Methyl styrene

Naphtha (coal tar)

*n*‐butyl glycidyl ether

*o*‐methylcyclohexanone

Propionic acid

*sec*‐hexyl acetate 1,2,4‐trimethylbenzene

Stoddard solvent

Tetramethyl lead

Vinyl toluene

**Class 3A (IIIA)**

1,2,3‐trichloropropane

1,2‐dibromo‐3‐chloropropane

1‐chloro‐1‐nitropropane

1‐dodecanethiol

2‐aminopyridine

2‐butoxyethanol (EGME)

2‐hydroxypropyl acrylate

2‐*N*‐dibutylaminoethanol

Aniline (and homologs)

Benzoyl peroxide

Benzyl chloride

*beta*‐propiolactone

Camphor

Chloroacetaldehyde

Cyclohexanol Formalin, 37% (methanol, ~7%)

Cyclohexanone

Decaborane

Diglycidyl ether

Dimethyl acetamide

Dimethyl carbamoyl chloride

Dimethyl sulfate

Dimethylamino propionitrile

Dipropylene glycol methyl ether

Divinyl benzene

Ethanolamine

Ethyl alcohol, 5%

Furfural

Furfuryl alcohol

Glycidol

Isooctyl alcohol

Isophorone

*m,o,p*‐cresol

Methacrylic acid

Methyl‐1,2‐cyanoacrylate

Methylcyclohexanol

Monomethyl aniline

*N,N*‐dimethylaniline

Naphthalene

*n*‐butyl lactate

*N*‐isopropylaniline

Nitrobenzene

*o,m,p*‐toluidine

*o,p*‐dichlorobenzene Idene

Phenol (carbolic acid)

Phenylhydrazine

*p*‐tert‐butyltoluene

**Class 3B (IIIB)**

1,1,1‐trichloroethane

1,1‐dichloroethylene

1,2,4‐trichlorobenzene

1,3‐dichloro‐5,5‐dimetnylhydantoin 4‐methoxyphenol

1:1 phenol:chloroform

1‐decanethiol

1‐hexadecanethiol

4,4’‐methylene dianiline

Acrylamide

Caprolactam

Catechol

Chloroacetophenone

Cyanamide

diamine

Dibutylphthalate

Diethanolamine

Diethyl phthalate

Diethylenetriamine

Dimethyl phthalate

Dinitrotoluene

Diphenyl 4‐nitrobiphenyl

Dipheylamine *p*‐nitrochlorobenzene

Di‐*sec* octyl phthalate *p*‐nitroaniline

Ethylene glycol

Ethylene thiourea

Formamide

Hexamethyl phosphoramide

Hexamethylene diisocyanate p‐phenylene

Hexylene glycol

Hydroquinone

Isoflurane

Isophorone diisocyanate

Maleic anhydride

Malononitrile

Methyl silicate

Methylene bisphenyl isocyanate

Naphthalene diisocyanate

Naphthylamine

Nicotine

*o,m,p*‐nitrotoluene

*o,m,p*‐terphenyl

*o,m*‐dinitrobenzene

*o*‐dianisidine

Oil mist (mineral)

*o‐sec*‐butylphenol

Paraffin wax

Phenyl ether (vapor)

Phthalic anhydride

Propane sultone

Succinonitrile

Sulfur monochloride

Tetrachloronaphthalene

Tetraethyl lead

Thioglycolic acid

Toluene‐2,4‐diisocyanate

Toluenediamine

Tributyl phosphate

Trichloroethylene

Trichloronaphthanlene

Triphenyl phosphate

Vinyl cyclohexene dioxide

Xylidine

Zinc stearate

**Appendix C1: REGULATORY AGENGIES**

**APPENDIX C:**

**LEGAL REFERENCES**

The following agencies regulate the purchase, transport, use, and disposal of all chemicals and chemical waste at the federal, state, and local level.

**Federal**

Department of Homeland Security

Environmental Protection Agency (EPA)

Department of Transportation (DOT)

Occupational Safety and Health Administration (OSHA)

Drug Enforcement Administration (DEA)

US Department of Health and Human Services (HHS)

Agency for Toxic Substances and Disease Registry (ATSDR)

Bureau of Alcohol, Tobacco, Firearms and Explosives

National Fire Protection Agency (NFPA)

National Institute for Occupational Safety and Health/ Centers for Disease Control

**State**

Environmental Protection Division, Georgia Department of Natural Resources

Georgia Department of Health and Human Resources

Georgia Department of Education

Georgia Department of Labor

Georgia Department of Transportation

Georgia Emergency Management Agency

**Local**

Augusta-Richmond County Health Department

Augusta-Richmond County Utilities Department

Augusta Richmond County Fire Department/ Emergency Management Agency

**Appendix C2: RCRA**

**The Resource Conservation and Recovery Act (RCRA)** is a federal law that provides, in broad terms, the general guidelines for the waste management program envisioned by Congress. It includes a Congressional mandate directing EPA to develop a comprehensive set of regulations to implement the law. The hazardous waste program, under RCRA Subtitle C, establishes a system for controlling hazardous waste from the time it is generated until its ultimate disposal — in effect, from “cradle to grave.”

In any given State, EPA or the State hazardous waste regulatory agency enforces hazardous waste laws. EPA encourages States to assume primary responsibility for implementing a hazardous waste program through State adoption, authorization, and implementation of the regulations.

**Hazardous Waste Regulations**

EPA regulations, or rulemakings, translate the general mandate of RCRA into a set of requirements for the Agency and the regulated community. The RCRA hazardous waste program regulates commercial businesses as well as federal, State, and local government facilities that generate, transport, treat, store, or dispose of hazardous waste.

Hazardous waste is a waste with properties that make it dangerous or potentially harmful to human health or the environment. In regulatory terms, a RCRA hazardous wastes fall into two categories:

1. Listed Wastes, which appear on one of the four hazardous wastes lists established by EPA regulations:

* **The F-list** (non-specific source wastes), which can be found in the regulations at 40 CFR §261.31.
* **The K-list** (source-specific wastes), which can be found in the regulations at 40 CFR §261.32.
* **The P-list and the U-list** (discarded commercial chemical products), which can be found in the regulations at 40 CFR §261.33.

1. Characteristic wastes, which exhibit one or more of four characteristics defined in 40 CFR Part 261 Subpart C:
   * **Ignitability**, as described in 40 CFR §261.21.
   * **Corrosivity**, as described in 40 CFR §261.22.
   * **Reactivity**, as described in 40 CFR §261.23.
   * **Toxicity**, as described in 40 CFR §261.24.

**40 CFR Part 260** contains all of the RCRA regulations governing hazardous waste identification, classification, generation, management and disposal. Of particular interest to public school systems are

* **Part 260** – Hazardous Waste Management System: General
* **Part 261** – Identification And Listing Of Hazardous Waste
* **Part 262** – Standards Applicable To Generators Of Hazardous Waste
* **Part 263** – Standards Applicable To Transporters Of Hazardous Waste

**40 CFR 261.52 Special requirements for hazardous waste generated by conditionally**

**exempt small quantity generators.**

### HAZARDOUS WASTE REQUIREMENTS

1. **Conditionally Exempt Small Quantity Generators** (CESQG) 40 CFR 261.5.   
   CESQG's generate less than 100 kilograms of HW per month and no more than 1 kilogram of acute HW (such as some pesticides, toxins or arsenic and cyanide compounds) per month. Many wastes that are recycled are included in this quantity determination.
2. Perform HW determination (262.11).
3. Cannot accumulate > 1000 kg at any time.
4. Ensure delivery of HW to a proper recycling facility or TSDF.
5. Keep records documenting proper disposal (FAC 62-730).

Hazardous wastes (HW) are wastes listed in 40 CFR 261 Subpart D as hazardous by the U.S. Environmental Protection Agency (EPA). Or they are wastes characterized in 40 CFR 261 Subpart C as hazardous by exhibiting one of four characteristics: ignitability (i.e., an oxidizer or flash point < 140°), corrosivity (i.e., pH < 2 or > 12.5), reactivity, or toxicity. A hazardous waste determination must be made of any waste material generated (262.11). If the material is hazardous, then it must be recycled, treated, stored, or disposed at a proper HW facility. HW cannot be disposed on or in the ground, or in local landfills, septic tanks, or injection wells. Also, regardless of quantity, the generator of HW is ultimately responsible for the waste from "cradle to grave", and can be held liable for improper management of HW even though it may have been sent to a "proper" HW management facility using a licensed transporter.

* 1. A generator is a conditionally exempt small quantity generator in a calendar month if he generates no more than 100 kilograms of hazardous waste in that month.
  2. Except for those wastes identified in paragraphs (e), (f), (g), and (j) of this section, a conditionally exempt small quantity generator’s hazardous wastes are not subject to regulation under parts 262 through 268, and parts 270 and 124 of this chapter, and the notification requirements of section 3010 of RCRA, provided the generator complies with the requirements of paragraphs (f), (g), and (j) of this section.
  3. When making the quantity determinations of this part and 40 CFR part 262, the generator must include all hazardous waste that it generates, except hazardous waste that:
     1. Is exempt from regulation under 40 CFR 261.4(c) through (f), 261.6(a)(3), 261.7(a)(1), or 261.8; or
     2. Is managed immediately upon generation only in on-site elementary neutralization units, wastewater treatment units, or totally enclosed treatment facilities as defined in 40 CFR 260.10; or
     3. Is recycled, without prior storage or accumulation, only in an on-site process subject to regulation under 40 CFR 261.6(c)(2); or
     4. Is used oil managed under the requirements of 40 CFR 261.6(a)(4) and 40 CFR part 279; or
     5. Is spent lead-acid batteries managed under the requirements of 40 CFR part 266, subpart G; or
     6. Is universal waste managed under 40 CFR 261.9 and 40 CFR part 273; or
     7. is a hazardous waste that is an unused commercial chemical product (listed in 40 CFR part 261, subpart D or exhibiting one or more characteristics in 40 CFR part 261, subpart C) that is generated solely as a result of a laboratory clean-out conducted at an eligible academic entity pursuant to § 262.213. For purposes of this provision, the term eligible academic entity shall have the meaning as defined in § 262.200 of Part 262.

1. In determining the quantity of hazardous waste generated, a generator need not include:
   * 1. Hazardous waste when it is removed from on-site storage; or
     2. Hazardous waste produced by onsite treatment (including reclamation) of his hazardous waste, so long as the hazardous waste that is treated was counted once;
     3. Spent materials that are generated, reclaimed, and subsequently reused on-site, so long as such spent materials have been counted once.
2. If a generator generates acute hazardous waste in a calendar month in quantities greater than set forth below, all quantities of that acute hazardous waste are subject to full regulation under parts 262 through 268, and parts 270 and 124 of this chapter, and the notification requirements of section 3010 of RCRA:
3. A total of one kilogram of acute hazardous wastes listed in §§ 261.31 or 261.33(e).
4. A total of 100 kilograms of any residue or contaminated soil, waste, or other debris resulting from the cleanup of a spill, into or on any land or water, of any acute hazardous wastes listed in §§ 261.31, or 261.33(e).
5. NOTE TO PARAGRAPH (E): ‘‘Full regulation’’ means those regulations applicable to generators of 1,000 kg or greater of hazardous waste in a calendar month.
6. In order for acute hazardous wastes generated by a generator of acute hazardous wastes in quantities equal to or less than those set forth in paragraphs (e)(1) or (e)(2) of this section to be excluded from full regulation under this section, the generator must comply with the following requirements:
   * 1. Section 262.11 of this chapter;
7. The generator may accumulate acute hazardous waste on-site. If he accumulates at any time acute hazardous wastes in quantities greater than those set forth in paragraph (e)(1) or (e) of this section, all of those accumulated wastes are subject to regulation under parts 262 through 268, and parts 270 and 124 of this chapter, and the applicable notification requirements of section 3010 of RCRA. The time period of § 262.34(a) of this chapter, for accumulation of wastes on-site, begins when the accumulated wastes exceed the applicable exclusion limit;
8. A conditionally exempt small quantity generator may either treat or dispose of his acute hazardous waste in an on-site facility or ensure delivery to an off-site treatment, storage, or disposal facility, either of which, if located in the U.S., is:
9. Permitted under part 270 of this chapter;
10. In interim status under parts 270 and 265 of this chapter;
11. Authorized to manage hazardous waste by a State with a hazardous waste management program approved under part 271 of this chapter;
12. Permitted, licensed, or registered by a State to manage municipal solid waste and, if managed in a municipal solid waste landfill is subject to Part 258 of this chapter;
13. Permitted, licensed, or registered by a State to manage non-municipal non-hazardous waste and, if managed in a non-municipal non-hazardous waste disposal unit after January 1,1998, is subject to the requirements in §§ 257.5 through 257.30 of this chapter; or
14. A facility which:
15. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
16. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation; or

vii) For universal waste managed under part 273 of this chapter, a universal waste handler or destination facility subject to the requirements of part 273 of this chapter.

1. In order for hazardous waste generated by a conditionally exempt small quantity generator in quantities of 100 kilograms or less of hazardous waste during a calendar month to be excluded from full regulation under this section, the generator must comply with the following requirements:
2. Section 262.11 of this chapter;
3. The conditionally exempt small quantity generator may accumulate hazardous waste on-site. If he accumulates at any time 1,000 kilograms or greater of his hazardous wastes, all of those accumulated wastes are subject to regulation under the special provisions of part 262 applicable to generators of greater than 100 kg and less calendar month as well as the requirements of parts 263 through 268, and parts 270 and 124 of this chapter, and the applicable notification requirements of section 3010 of RCRA. The time period of § 262.34(d) for accumulation of wastes on-site begins for a conditionally exempt small quantity generator when the accumulated wastes equal or exceed 1000 kilograms;
4. A conditionally exempt small quantity generator may either treat or dispose of his hazardous waste in an on-site facility or ensure delivery to an off-site treatment, storage or disposal facility, either of which, if located in the U.S., is:

i) Permitted under part 270 of this chapter;

ii) In interim status under parts 270 and 265 of this chapter;

iii) Authorized to manage hazardous waste by a State with a hazardous waste management program approved under part 271 of this chapter;

iv) Permitted, licensed, or registered by a State to manage municipal solid waste and, if managed in a municipal solid waste landfill is subject to Part 258 of this chapter;

v) Permitted, licensed, or registered by a State to manage non-municipal non-hazardous waste and, if managed in a non-municipal non-hazardous waste disposal unit after January 1, 1998, is subject to the requirements in §§ 257.5 through 257.30 of this chapter; or

vi) A facility which:

* 1. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
  2. Treats its waste prior to beneficial use or reuse, or legitimate recycling or reclamation; or

vii) For universal waste managed under part 273 of this chapter, a universal waste handler or destination facility subject to the requirements of part 273 of this chapter.

1. Hazardous waste subject to the reduced requirements of this section may be mixed with non-hazardous waste and remain subject to these reduced requirements even though the resultant mixture exceeds the quantity limitations identified in this section, unless the mixture meets any of the characteristics of hazardous waste identified in subpart C.
2. If any person mixes a solid waste with a hazardous waste that exceeds a quantity exclusion level of this section, the mixture is subject to full regulation.
3. If a conditionally exempt small quantity generator’s wastes are mixed with used oil, the mixture is subject to part 279 of this chapter. Any material produced from such a mixture by processing, blending, or other treatment is also so regulated.

**Appendix C3: OSHA Standards**

Section 5(a)(1) of the Occupational Safety and Health Act of 1970 (OSH Act), the General Duty Clause, requires that employers “shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees.” Therefore, even if an OSHA standard has not been promulgated that deals with a specific hazard or hazardous operation, protection of workers from all hazards or hazardous operations may be enforceable under section 5(a)(1) of the OSH Act. For example, best practices that are issued by non-regulatory organizations such as the National Institute for Occupational Safety and Health (NIOSH), the Centers for Disease Control and Prevention (CDC), the National Research Council (NRC), and the National Institutes of Health (NIH), can be enforceable under section 5(a)(1).

The principal OSHA standards that apply to all nonproduction laboratories are listed below. Although this is not a comprehensive list, it includes standards that cover the major hazards that workers are most likely to encounter in their daily tasks. Employers must be fully aware of these standards and must implement all aspects of the standards that apply to specific laboratory work conditions in their facilities.

1. **The Occupational Exposure to Hazardous Chemicals in Laboratories standard (29 CFR 1910.1450)**, commonly referred to as the Laboratory standard, requires that the employer designate a Chemical Hygiene Officer and have a written Chemical Hygiene Plan (CHP), and actively verify that it remains effective. The CHP must include provisions for worker training, chemical exposure monitoring where appropriate, medical consultation when exposure occurs, criteria for the use of personal protective equipment (PPE) and engineering controls, special precautions for particularly hazardous substances, and a requirement for a Chemical Hygiene Officer responsible for implementation of the CHP. The CHP must be tailored to reflect the specific chemical hazards present in the laboratory where it is to be used. Laboratory personnel must receive training regarding the Laboratory standard, the CHP, and other laboratory safety practices, including exposure detection, physical and health hazards associated with chemicals, and protective measures.
2. **Chemical Hazards (29 CFR 1910.1200)**

Hazardous chemicals present physical and/or health threats to workers in clinical, industrial, and academic laboratories. Laboratory chemicals include cancer-causing agents (carcinogens), toxins (e.g., those affecting the liver, kidney, and nervous system), irritants, corrosives, sensitizers, as well as agents that act on the blood system or damage the lungs, skin, eyes, or mucous membranes. OSHA rules regulate exposures to approximately 400 substances.

1. **Laboratory Standard (29 CFR 1910.1450)**

In 1990, OSHA issued the Occupational Exposure to Hazardous Chemicals in Laboratories standard (**29 CFR 1910.145**0). Commonly known as the Laboratory standard, it was developed to address workplaces where relatively small quantities of hazardous chemicals are used on a non-production basis. However, not all laboratories are covered by the Laboratory standard. For example, most quality control laboratories are not covered under the standard. These laboratories are usually adjuncts of production operations which typically perform repetitive procedures for the purpose of assuring reliability of a product or a process. On the other

hand, laboratories that conduct research and development and related analytical work and laboratories designed for educational purposes are subject to the requirements of the Laboratory standard

The purpose of the Laboratory standard is to ensure that workers in non-production laboratories are informed about the hazards of chemicals in their workplace and are protected from chemical exposures exceeding allowable levels [i.e., OSHA permissible exposure limits (PELs)] as specified in Table Z of the Air Contaminants standard (**29 CFR 1910.1000**) and as specified in other substance-specific health standards. The Laboratory standard achieves this

protection by establishing safe work practices in laboratories to implement a Chemical

Hygiene Plan (CHP).

**Scope and Application**

The Laboratory standard applies to all individuals engaged in laboratory use of hazardous chemicals. Work with hazardous chemicals outside of laboratories is covered by the Hazard Communication standard (**29 CFR 1910.1200**). Laboratory uses of chemicals which provide no potential for exposure (e.g., chemically impregnated test media or prepared kits for pregnancy testing) are not covered by the Laboratory standard.

Formaldehyde is one of the most commonly used hazardous chemicals in laboratories. The OSHA Formaldehyde standard (**29 CFR 1910.1048**) specifically deals with protecting workers from the hazards associated with exposure to this chemical. It should be noted that the scope of the Formaldehyde standard is not affected in most cases by the Laboratory standard. The Laboratory standard specifically **does not apply** to formaldehyde use in histology, pathology and human or animal anatomy laboratories; however, if formaldehyde is used in other types of laboratories which are covered by the Laboratory standard, the employer must comply with **29 CFR 1910.1450.**

**Program Description**

The Laboratory standard consists of five major elements:

* Hazard identification;
* Chemical Hygiene Plan
* Information and training
* Exposure monitoring
* Medical consultation and examinations.

Each laboratory covered by the Laboratory standard must appoint a Chemical Hygiene Officer (CHO) to develop and implement a Chemical Hygiene Plan (CH). The CHO is responsible for duties such as monitoring processes, procuring chemicals, helping project directors upgrade facilities, and advising administrators on improved chemical hygiene policies and practices. A worker designated as the CHO must be qualified, by training or experience, to provide technical guidance in developing and implementing the provisions of the CHP.

**Hazard Identification:** Each laboratory must identify which hazardous chemicals will be encountered by its workers. All containers for chemicals must be clearly labeled. An employer must ensure that workers do not use, store, or allow any other person to use or store, any hazardous substance in his or her laboratory if the container does not meet the labeling requirements outlined in the Hazard Communication standard, **CFR 1910.1200(f)(4**). Labels on chemical containers must not be removed or defaced.

**Material Safety and Data Sheets:** Material Safety Data Sheets (MSDSs) for chemicals received by the laboratory must be supplied by the manufacturer, distributor, or importer and must be maintained and readily accessible to laboratory workers. MSDSs are written or printed materials concerning a hazardous chemical. Employers must have an MSDS in the workplace for each hazardous chemical in use.

MSDS sheets must contain:

1. Name of the chemical
2. Manufacturer’s information
3. Hazardous ingredients/identity information
4. Physical/chemical characteristics
5. Fire and explosion hazard data
6. Reactivity data
7. Health hazard data
8. Precautions for safe handling and use
9. Control measures.

**Chemical Hygiene Plan (CHP):** The purpose of the CHP is to provide guidelines for prudent practices and procedures for the use of chemicals in the laboratory. The Laboratory standard requires that the CHP set forth procedures, equipment, PPE and work practices capable of protecting workers from the health hazards presented by chemicals used in the laboratory. The following information must be included in each CHP:

**Standard Operating Procedures (SOPs):** SOPs include prudent laboratory practices which must be followed when working with chemicals in a laboratory. These include general and laboratory-specific procedures for work with hazardous chemicals.

**Criteria for Exposure Control Measures:** The CHP must include criteria used by the employer to determine and implement control measures to reduce worker exposure to hazardous chemicals including engineering controls, the use of PPE and hygiene practices.

**Adequacy and Proper Functioning of Fume Hoods and other Protective Equipment:** Specific measures that must be taken to ensure proper and adequate performance of protective equipment, such as fume hoods.

**Information and Training:** The employer must provide information and training required to ensure that workers are apprised of the hazards of chemicals in their work areas and related information.

**Requirement of Prior Approval of Laboratory Procedures:** The CHP must detail the circumstances under which certain laboratory procedures or activities require approval from the employer or employer’s designee before work is initiated.

**Medical Consultations and Examinations:** Provisions for medical consultation and examination when exposure to a hazardous chemical has or may have taken place.

**Chemical Hygiene Officer Designation:** Identification of the laboratory CHO and outline of his or her role and responsibilities; and, where appropriate, establishment of a Chemical Hygiene Committee.

**Particularly Hazardous Substances:** Outlines additional worker protections for work with particularly hazardous substances. These include select carcinogens, reproductive toxins, and substances which have a high degree of acute toxicity.

**Information and Training:** Laboratory workers must be provided with information and training relevant to the hazards of the chemicals present in their laboratory. The training must be provided at the time of initial assignment to a laboratory and prior to assignments involving new exposure situations.

The employer must inform workers about the following:

* The content of the OSHA Laboratory standard and its appendices (the full text must be made available)
* The location and availability of the Chemical Hygiene Plan
* Permissible exposure limits (PELs) for OSHA- regulated substances, or recommended exposure levels for other hazardous chemicals where there is no applicable standard
* Signs and symptoms associated with exposure to hazardous chemicals in the laboratory
* The location and availability of reference materials on the hazards, safe handling, storage and disposal of hazardous chemicals in the laboratory, including, but not limited to, MSDSs.

Training must include the following:

* Methods and observations used to detect the presence or release of a hazardous chemical. These may include employer monitoring, continuous monitoring devices, and familiarity with the appearance and odor of the chemicals.
* The physical and health hazards of chemicals in the laboratory work area.
* The measures that workers can take to protect themselves from these hazards, including protective equipment, appropriate work practices, and emergency procedures.
* Applicable details of the employer’s written Chemical Hygiene Plan.
* Retraining, if necessary.

**Exposure Determination:** OSHA has established permissible exposure limits (PELs), as specified in 29 CFR 1910, subpart Z, for hundreds of chemical substances. A PEL is the chemical-specific concentration in inhaled air that is intended to represent what the average, healthy worker may be exposed to daily for a lifetime of work without significant adverse health effects. The employer must ensure that workers’ exposures to OSHA-regulated substances do not exceed the PEL.

Employers must conduct exposure monitoring, through air sampling, if there is reason to believe that workers may be exposed to chemicals above the action level or, in the absence of an action level, the PEL. Periodic exposure monitoring should be conducted in accord with the provisions of the relevant standard. The employer should notify workers of the results of any monitoring within 15 working days of receiving the results. Some OSHA chemical standards have specific provisions regarding exposure monitoring and worker notification. Employers should consult relevant standards to see if these provisions apply to their workplace.

**Medical Consultations and Examinations**

Employers must do the following:

* Provide all exposed workers with an opportunity to receive medical attention by a licensed physician, including any follow-up examinations which the examining physician determines to be necessary
* Provide an opportunity for a medical consultation by a licensed physician whenever a spill, leak, explosion or other occurrence results in the likelihood that a laboratory worker experienced a hazardous exposure in order to determine whether a medical examination is needed.
* Provide an opportunity for a medical examination by a licensed physician whenever a worker develops signs or symptoms associated with a hazardous chemical to which he or she may have been exposed in the laboratory.
* Establish medical surveillance for a worker as required by the particular standard when exposure monitoring reveals exposure levels routinely exceeding the OSHA action level or, in the absence of an action level, the PEL for an OSHA regulated substance.
* Provide the examining physician with the identity of the hazardous chemical(s) to which the individual may have been exposed, and the conditions under which the exposure may have occurred, including quantitative data, where available, and a description of the signs and symptoms of exposure the worker may be experiencing.
* Provide all medical examinations and consultations without cost to the worker, without loss of pay, and at a reasonable time and place.

**Recordkeeping**

Employers must also maintain an accurate record of exposure monitoring activities and exposure measurements as well as medical consultations and examinations, including medical tests and written opinions. Employers generally must maintain worker exposure records for 30 years and medical records for the duration of the worker’s employment plus 30 years, unless one of the exemptions listed in **29 CFR 1910.1020(d)(1)(i)(A)-(C)**

applies. Such records must be maintained, transferred, and made available, in accord with **29 CFR 1910.1020**, to an individual’s physician or made available to the worker or his/her designated representative upon request.

**Roles and Responsibilities in Implementing the Laboratory Standard**

The following are the National Research Council’s recommendations concerning the responsibilities of various individuals for chemical hygiene in laboratories.

**Chief Executive Officer**

* Bears ultimate responsibility for chemical hygiene within the facility.
* Provides continuing support for institutional chemical hygiene.

**Chemical Hygiene Officer**

* Develops and implements appropriate chemical hygiene policies and practices.
* Monitors procurement, use, and disposal of chemicals used in the lab.
* Ensures that appropriate audits are maintained.
* Helps project directors develop precautions and adequate facilities.
* Knows the current legal requirements concerning regulated substances.
* Seeks ways to improve the chemical hygiene program.

**Laboratory Supervisors**

* Have overall responsibility for chemical hygiene in the laboratory.
* Ensure that laboratory workers know and follow the chemical hygiene rules.
* Ensure that protective equipment is available and in working order.
* Ensure that appropriate training has been provided.
* Provide regular, formal chemical hygiene and housekeeping inspections, including routine inspections of emergency equipment.
* Know the current legal requirements concerning regulated substances.
* Ensure that facilities and training for use of any material being ordered are adequate.

**Laboratory Workers**

* Plan and conduct each operation in accord with the facility’s chemical hygiene procedures, including use of PPE and engineering controls, as appropriate.
* Develop good personal chemical hygiene habits.
* Report all accidents and potential chemical exposures immediately.

1. **The Hazard Communication standard (29 CFR 1910.1200)**, sometimes called the HazCom standard, is a set of requirements first issued in 1983 by OSHA. The standard requires evaluating the potential hazards of chemicals, and communicating information concerning those hazards and appropriate protective measures to employees. The standard includes provisions for: developing and maintaining a written hazard communication program for the workplace, including lists of hazardous chemicals present; labeling of containers of chemicals in the workplace, as well as of containers of chemicals being shipped to other workplaces; preparation and distribution of material safety data sheets (MSDSs) to workers and downstream employers; and development and implementation of worker training programs regarding hazards of chemicals and protective measures. This OSHA standard requires manufacturers and importers of hazardous chemicals to provide material safety data sheets to users of the chemicals describing potential hazards and other information. They must also attach hazard warning labels to containers of the chemicals. Employers must make MSDSs available to workers. They must also train their workers in the hazards caused by the chemicals workers are exposed to and the appropriate protective measures that must be used when handling the chemicals.
2. **The Personal Protective Equipment (PPE) standard (29 CFR 1910.132)** requires that employers provide and pay for PPE and ensure that it is used wherever “hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants are encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact.” **[29 CFR 1910.132(a) and 1910.132(h)].**

In order to determine whether and what PPE is needed, the employer must “assess the workplace to determine if hazards are present, or are likely to be present, which necessitate the use of [PPE],”29 CFR 1910.132(d)(1). Based on that assessment,

the employer must select appropriate PPE (e.g., protection for eyes, face, head, extremities; protective clothing; respiratory protection; shields and barriers) that will protect the affected worker from the hazard, **29 CFR 1910.132 (d)(1)(i**), communicate selection decisions to each affected worker, **29 CFR 1910.132 (d)(1)(ii)**, and select PPE that properly fits each affected employee, **29 CFR 1910.132(d)(1)(iii)**.

Employers must provide training for workers who are required to use PPE that addresses when and what PPE is necessary, how to wear and care for PPE properly, and the limitations of PPE, **29 CFR 1910.132(f).**

1. **The Eye and Face Protection standard (29 CFR 1910.133**) requires employers to ensure that each affected worker uses appropriate eye or face protection when exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapors, or potentially injurious light radiation, **29 CFR 1910.133(a)**.
2. **The Respiratory Protection standard (29 CFR 1910.134)** requires that a respirator be provided to each worker when such equipment is necessary to protect the health of such individual. The employer must provide respirators that are appropriate and suitable for the purpose intended, as described in **29 CFR 1910.134(d)(1**). The employer is responsible for establishing and maintaining a respiratory protection program, as required by **29 CFR 1910.134(c)**, that includes, but is not limited to, the following:

* selection of respirators for use in the workplace
* medical evaluations of workers required to use respirators
* fit testing for tight-fitting respirators
* proper use of respirators during routine and emergency situations
* procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing and discarding of respirators
* procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators
* training of workers in respiratory hazards that they may be exposed to during routine and emergency situations
* training of workers in the proper donning and doffing of respirators, and any limitations on their use and maintenance; and regular evaluation of the effectiveness of the program.

1. **The Hand Protection standard (29 CFR 1910.138)**, requires employers to select and ensure that workers use appropriate hand protection when their hands are exposed to hazards such as those from skin absorption of harmful substances; severe cuts or lacerations; severe abrasions; punctures; chemical burns; thermal burns; and harmful temperature extremes, **29 CFR 1910.138(a)**.

Further, employers must base the selection of the appropriate hand protection on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the hazards and potential hazards identified, **29 CFR 1910.138(b)**.

1. **Compressed Gases:** According to OSHA’s Laboratory standard, a “compressed gas ” (1) is a gas or mixture of gases in a container having an absolute pressure exceeding 40 pounds per square inch (psi) at 70°F (21.1°C); or (2) is a gas or mixture of gases having an absolute pressure exceeding 104 psi at 130°F (54.4°C) regardless of the pressure at 70°F (21.1°C); or (3) is a liquid having a vapor pressure exceeding 40 psi at 100°F (37.8°C) as determined by ASTM (American Society for Testing and Materials) D-323-72, [**29 CFR 1910. 1450(c)(1)-(3)**].

Within laboratories, compressed gases are usually supplied either through fixed piped gas systems or individual cylinders of gases. Compressed gases can be toxic, flammable, oxidizing, corrosive, or inert. Leakage of any of these gases can be hazardous. Leaking inert gases (e.g., nitrogen) can quickly displace air in a large area creating an oxygen deficient atmosphere; toxic gases (e.g., can create poison atmospheres; and flammable (oxygen) or reactive gases can result in fire and exploding cylinders.

In addition, there are hazards from the pressure of the gas and the physical weight of the cylinder. A gas cylinder falling over can break containers and crush feet. The gas cylinder can itself become a missile if the cylinder valve is broken off.

All schools must include compressed gases in their inventory of chemicals in their Chemical Hygiene Plan.

Compressed gases contained in cylinders vary in chemical properties, ranging from inert and harmless to toxic and explosive. The high pressure of the gases constitutes a serious hazard in the event that gas cylinders sustain physical damage and/or are exposed to high temperatures.

Store, handle, and use compressed gases in accord with OSHA’s Compressed Gases standard (**29 CFR 1910.101**) and Pamphlet P-1-1965 from the Compressed Gas Association.

* All cylinders whether empty or full must be stored upright.
* Secure cylinders of compressed gases. Cylinders should never be dropped or allowed to strike each other with force.
* Transport compressed gas cylinders with protective caps in place and do not roll or drag the cylinders.

**Appendix C4: Georgia's Right To Know Law**

**SECTIONS O2 AND 03**

**300-3-19-.02 Administration.**

1) Department of Labor Responsibilities.

1. The Department shall as required under the Act ensure compliance with all training programs.
2. The Department must provide written approval of all written training programs required under the Act.
3. The purpose of these rules is to ensure that all employees who are exposed to hazardous chemicals listed in the State of Georgia Hazardous Chemical List are informed of the hazards of these chemicals and of measures to protect themselves.

2) Public Employer Responsibilities.

1. Each public employer covered by the Act and these regulations shall ensure that all employees within the agency are aware of the Act, these regulations, and their responsibilities by means of a written hazardous chemical communication program.
2. Each public employer shall designate a hazardous chemicals protection communication coordinator.
3. The hazardous chemicals protection communication coordinator will be provided with authority sufficient to carry out the duties of the position.
4. An individual in an existing position within an agency may be assigned hazardous chemicals protection communication coordinator responsibilities as an additional duty.
5. The hazardous chemicals protection communication coordinator will assume the following responsibilities:
6. Act as a liaison between the agency and the Safety Engineering Section of the Georgia Department of Labor on hazardous chemicals issues which may arise within his or her agency.
7. Determine applicability of these rules to individual workplaces and work areas within his agency using on-site inspections, review of written records including Material Safety Data Sheets, and industrial hygiene studies.
8. Make arrangements for and/or provide appropriate and adequate training to all employees.
9. The hazardous chemicals protection communication coordinator will ensure that:
10. A written workplace-specific hazard communication program is developed for each workplace in the agency. This workplace-specific program will include a list of hazardous chemicals used, stored, or manufactured in that particular workplace, and will be available to all employees in the workplace.
11. Upon their request, employees at each workplace within their agency shall have access to the most current MSDS's for those chemicals used in that workplace which are included on the Georgia Right to Know Hazardous Chemicals List.
12. Employees at each workplace are made aware of and are properly trained in the uses and hazards associated with chemicals to which they are exposed in their workplaces.
13. Employee training on and notification of the use of hazardous chemicals in the workplace are adequately documented in each employee's personnel file.
14. Employees at each workplace within the agency are provided with personal protective equipment as required in each work environment, and receive adequate training on the use and maintenance of this equipment.

Authority O.C.G.A. 45-22-8. **History.** Original Rule entitled "Administration" adopted. F. Apr. 11, 1990; eff. May 1, 1990.

**300-3-19-.03 Training.**

1. Frequency of Training.
2. Each employee shall be provided with information and training as required by the Act and these regulations at the time of initial assignment to a workplace.
3. Each employee shall be provided with periodic re-training regarding the hazards associated with the hazardous chemicals to which the employee is exposed. Such re - training must occur at least annually.
4. An employee shall not be exposed to a hazardous chemical until the employee has been trained in its hazards.
5. Content of Training. Training programs shall be tailored to the specific nature of each individual workplace and the educational levels of the employees. At a minimum, the information imparted to employees must include the following:
6. The requirements of the Act.
7. Identification of specific work areas in the workplace where hazardous chemicals are handled and/or produced.
8. The location and content of the public employer's written hazardous chemical protection communication program.
9. The purpose of a Material Safety Data Sheet, including the information contained therein.
10. The labeling system used at the workplace and how to respond to an unlabeled container delivered to or discovered in the workplace.
11. The various control measures to be used to minimize the employees' exposure to hazardous chemicals. Where applicable, this shall include information on:
12. The proper use, care, storage, selection, and fitting of respirators, and the elements of a respirator program;
13. The use of face shields, goggles, and safety glasses;
14. The use of appropriate gloves, aprons, protective clothing, and foot coverings;
15. The use of exhaust ventilation equipment; and
16. Work practices which reduce exposure to hazardous chemicals.
17. The right of the employee's physician to receive hazardous chemical information.
18. Methods of detecting an employee's exposure, such as air sampling, biological monitoring, visual detection, odor identification, warning properties of the hazardous chemicals used, and other standard industrial hygiene techniques.
19. Emergency procedures, such as spill response and first aid.
20. Proper storage of chemicals and separation of incompatible substances.
21. Training in hazards associated with improper mixing of chemicals located in the employee's work area and potential hazards associated with exposure to chemical reaction products.
22. Where additional information and training can be obtained.
23. Training Format.
24. All training sessions must include an opportunity for employees to ask questions.
25. Training Activities.
26. A written log of all training activities shall be maintained at the workplace. This log shall be retained for three (3) years after training has been completed.

5) Employee Information Poster.

a) Location.

1. A poster describing employee rights under the Act shall be posted in all workplaces covered by the Act in a prominent manner so that it is visible to all employees on a routine basis. For those workplaces with geographically dispersed work areas, a poster shall be placed in each work area.

(b) Content.

1. The Poster shall be worded as follows:

Label First Aid

Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large

quantities of water. Never give anything by mouth to an unconscious person. If vomiting occurs, keep head below hips to prevent aspiration into lungs. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. In all cases call a physician immediately.

**References:** Upon request

Employees of the State of Georgia

YOU HAVE THE RIGHT TO KNOW ABOUT THE HAZARDOUS CHEMICALS

IN YOUR WORKPLACE

Under the "Public Employee Hazardous Chemical Protection and Right to Know Act of 1988" you must be informed of the following:

* The Requirements of the law;
* Your right to receive information regarding hazardous chemicals faced on your job;
* Your right to receive formal training and education on hazardous chemicals;
* What a Material Safety Data Sheet is, and how to use it;
* Where hazardous chemicals are used in your work area;
* Your physician's right to receive information on the chemicals to which you may be exposed.

YOU CANNOT BE FIRED, DISCRIMINATED AGAINST, OR DISCIPLINED FOR EXERCISING YOUR RIGHT TO KNOW

* No pay, position, seniority, or other benefits may be lost for exercising your right to know.
* You may present a written request to receive a Material Safety Data Sheet for any chemical used on your job.
* You have the right to refuse to work with a hazardous chemical if a Material Safety Data Sheet in your employer's possession has not been provided to you within 5 working days after your written request, unless you are required to perform essential services.

GRIEVANCE PROCEDURE

1. File a grievance through the established procedure for your agency.
2. If unresolved, or if no established grievance procedure exists, then file a grievance with:

Commissioner of Labor

c/o Safety Engineering Section

Georgia Department of Labor

223 Courtland St. NE, Suite 301

Atlanta, Georgia 30303

(404)-656-2966

Authority O.C.G.A. 45-22-7, 45-22-8.

**Appendix D: Understanding an MSDS: ANSI Standardized MSDS Forma**t

**APPENDIX D:**

**MATERIAL SAFETY AND DATA SHEETS**

**The Hazard Communication Standard (29 CFR 1910.1200)**, also known as the Right-to-Know Law, requires the maintenance of Material Safety Data Sheets (MSDS) for every hazardous material located at the school **(29 CFR 1910.1200(g)).**

Manufacturers or distributors of hazardous materials are required to supply you with an MSDS when you purchase hazardous materials from the manufacturer or distributor. No standard form is required, but most manufacturers use either the American National Standards Institute (ANSI) form or the Occupational Safety and Health (OSHA) form. Both are described below. You may find after an inventory that you have in storage some materials for which no MSDS has been supplied. In that case, you should write your own using one of the forms described or download one from the Internet sources listed in Appendix H.

**ANSI MSDS FORMAT**

.**Section 1**: what the chemical or substance is, CAS number, synonyms, the name of the company issuing the data sheet, and often an emergency contact number

**Section 1 - Chemical product and Company Identification**

The name on the label and any synonyms; the manufacturer or distributor's name, address, emergency telephone number, date MSDS was prepared or revised

.

**Section 2** identifies the *OSHA hazardous ingredients*, and may include *other key ingredients* and exposure limits

**Section 2 - Composition, Information on Ingredients**

The composition of mixtures; the identity of the hazardous ingredient(s) including both chemical and common name(s); Chemical Abstracts Registry Number (CAS); PEL (permissible exposure limit), TLV (threshold limit values), any other recommended limits

.

**Section 3** lists the *major health effects* associated with the chemical. Sometimes both the acute and chronic hazards are given.

**Section 3 - Hazard Identification**

Appearance of material; health effects, signs and symptoms of exposure, mode of entry (inhalation, skin, ingestion), target organs

.

**Section 4** provides *first aid measures* that should be initiated in case of exposure.

**Section 4 - First Aid Measures**

Emergency and first aid procedures to be followed after exposure

.

**Section 5** presents the *fire-fighting measures* to be taken.

**Section 5 - Fire-Fighting Measures**

Extinguishing agents; danger of explosion; special firefighting procedures; flash point and method of determination; flammable limits, lower explosion limit (LEL), upper explosion limit (UEL)

.

**Section 6** details the *procedures to be taken in case of an accidental release*. The instructions given may not be sufficiently comprehensive in all cases, and local rules and procedures should be utilized to supplement the information given in the MSDS sheet.

**Section 6 - Accidental Release Measures**

How to respond to spills, leaks, air release including containment and type of equipment to be used

.

**Section 7** addresses the *storage and handling* information for the chemical. This is an important section as it contains information on the flammability, explosive risk, propensity to form peroxides, and chemical incompatibility for the substance. It also addresses any special storage requirements for the chemical (i.e., special cabinets or refrigerators).

**Section 7 - Handling and Storage**

Precautions to prevent overexposure; instructions for hygiene

**Section 8** outlines the *regulatory limits for exposure*, usually the maximum permissible exposure limits (PEL) (refer to Appendix G). The PEL, issued by the Occupational Safety and Health Administration, tells the concentration of air contamination a person can be exposed to for 8 hours a day, 40 hours per week over a working lifetime (30 years) without suffering adverse health effects. It also provides information on personal protective equipment.

**Section 8 - Exposure Controls and Personal Protection**

Engineering controls (including equipment and ventilation - local or mechanical); personal protective equipment (eye, skin - gloves and clothing, respiratory, including type of device); work and hygiene practices

.

**Section 9** gives the *physical and chemical properties* of the chemical. Information such as the evaporation rate, specific gravity, and flash points are given.

**Section 9 - Physical and Chemical Properties**

Appearance, odor, physical state, pH, vapor pressure, vapor density, evaporation rate, boiling point, melting point, solubility in water, density or specific gravity

**Section 10** gives the *stability and reactivity* of the chemical with information about chemical incompatibilities and conditions to avoid.

**Section 10 - Stability and Reactivity**

Stability; hazardous by-products of decomposition or burning; possible hazardous reactions; conditions to avoid; incompatibilities; possibility of hazardous decomposition or polymerization

**Section 11** provides both the *acute and chronic toxicity* of the chemical and any health effects that may be attributed to the chemical.

**Section 11 - Toxicological Information**

Data used to identify hazard; acute data; carcinogenicity (National Toxicological Program - NTP, Occupational Safety and Health Administration - OSHA, International Agency for Research on Cancer - IARC); reproductive effects; target organ effects; acute and chronic health hazards; medical conditions aggravated by exposure

.

**Section 12** identifies both the *ecotoxicity* and the environmental fate of the chemical.

**Section 12 - Ecological Information**

Impact on the environment should release occur

**Section 13** offers suggestions for the *disposal of the chemical*. Local, state, and Federal regulations should be followed.

**Section 13 - Disposal Considerations**

Disposal, recycling, reclamation

**Section 14** gives the *transportation information* required by the Department of Transportation. This often identifies the dangers associated with the chemical, such as flammability, toxicity, radioactivity, and reactivity.

**Section 14 - Transport Information**

Hazard materials description; hazard class, ID number (UN or NA)

**Section 15** outlines the *regulatory information* for the chemical. The hazard codes for the chemical are given along with principle hazards associated with the chemical. A variety of country and/or state specific details may be given.

**Section 15 - Regulatory Information**

Information from: Occupational Safety and Health Administration (OSHA); Toxic Substances Control Act (TSCA); Comprehensive Environmental Response, Composition, and Liability Act (CERCLA); Superfund Amendments and Reauthorization Act (SARA)

.

**Section 16** provides *additional information* such as the label warnings, preparation and revision dates, name of the person or firm that prepared the MSDS, disclaimers, and references used to prepare the MSDS

**Section 16 - Other Information**

Hazard rating; preparation and revision of MSDS; label information

.

### Sample MSDS

#### Material Safety Data Sheet

**Toluene MSDS No. XXXX**

1. **Product and Company Identification**

Product Name: TOLUENE

Synonyms: Methylbenzene, Methylbenzol, Phenylmethane, Toluol

CAS No.: 108–88–3

Chemical Formula: C6H5–CH3

Catalog Number: Tol 12

Supplier: Company X XXXXXXXXX Anywhere, XX XXXXX Emergency Information: 800–XXX–XXXX

#### Composition/Information on Ingredients

Ingredient CAS No Percent Hazardous

Toluene 108–88–3 100% Yes

#### Hazards Identification Emergency Overview

**DANGER!** Harmful or fatal if swallowed. Vapor harmful. **POISON**! May be absorbed through intact skin. Flammable liquid and vapor. May cause liver and kidney damage, may affect blood system or central nervous system. Causes irritation to skin, eyes, and respiratory tract.

#### Potential Acute Health Effects

* + Eye Contact: Causes severe eye irritation with redness and pain.
  + Skin Contact: Causes irritation. May be absorbed through skin.
  + Inhalation: Inhalation may cause irritation of the upper respiratory tract.
  + Symptoms of overexposure may include fatigue, confusion, headache, dizziness, and drowsiness. Very high concentrations may cause unconsciousness and death.
  + Ingestion: Swallowing may cause abdominal spasms and other symptoms that parallel over-exposure from inhalation.
  + Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal.
  + Chronic Exposure: Chronic exposure may result in anemia, decreased blood cell count, and bone marrow hypoplasia.
  + Liver and kidney damage may occur.
  + Repeated or prolonged contact may cause dermatitis.

#### First Aid Measures

**Eye Contact**: Immediately flush eyes with plenty of water for at least 15 minutes, lifting the upper and lower eye lids occasionally. Get medical attention immediately.

**Skin Contact**: In case of contact, immediately flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Call a physician immediately.

**Inhalation**: Evacuate victim to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Seek medical aid immediately.

**Ingestion**: Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give 2–4 cups of milk or water. Never give anything by mouth to an unconscious person. Get medical attention immediately.

#### Fire Fighting Measures

**Fire**: Flash point: 4 oC (40 oF) Autoignition temperature: 480 oC (896 oF)

Flammable limits in air % by volume: lower: 1.3%; upper: 7.1% Flammable liquid and vapor!

Extremely flammable when exposed to flame or sparks.

Vapors are heavier than air and can flow along surfaces to distant ignition source and flash back.

**Explosion**: Vapor-air concentrations above flammable limits are explosive. Contact with strong oxidizers may cause fire or explosion. Sensitive to static discharge.

**Fire Extinguishing Media**: Dry chemical, carbon dioxide, or foam. Material is lighter than water and a fire may be spread by use of water. Water may be used to cool fire surface and protect personnel. Water may also be used to flush spills away from exposures and to dilute spills to non-flammable mixtures. Avoid flushing hydrocarbon into sewers.

**Special Information**: In the event of a fire, wear full protective clothing and NIOSH- approved self-contained breathing apparatus operated in the pressure demand or other positive pressure mode.

#### Accidental Release Measures

Avoid contact: Ventilate area of leak or spill. Remove all ignition sources. Wear

appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Contain and recover liquid when possible. Collect liquid in an appropriate container or absorb with an inert material such as earth, sand, or vermiculite. Do not use combustible materials, such as saw dust. Do not flush to sewer.

#### Handling and Storage

**Handling**: Wash thoroughly after handling. Use with adequate ventilation. Avoid contact with skin, eyes, or clothes. Electrically ground and bond containers when transferring material to avoid static accumulation.

**Storage:** Store in a cool, dry, well-ventilated location, away from any area where the fire hazard. Separate from incompatibles. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid). Observe all warnings and precautions listed for the product. Protect container against physical damage. Keep container tightly closed.

#### Exposure Controls/Personal Protection

**Ventilation System**: A system of local and/or general exhaust is recommended to

keep exposures below the Airborne Exposure Limits.

**Exposure Limits**: Toluene:

* OSHA Permissible Exposure Limit (PEL): 200 ppm TWA; 300 ppm (acceptable ceiling conc.); 500 ppm (acceptable maximum conc.).
* NIOSH Recommended Exposure Limit (REL): 100 ppm TWA (375 mg/m3); STEL 150 ppm (560 mg/m3)
* ACGIH Threshold Limit Value (TLV): 50 ppm TWA skin – potential for cutaneous absorption

**Personal Respirators** (NIOSH/EN 149 Approved): If the exposure limit is exceeded a half-face organic vapor respirator may be worn for up to 10 times the exposure limit. A full-face organic vapor respirator or self-contained breathing apparatus may be worn up to 50 times the exposure limit. For emergencies or instances where the exposure levels are not known, use a full-face piece positive-pressure, air-supplied respirator.

**Skin Protection**: Wear impervious protective clothing, including boots, gloves, lab coat, apron, or coveralls, as appropriate, to prevent skin contact.

Eye Protection: Use chemical splash goggles and/or a full-face shield. Maintain eyewash fountain facilities in work area.

#### Physical and Chemical Properties

**Physical State and appearance**: Clear, colorless liquid

**Odor:** Aromatic benzene-like

**Solubility:** Very slight

**Specific** Gravity (Water = 1): 0.9 **Viscosity:** 20cP @ 20 oC **Boiling Point:** 110 oC (232 oF)

**Melting Point:** −95 oC (−139 oF)

**Vapor** Density (Air=1): 3.1

**Vapor Pressure (mm Hg)**: 53.3 @ 20 oC (68 oF) **Evaporation Rate (Butyl acetate=1):** 2.4

**Molecular formula:** C6H5CH3

**Molecular weight:** 92.06

#### Stability and Reactivity

**Stability:** Stable under ordinary conditions of use and storage. Containers may burst

when heated.

**Hazardous Decomposition Products:** Carbon dioxide and carbon monoxide may form when heated to decomposition.

**Hazardous Polymerization:** Has not been reported.

**Incompatibilities:** Heat, flame, strong oxidizers, and nitric and sulfuric acids; will attack some forms of plastics, rubber, coatings.

**Conditions to Avoid:** Heat, flames, ignition sources, and incompatibles.

#### Toxicological Information

Toxicological Data:

Oral rat LD50: 636 mg/kg

Skin rabbit LD50: 14,100 μL/kg

Inhalation rat LC50: 49 gm/m3/4H

Inhalation mouse LC50: 400 ppm/24H

Irritation data: skin rabbit, 500 mg,

Eye rabbit, 2 mg/24H, Severe. Moderate

Investigated as a tumorigen, mutagen, reproductive effector.

Reproductive Toxicity: Has shown some evidence of reproductive effects in laboratory animals.

#### Ecological Information

**Environmental Fate:** When released into the soil, this material may evaporate and

is microbiologically biodegradable. When released into the soil, this material is expected to leach into groundwater. When released into water, this material may evaporate and biodegrade to a moderate extent. When released into the air, this material may be moderately degraded by reaction with photochemically produced hydroxyl radicals.

**Environmental Toxicity:** No data available; however, this material is expected to be toxic to aquatic life.

#### Disposal Considerations

Waste material should be handled as hazardous waste and sent to a RCRA-approved

incinerator or disposed in a RCRA-approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from Federal disposal regulations. Dispose of container and unused contents in accordance with Federal, State, and local requirements.

1. **Transport Information Domestic** (Land, U.S. D.O.T.)

**Proper Shipping Name:** TOLUENE

**Hazard Class**: 3 UN/NA: UN1294

**Packing Group**: II

Canada TDG

**Proper Shipping Name:** TOLUENE **Hazard Class**: 3 (9.2)UN/NA: UN1294 **Packing Group:** II

**Additional Information**: Flashpoint 4 oC

#### Regulatory Information

**CALIFORNIA PROPOSITION 65: WARNING**

This product contains a chemical known to the State of California to cause birth defects or other reproductive harm. Reportable Quantity: 1,000 Pounds (454 Kilograms) (138.50 Gals)

**NFPA Rating**: Health – 2; Fire – 3; Reactivity – 00=Insignificant

1=Slight 2=Moderate 3=High 4=Extreme

#### Carcinogenicity Lists: No

**NTP:** No

#### IARC Monograph: No

**OSHA Regulated:** No

Section 313 Supplier Notification: This product contains the following toxic chemical(s) subject to the reporting requirements of SARA TITLE III Section 313 of the Emergency Planning and Community Right-To-Know Act of 1986 and of 40 CFR 372:

CAS No. Chemical Name % By Weight 108–88–3 Toluene 100

#### Other Information Label Hazard Warning

**POISON! DANGER! HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. VAPOR HARMFUL. FLAMMABLE LIQUID AND VAPOR. MAY AFFECT LIVER, KIDNEYS, BLOOD SYSTEM, OR CENTRAL NERVOUS SYSTEM. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.**

**Label Precautions**

* 1. Keep away from heat, sparks, and flame.
  2. Keep container closed.
  3. Use only with adequate ventilation.
  4. Wash thoroughly after handling. Avoid breathing vapor. Avoid contact with eyes, skin, and clothing.

## 

## Free MSDS Resources

|  |  |  |
| --- | --- | --- |
|  | SIRI Vermont | [www.hazard.com/msds/](http://www.hazard.com/msds/) |
|  | MSDS XChange | [www.msdsxchange.com/](http://www.msdsxchange.com/) |
|  | MSDS –SEARCH National Repository | [www.msdssearch.com/msdssearch.htm](http://www.msdssearch.com/msdssearch.htm) |
|  | Worldwide MSDS Search | [www3.3m.com/search/](http://www3.3m.com/search/) |
|  | Flinn Scientific | [www.flinnsci.com/search\_MSDS.asp](http://www.flinnsci.com/search_MSDS.asp) |
|  | Mallinckrodt Baker MSDSs | [www.](http://www/)[dino.wiz.uni-kassel.de/dain/ddb/x350.html](http://dino.wiz.uni-kassel.de/dain/ddb/x350.html) |
|  | MSDS Search | [www.](http://www/)[new.fishersci.com/wps/portal/](https://new.fishersci.com/wps/portal/) |
|  | Material Data Safety Sheets (MSDS) | [www.carolina.com/category/teacher+resources](http://www.carolina.com/category/teacher%2Bresources) |

**APPENDIX E:**

**CHEMICAL HYGIENE PLAN OUTLINE**

**Appendix E: Chemical Hygiene Plan**

#### What Is a Chemical Hygiene Plan (CHP)?

A chemical hygiene plan (CHP) is a written program stating the policies, procedures, and

responsibilities that serve to protect employees from the health hazards associated with the hazardous chemicals used in that particular workplace.

OSHA’s *Occupational Exposure to Hazardous Chemicals in Laboratories Standard* (Title 29, Code of Federal Regulations, Part 1910.1450) specifies the mandatory requirements of a CHP to protect persons from harm due to hazardous chemicals. The Standard can be viewed on the OSHA Web site at [www.osha.gov.](http://www.osha.gov/) It applies to school employees who work in laboratory settings (i.e., science teachers and lab assistants); indirectly it may serve to protect students.

The school superintendent, science department chairperson, and/or chemistry teacher(s) are typically responsible for developing the CHP for the school.

Appendix A of 29 Code of Federal Regulations 1910.1450 provides non-mandatory recommendations to assist in the development of a CHP:

1. Training for persons working with hazardous substances that includes methods and observations to detect the presence or release of a hazardous chemical
2. The physical and health hazards of the chemicals used
3. Hazard identification including proper labeling of containers of hazardous chemicals and maintaining MSDSs in a readily accessible location.
4. The measures to be taken to protect against these hazards (i.e., personal protective equipment, appropriate work practices, emergency response actions)
5. The circumstances under which a particular laboratory operation or procedure requires prior approval from the appropriate administrator.
6. Requirements for medical consultation and medical examination whenever
   1. a person develops signs or symptoms associated with a hazardous chemical,
   2. exposure monitoring reveals an exposure level routinely above the action level
   3. an event takes place in the work area such as a spill, leak, explosion or other occurrence resulting in the likelihood of a hazardous exposure.
7. Designation of personnel responsible for the implementation of the CHP, including the assignment of a Chemical Hygiene Officer.
8. Requirements for additional protection when working with particularly hazardous substances including ―select carcinogens,‖ reproductive toxins, and substances with a high degree of acute toxicity.
9. Requirements to establish and maintain accurate records monitoring employee exposures and any medical consultation and/or examinations, and to assure the confidentiality of these records.
10. Provisions for yearly re-evaluation of the CHP.

For additional information on developing a CHP consult the following sources:

* + *Handbook of Chemical Health and Safety (ACS Handbooks)* by Robert J Alaimo (2001)
  + *Prudent Practices in the Laboratory: Handling and Disposal of Chemicals* by The National Research Council (1995)

#### Chemical Hygiene Plan Required Elements

1. Defined standard operating procedures relevant to safety and health considerations for

each activity involving the use of hazardous chemicals.

1. Criteria to use to determine and implement control measures to reduce exposure to hazardous materials (i.e., engineering controls, the use of personal protective equipment, administrative controls, and hygiene practices) with particular attention given to the selection of control measures for extremely hazardous materials.
2. A requirement to ensure laboratory chemical hoods and other protective equipment are installed and functioning properly.
3. Information for persons working with hazardous substances should include
   1. the hazards of the chemicals in the work area
   2. the location of the CHP
   3. signs and symptoms associated with hazardous chemical exposures
   4. the permissible or recommended exposure limits of the chemicals
   5. the location and availability of information on the hazards, safe handling, storage, and disposal of hazardous chemicals [not limited to Material Safety Data Sheets (MSDSs)].

#### Chemical Tracking System

A good chemical tracking system can reduce procurement costs, eliminate unnecessary

purchases, and minimize disposal expenses. A chemical tracking system is a database of chemicals in the laboratory, and a ―cradle-to-grave‖ chemical tracking system should track chemicals from the time they are purchased through the time they are used and discarded. A tracking system can be set up by (1) using index cards or another paper system organized by chemical name and/or molecular formula or (2) by creating a computer-based system.

The following tracking fields are recommended:

1. Chemical name as printed on the container
2. Chemical name as it appears on the MSDS if different from that on the container
3. Molecular formula
4. Chemical Abstract Service (CAS) registry number
5. Date received
6. Source (i.e., chemical manufacturer, and if known, supplier)
7. Type of container
8. Hazard classification (for storage, handling, and disposal)
9. Required storage conditions
10. Room number (for larger institutions with multiple storage locations)
11. Location within the room (i.e., shelf #1, acid cabinet)
12. Expiration or ―use by date
13. Amount of the chemical in the container
14. Name of the person who ordered or requested the chemical

Each record represents a SINGLE CONTAINER of a chemical (rather than just the chemical itself). Keep accurate, up-to-date records of the use of each chemical in the system.

**The Chemical Hygiene Plan**

The Occupational Safety and Health Administration (OSHA) requires all employers to have Chemical Hygiene Plans that address the following topics.

1. **Introduction**
   1. Purpose of the plan
   2. Applicability of the plan
2. **District Organization and Responsibilities (if applicable)**
   1. Superintendent
   2. Principal
   3. Science department head
   4. District officers
   5. School employees
   6. Chemical hygiene personnel including the designation of a Chemical Hygiene Officer
   7. Students
3. **General Principles**
   1. Preparation for emergencies
   2. Adherence to rules and procedures
   3. Avoiding exposure to hazardous materials
   4. Risk evaluation including criteria for implementing control measures
   5. Exposure limits
   6. Ventilation
   7. MSDSs
4. **Standard Operating Procedures for Safety and Health**
   1. General rules for laboratory work
   2. Working alone prohibited
   3. Personal protective devices
   4. Planning for safe work habits
   5. Behavior in the laboratory
   6. Personal hygiene
   7. Housekeeping
   8. Food handling
   9. Glassware
   10. Flammability hazards
   11. Electrical hazards
   12. Compressed gases
   13. Prior approval for new operations/processes/activities
5. **Record Keeping**
   1. Results of air monitoring
   2. MSDSs
   3. Training records
   4. Exposure testing records
   5. Medical records
   6. Prior approval records
   7. Incident reports
   8. Chemical inventory records
   9. Waste disposal records
   10. Safety inspection results
6. **Laboratory Safety Procedures**
   1. Employee protection
   2. Facilities
   3. Ventilation
   4. Medical consultation/examination including the following requirements:
      1. Whenever exposure occurs the employee must be given the opportunity for medical consultation to determine the need for a medical examination at no cost to the employee.
      2. Obtain a written opinion from the physician for all medical consultations.
   5. Reagent purchasing
   6. Chemical storage
   7. Inventory control
   8. Labeling
   9. MSDSs
   10. Waste disposal
7. **Inspections**
   1. Laboratory equipment including ventilation hood performance evaluations
   2. Safety audits
8. **Exposure Control Including Monitoring**
   1. Toxins
   2. Flammables
   3. Reactives
   4. Corrosives
   5. Reproductive toxins
   6. Carcinogens including the handling of "select carcinogens" to provide for:
      1. establishing designated areas
      2. determining containment devices
      3. establishing methods of disposal
      4. instituting methods of decontamination
   7. Exposure potential
9. **Employee Information and Training**
   1. The existence and content of the OSHA Laboratory Standard
   2. The location and availability of the Chemical Hygiene Plan
   3. Occupational exposure standards, such as OSHA Permissible Exposure Limits
   4. Signs and symptoms associated with the overexposure to chemicals
   5. The location of reference materials such as MSDSs
   6. The methods and observations that employees may use to detect the presence or release of hazardous chemicals
   7. Work practices, emergency response procedures, and protective equipment to be used
   8. Training of students
10. **Emergency Procedures**
    1. Response procedures including an evacuation plan
    2. First aid
    3. Emergency equipment
    4. Fire prevention
    5. Fire fighting
    6. Injuries involving fire
    7. Chemical spills on personnel
    8. Eye splashes
    9. Medical help
    10. Injury to personnel
    11. Chemical spills
    12. Accident reports
11. **Spill response**
    1. Personal injury
    2. Identification of the spilled material
    3. Containment of the spilled material
    4. Cleanup of the spilled material
    5. Protective equipment
    6. Training for emergencies
    7. Disposal of cleanup materials
    8. Record keeping

In addition, appendices should be attached to the plan, including a copy of the OSHA Laboratory Standard, a bibliography, various forms to be used, and any other information specific to the local operation.

In developing plans, Chemical Hygiene Officers are encouraged to use the American Chemical Society publication, *A Model Chemical Hygiene Plan for High Schools*, and the model plan designed by the Flinn Scientific Company. Additional suggestions can be found in **29 CFR 1910.1450, Appendix A**.

**APPENDIX F:**

**ESSENTIAL LABORATORY SKILLS**

**Appendix F: Essential Laboratory Techniques**

Working in the science laboratory, you will be handling potentially dangerous substances and performing unfamiliar tasks. This section provides you with a guide to the safe laboratory techniques. While performing experiments throughout the year refer back to this section any time you are unsure of proper laboratory techniques.

1. Always read the label on a reagent bottle before using its contents.
2. Always wear safety goggles when handling chemicals.
3. Never touch chemicals with your hands.
4. Never return unused chemicals to their original containers.
5. To avoid waste, do not take excessive amounts of reagents.

**Pouring liquids**

1. Use the back of your fingers to remove the stopper from a reagent bottle. Hold the stopper between your fingers until the transfer of liquid is complete. Do not place the stopper on your workbench.
2. Grasp the container from which you are pouring with the palm of your hand covering the label.
3. When you are transferring a liquid to a test tube or measuring cylinder, the container should be held at eye level. Pour the liquid slowly, until the correct volume has been transferred.
4. When you are pouring a liquid from a reagent bottle into a beaker, the reagent should be poured slowly down a glass stirring rod. When you are transferring a liquid from one beaker to another, you can hold the stirring rod and beaker in one hand.

**Filtering a Mixture**  
Sometimes it is necessary to separate a solid from a liquid. The most common method of separating such a mixture is filtration.

1. Fold a filter paper circle in half and then quarters. Open the folded paper to form a cone, with one thickness of paper on one side and three thicknesses on the other.
2. Put the paper cone in a filter funnel. Place the funnel in an iron ring clamped to a ring stand. Moisten the filter paper with a small volume of distilled water, and gently press the paper against the sides of the funnel to achieve a good fit. (If the correct size of filter paper has been used, the top edge of the cone will be just below the rim of the filter funnel.)
3. Place a beaker beneath the funnel to collect the filtrate. The tip of the funnel should touch the inside surface of the beaker and extend about one inch below the rim. Guide flow of liquid with a glass rod Mixture being filtered Filtrate Solid collects on filter paper Stem touches side of beaker.
4. Decant the liquid from the solid by pouring it down a glass stirring rod into the funnel. Be careful to keep the liquid below the top edge of the cone of filter paper at all times; the liquid must not overflow. Finally, use a jet of distilled water from a wash bottle to wash the solid into the filter.
5. When the filtration is complete, wash the solid residue on the filter paper with distilled water to remove traces of solvent. Dry the solid.
6. If the filtrate contains a dissolved salt, it may be recovered by evaporation if desired.

**Using a Gas Burner**

Laboratory gas burners produce various kinds of flames when different mixtures of gas and air are burned. The two most common models are the Bunsen burner and the Tirrell burner. Both have adjustable air vents; the Tirrell burner has a gas control valve in its base.

1. Examine your laboratory burner. Determine which model you have.
2. Connect the burner to the gas supply with rubber tubing.
3. Close the air vents. If your model is a Tirrell burner, also close the gas control valve at the base of the burner.
4. Hold a lighted match at the top of the burner tube and turn on the gas supply. Do this by opening the main gas supply valve located on top of the nozzle to which you attached the rubber tubing. (If your model is a Tirrell burner, first open the main gas supply valve, then open the gas control valve at the base approximately onehalf- turn.) You should get a yellow, or luminous, flame. When a Tirrell burner is used, the main gas supply valve should be opened fully and the gas flow regulated by the gas control valve. Gas supply to a Bunsen burner is controlled by the main gas valve.
5. Open the air vents slowly, to admit more air into the flame, to produce a light blue (nonluminous) cone-shaped flame. If the flame “blows out” after lighting, the gas supply should be reduced.
6. Adjust the air vents and gas supply to produce the desired size of flame. For most laboratory work, the blue inner cone of the flame should be about 1 inch high and free of yellow color. If you want a smaller flame, close the air vent slightly and reduce the gas supply. You will learn how to control the burner flame by trial and error.
7. Turn the burner off at the main gas supply valve when done. CAUTION: Confine long hair and loose clothing when using a gas burner. Do not reach over a burner. Ensure that flammables are not being used when a burner is lit. Never leave a lit burner unattended. Know the location of fire extinguishers, the fire blanket, and safety  
   shower.

**Heating Liquids**

**Heating a Liquid in a Test Tube**

1. The correct procedure for heating liquids in the laboratory is important to laboratory safety
2. Adjust your gas burner to produce a gentle blue flame.
3. Fill a test tube one-third full with the liquid to be heated.
4. Grasp the test tube with a test-tube holder, near the upper end of the tube.
5. Hold the test tube in a slanting position in the flame, and gently heat the tube a short distance below the surface of the liquid.
6. Shake the tube gently as it is being heated, until the liquid boils or reaches the desired temperature.
7. CAUTION: Never point the open end of a test tube you are heating either toward yourself or anyone working nearby. Never heat the bottom of the test tube.

**Heating a Liquid in a Beaker Using a Bunsen Burner**

Many laboratory experiments require the use of a hot water or boiling water bath. This procedure describes how to assemble a water bath.

1. Fasten an iron ring securely to a ring stand so that it is 2–4 cm above the top of a gas burner placed on the ring stand base.
2. Place a 250-mL beaker one-half-filled with water on a wire gauze resting on the iron ring.
3. Light your gas burner and adjust it to produce a hot flame.
4. Place the burner beneath the wire gauze. For a slower rate of heating, reduce the intensity of the burner flame.
5. CAUTION: Never heat plastic beakers or graduated glassware in a burner flame. Never let a boiling water bath boil dry; add water to it as necessary.

**Inserting Glass Tubing**

In many experimental procedures, you are required to insert a thermometer or a length of glass tubing into a hole in a rubber stopper. It is essential that you know the correct way to do this. Otherwise, serious injury may result.

1. Lubricate the end of the glass tubing with a few drops of water, washing-up liquid, glycerol, or vegetable oil.
2. Hold the glass tubing close to where it enters the hole in the rubber stopper. Protect your hands with work gloves or pieces of cloth.
3. Ease the tubing into the hole with a gentle twisting motion. Push the tubing through the hole as far as is required. Do not use force!
4. Wipe excess lubricating material from the tubing before continuing with the experiment.
5. If the glass tubing is to be removed from the stopper, it should be done immediately after the experiment is completed.
6. CAUTION: The end of the glass tubing should be fire-polished or smoothed with emery cloth before being inserted into a rubber stopper. Do not try to bend the glass tubing—it will break. Ensure that the palm of the hand holding the rubber stopper is not in line with the emerging glass tube.

Measuring Mass

In many experiments you are required to determine the mass of a chemical used or produced in a reaction. An object’s mass is determined by measuring it on a balance. When you determine the mass of an object, you are comparing its mass with a known mass. In the SI, the base unit of mass is the kilogram.

1. Check the balance before you start. The balance pan should be empty and clean, and all masses (or dials) should be set on zero. The balance must be level. Check the bubble level on the base. See your teacher if you need assistance with checking your balance.
2. Objects to be placed directly on the balance pan must be clean, dry, and at room temperature. Solid chemicals and liquids must never be put directly on the balance pan. Liquid samples should be placed in beakers or sealed containers. Solid chemicals can be conveniently placed in beakers, disposable plastic weighing boats, or on 10-cm squares made of glossy paper.
3. The balance is a precision instrument that must be handled with care. To avoid damaging it, always be sure that the balance is in an arrested position when objects are placed on or removed from the pan. Always turn all dials slowly.
4. Never move or jar either a balance or the balance table.
5. If you spill a chemical on or near the balance, clean it up immediately. If in doubt, inform your teacher. A camel-hair brush is usually provided to wipe minute traces of solid from the balance pan before you use it.
6. Never attempt to measure an object with a mass greater than the maximum capacity of the balance.
7. When you are done, return all the masses to zero, and make sure the balance pan is clean.
8. Do not attempt to use a balance until your teacher has demonstrated the proper technique.

**Measuring Volum**e

Volume measurements are important in many experimental procedures. Sometimes volume measurements must be accurate; other times they can be approximate. Most volume measures in the laboratory are made using equipment calibrated in milliliters. Although some beakers have graduation marks, these marks are designed only for quick, rough estimates of volume. Accurate volumes must be measured with pipets, burets, or volumetric flasks.

1. Using a Graduated Cylinder
2. Half-fill a 100-mL graduated cylinder with water, and set the cylinder on your laboratory bench. Examine the surface of the water. Notice how the surface curves upward where the water contacts the cylinder walls. This  
   curved surface is called a meniscus.
3. A volume measurement is always read at the bottom of the meniscus, with your eye at the same level as the liquid surface. To make the meniscus more visible, you can place your finger or a dark piece of paper behind and just below the meniscus while making the reading.
4. Graduated cylinders are available in many capacities. The 100-mL cylinder is marked in 1-mL divisions, and volumes can be estimated to the nearest 0.1 mL. The last digit in these measurements is therefore significant  
   but uncertain.

Using a Pipet

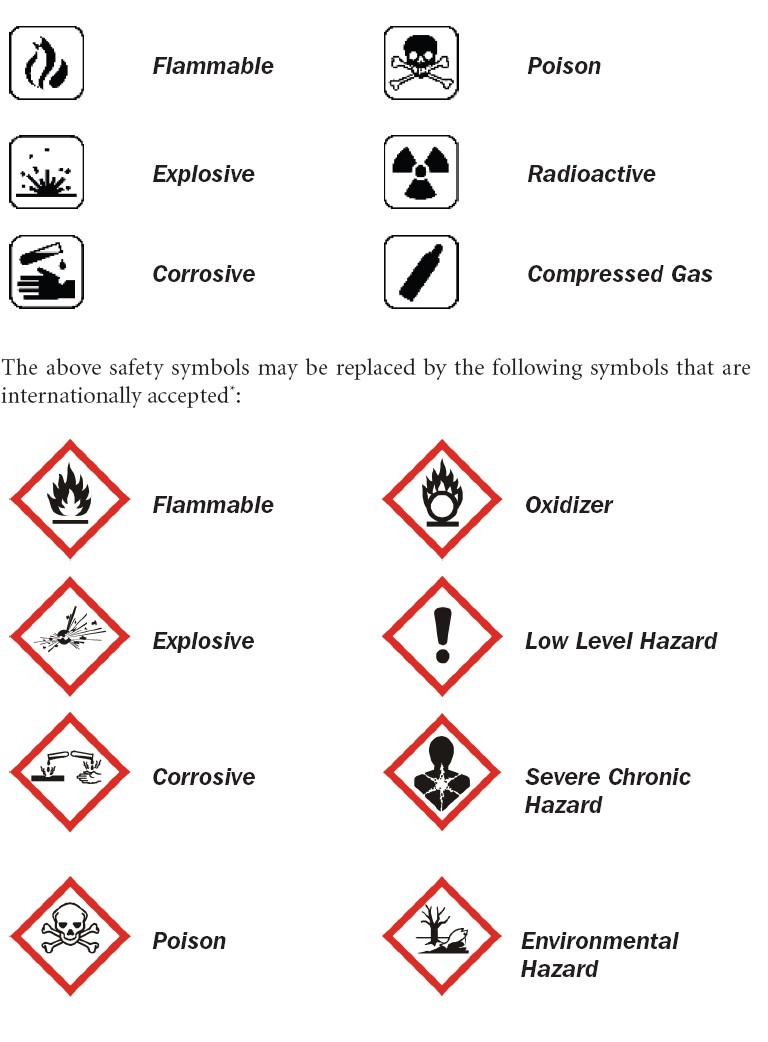
1. A pipet is used to accurately measure and deliver volumes of liquids. Two types are in common use: volumetric pipets and graduated, or measuring, pipets. The use of a volumetric pipet will be described. A volumetric pipet has a single calibration mark and delivers the volume printed on the bulb of the pipet at the temperature specified. (A graduated pipet has calibrations along the length of the pipet.) Volumes can be measured more accurately with a volumetric pipet than with a graduated pipet.
2. Place the tip of the pipet below the surface of the liquid to be dispensed.
3. Compress a pipet bulb and press the hole in the bulb against the upper end of the pipet. CAUTION: Never fill a pipet by applying suction with your mouth. Never push the pipet bulb over the end of the pipet.
4. Slowly release pressure on the bulb so that liquid is drawn into the pipet to a level about 2 cm above the calibration mark.
5. Remove the bulb and simultaneously place your index finger over the end of the pipet. If you are right-handed, you should hold the pipet in your right hand and the pipet bulb in your left.
6. Keep your index finger pressed firmly against the end. Withdraw the pipet from the liquid, and carefully wipe the outside of the stem with a paper towel.
7. Slowly reduce the pressure on your finger to allow the excess liquid to drain into a waste receiver, until the bottom of the meniscus is at the calibration mark.
8. Now, deliver the remaining liquid in the pipet into the designated receiver. When releasing liquid from a volumetric pipet, let it drain completely. Wait 20 seconds, then touch the pipet tip to the side of the flask or surface of the liquid. This action will remove some, but not all, of the liquid in the tip. The pipet delivers the stated volume when this procedure is followed. A small amount of liquid remains in the tip. Do not blow this out into your receiver.

**Glassworking**

1. **Cutting and Fire Polishing**
2. Place the glass tubing or glass rod on a flat surface (such as the laboratory bench).
3. Hold the glass tightly with one hand close to the area to be cut.
4. Using a firm stroke, make a single deep scratch with a triangular file.  
   CAUTION: Do not use a sawing motion or repeated scratching.
5. Grasp the glass in both hands with the scratch facing away from you and both thumbs directly behind the scratch.
6. Push firmly with the thumbs and pull with your fingers. The glass should snap with a clean break.  
   CAUTION: Be careful with the cut ends of the glass. They may be sharp and jagged. Do not attempt to break glass tubing having an outside diameter greater than 6 mm.
7. The cut ends of the glass tubing should be fire-polished to make the tubing safe to handle. Rotate one end of the glass tube in the hottest part of a burner flame, until the sharp edges have softened and become rounded.   
   CAUTION: Do not hold the tubing in the flame too long. If you do, the hole in the tube will close.
8. Place the hot glass on a wire gauze square to cool.  
   CAUTION: Hot glass and cold glass look alike. Make sure one end of a piece of glass has cooled before you attempt to fire-polish the other end.
9. **Bending Glass Tubing**
10. Put a wing top or flame spreader on your gas burner.
11. Light the burner and adjust the flame to produce an even blue (hot) flame across the wing top.
12. Grasp a length of glass tubing that has been fire-polished at both ends. Hold the center of it lengthwise in the flame, just at the top of the blue region. This is the hottest part of the flame.
13. Rotate the tubing in the flame to heat approximately a 5-cm section uniformly, until it becomes soft and just begins to sag.
14. Remove the tubing from the flame and bend it to the desired shape in one movement.
15. When it has hardened, put the glass tubing on a wire gauze to cool.  
    CAUTION: Hot and cold glass look alike.

**APPENDIX G:**

**HAZARD SYMBOLS**



**APPENDIX H:**

**NFPA CODES**

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|  |  |
| --- | --- |
| **Health (Blue)** | |
| **0** | Poses no health hazard, no precautions necessary and would offer no hazard beyond that of ordinary combustible materials (e.g., water) |
| **1** | Exposure would cause irritation with only minor residual injury (e.g., acetone) |
| **2** | Intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury (e.g., diethyl ether) |
| **3** | Short exposure could cause serious temporary or moderate residual injury (e.g., chlorine) |
| **4** | Very short exposure could cause death or major residual injury (e.g., hydrogen cyanide, phosphine, carbon monoxide, [sarin](http://en.wikipedia.org/wiki/Sarin)) |

|  |  |
| --- | --- |
| **Flammability (Red)** | |
| **0** | Materials that will not burn under typical fire conditions (e.g., carbon dioxide), including intrinsically noncombustible materials such as concrete, stone and sand. (Materials that will not burn in air when exposed to a temperature of 816°C (1500°F) for a period of 5 minutes.) |
| **1** | Materials that require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur (e.g., mineral oil). Includes some finely divided suspended solids that do not require heating before ignition can occur. (Flash point at or above 93.4°C (200°F) |
| **2** | Must be moderately heated or exposed to relatively high ambient temperature before ignition can occur (e.g., diesel fuel) and some finely divided suspended solids that do not require heating before ignition can occur. Flash point between 38°C (100°F) and 93°C (200°F) |
| **3** | Liquids and solids (including finely divided suspended solids) that can be ignited under almost all ambient temperature conditions (e.g., gasoline). Liquids having a flash point below 23°C (73°F) and having a boiling point at or above 38°C (100°F) or having a flash point between 23°C (73°F) and 38°C (100°F) |
| **4** | Will rapidly or completely vaporize at normal atmospheric pressure and temperature, or is readily dispersed in air and will burn readily (e.g., [acetylene](http://en.wikipedia.org/wiki/Acetylene), [diethylzinc](http://en.wikipedia.org/wiki/Diethylzinc)). Includes [pyrophoric](http://en.wikipedia.org/wiki/Pyrophoricity) substances. [Flash point](http://en.wikipedia.org/wiki/Flash_point) below 23°C (73°F) |

|  |  |
| --- | --- |
| **Instability/Reactivity (Yellow)** | |
| **0** | Normally stable, even under fire exposure conditions, and is not reactive with water (e.g. [helium](http://en.wikipedia.org/wiki/Helium)) |
| **1** | Normally stable, but can become unstable at elevated temperatures and pressures (e.g. [propene](http://en.wikipedia.org/wiki/Propene)) |
| **2** | Undergoes violent chemical change at elevated temperatures and pressures, reacts violently with water, or may form explosive mixtures with water (e.g., [white phosphorus](http://en.wikipedia.org/wiki/Allotropes_of_phosphorus), [potassium](http://en.wikipedia.org/wiki/Potassium), [sodium](http://en.wikipedia.org/wiki/Sodium)) |
| **3** | Capable of detonation or explosive decomposition but requires a strong initiating source, must be heated under confinement before initiation, reacts explosively with water, or will detonate if severely shocked (e.g. [ammonium nitrate](http://en.wikipedia.org/wiki/Ammonium_nitrate), [chlorine trifluoride](http://en.wikipedia.org/wiki/Chlorine_trifluoride)) |
| **4** | Readily capable of [detonation](http://en.wikipedia.org/wiki/Detonation) or [explosive decomposition](http://en.wikipedia.org/wiki/Explosive_material) at normal temperatures and pressures (e.g., [nitroglycerin](http://en.wikipedia.org/wiki/Nitroglycerin), [chlorine azide](http://en.wikipedia.org/wiki/Chlorine_azide), [chlorine dioxide](http://en.wikipedia.org/wiki/Chlorine_dioxide)) |

|  |  |
| --- | --- |
| **Special (White)** | |
| *The white "special notice" area can contain several symbols. The following symbols are defined by the NFPA 704 standard.* | |
| **OX** | [Oxidizer](http://en.wikipedia.org/wiki/Oxidizer) (e.g., [potassium perchlorate](http://en.wikipedia.org/wiki/Potassium_perchlorate), [ammonium nitrate](http://en.wikipedia.org/wiki/Ammonium_nitrate), [hydrogen peroxide](http://en.wikipedia.org/wiki/Hydrogen_peroxide)) |
| **~~W~~** | Reacts with [water](http://en.wikipedia.org/wiki/Water) in an unusual or dangerous manner (e.g., [cesium](http://en.wikipedia.org/wiki/Cesium), [sodium](http://en.wikipedia.org/wiki/Sodium), [sulfuric acid](http://en.wikipedia.org/wiki/Sulfuric_acid)) |
| **SA** | Simple [asphyxiant gas](http://en.wikipedia.org/wiki/Asphyxiant_gas). Specifically limited to the following gases: [nitrogen](http://en.wikipedia.org/wiki/Nitrogen), [helium](http://en.wikipedia.org/wiki/Helium), [neon](http://en.wikipedia.org/wiki/Neon), [argon](http://en.wikipedia.org/wiki/Argon), [krypton](http://en.wikipedia.org/wiki/Krypton) and [xenon](http://en.wikipedia.org/wiki/Xenon).[[2]](http://en.wikipedia.org/wiki/NFPA_704) |