RICHMOND COUNTY SCHOOLS SYSTEM SECONDARY LABORATORY SAFETY MANUAL

2023

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

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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
    a. allows a foolish or imprudent act to be committed
    b. is careless in performing a demonstration
    c. neglects to warn of any hazards associated with an exercise, operation or demonstration
    d. 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.
2. 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:
    a. **Misfeasance**: the defendant acts in an improper manner.
    b. **Nonfeasance**: the defendant did not act at all when he or she had a duty to act.
    c. **Malfeasance**: the defendant acts with a bad motive or inflicts deliberate injury.

2. Four elements must exist for a liability tort to be brought:
    a. A legal duty of one person to another, as a teacher's duty to protect the students in his or her charge.
    b. A breach of this duty existing between two parties.
    c. Personal injury or monetary damages directly caused by the breach in legal responsibility.
    d. 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:
   a. to identify the hazards that exist
   b. to identify the consequences and probabilities of adverse occurrences
   c. to identify necessary control systems to eliminate unacceptable consequences.
2. 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 requires 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 designation 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

23. **Any time chemicals, heat, or glassware are used, students will wear laboratory goggles. There will be no exceptions to this rule!**
24. Contact lenses should not be worn in the laboratory unless you have permission from your instructor.
25. 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.
26. Lab aprons have been provided for your use and should be worn during laboratory activities.

6.3 Accidents And Injuries

27. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.

28. If you or your lab partner are hurt, immediately yell out “Code one, Code one” to get the instructor’s attention.
29. 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.
30. When mercury thermometers are broken, mercury must not be touched. Notify the instructor immediately.

6.4 Handling Chemicals

31. 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.
32. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need.
33. Never return unused chemicals to their original containers.
34. Never use mouth suction to fill a pipet. Use a rubber bulb or pipet pump.
35. When transferring reagents from one container to another, hold the containers away from your body.
36. 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.
37. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.
38. Never remove chemicals or other materials from the laboratory area.
39. Take great care when transporting acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

APPENDICES

Appendices

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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.

Teacher Signature:_____ Date: _____

Department Chair Signature: _____ Date: _____

Principal Signature: _____ Date: _____

Appendix A4:

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 B:
CHEMICALS OF INTEREST AND CONCERN

Appendix B1: Chemical Listings

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-s*ec* 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 C:
LEGAL REFERENCES

Appendix C1: REGULATORY AGENGIES

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.
2. 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.

a. 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.
b. 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.
c. 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.

d. 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.
e. 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:
   1) A total of one kilogram of acute hazardous wastes listed in §§ 261.31 or 261.33(e).
   2) 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).
   3) 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.
f. 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;

2) 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;
3) 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:
   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:
      A. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
      B. 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.

g) 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:
   1) Section 262.11 of this chapter;
   2) 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;

3) 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:
      A. Beneficially uses or reuses, or legitimately recycles or reclaims its waste; or
      B. 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.

h. 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.

i. 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.

j. 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.

3. **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.

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4. **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.

5. **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).**

6. **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)**.

7. **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.

8. **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)**.

9. **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

300-3-19-.02 Administration.

1) Department of Labor Responsibilities.
   a) The Department shall as required under the Act ensure compliance with all training programs.
   b) The Department must provide written approval of all written training programs required under the Act.
   c) 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.
   a) 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.
   b) Each public employer shall designate a hazardous chemicals protection communication coordinator.
   c) The hazardous chemicals protection communication coordinator will be provided with authority sufficient to carry out the duties of the position.
      1. An individual in an existing position within an agency may be assigned hazardous chemicals protection communication coordinator responsibilities as an additional duty.
      2. The hazardous chemicals protection communication coordinator will assume the following responsibilities:
         i. 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.
         ii. 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.
         iii. Make arrangements for and/or provide appropriate and adequate training to all employees.
   d) The hazardous chemicals protection communication coordinator will ensure that:
      1. 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.
      2. 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.

3. 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.
4. Employee training on and notification of the use of hazardous chemicals in the workplace are adequately documented in each employee's personnel file.
5. 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.
   a) 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.
   b) 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.
   c) An employee shall not be exposed to a hazardous chemical until the employee has been trained in its hazards.
2) 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:
   a) The requirements of the Act.
   b) Identification of specific work areas in the workplace where hazardous chemicals are handled and/or produced.
   c) The location and content of the public employer's written hazardous chemical protection communication program.
   d) The purpose of a Material Safety Data Sheet, including the information contained therein.
   e) The labeling system used at the workplace and how to respond to an unlabeled container delivered to or discovered in the workplace.
   f) The various control measures to be used to minimize the employees' exposure to hazardous chemicals. Where applicable, this shall include information on:
      1. The proper use, care, storage, selection, and fitting of respirators, and the elements of a respirator program;
      2. The use of face shields, goggles, and safety glasses;
      3. The use of appropriate gloves, aprons, protective clothing, and foot coverings;
      4. The use of exhaust ventilation equipment; and
      5. Work practices which reduce exposure to hazardous chemicals.

g) The right of the employee's physician to receive hazardous chemical information.
h) 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.
i) Emergency procedures, such as spill response and first aid.
j) Proper storage of chemicals and separation of incompatible substances.
k) 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.
l) Where additional information and training can be obtained.

3) Training Format.
   a) All training sessions must include an opportunity for employees to ask questions.
4) Training Activities.
   a) 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

APPENDIX D:
MATERIAL SAFETY AND DATA SHEETS

Appendix D: Understanding an MSDS: ANSI Standardized MSDS Format

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: $C_6H_5–CH_3$
Catalog Number: Tol 12
Supplier: Company X XXXXXXXXX Anywhere, XX XXXXX Emergency Information: 800–XXX–XXXX

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Toluene	108–88–3	100%	Yes

3. 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.

4. 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.

5. Fire Fighting Measures

Fire: Flash point: 4 ^{o}C (40 ^{o}F)
Autoignition temperature: 480 ^{o}C (896 ^{o}F)
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.

6. 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.

7. 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.

8. 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.

9. 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: $C_6H_5CH_3$
Molecular weight: 92.06

10. 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.

11. 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.

12. 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.

13. 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.

14. 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

15. 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

16. 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

a. Keep away from heat, sparks, and flame.
b. Keep container closed.
c. Use only with adequate ventilation.

d. Wash thoroughly after handling. Avoid breathing vapor. Avoid contact with eyes, skin, and clothing.

Free MSDS Resources

- SIRI Vermont www.hazard.com/msds/
- MSDS XChange www.msdsxchange.com/
- MSDS –SEARCH National Repository www.msdssearch.com/msdssearch.htm
- Worldwide MSDS Search www3.3m.com/search/
- Flinn Scientific www.flinnsci.com/search_MSDS.asp
- Mallinckrodt Baker MSDSs www.dino.wiz.uni-kassel.de/dain/ddb/x350.html
- MSDS Search www.new.fishersci.com/wps/portal/
- Material Data Safety Sheets (MSDS) www.carolina.com/category/teacher+resources

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. 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
    a. a person develops signs or symptoms associated with a hazardous chemical,
    b. exposure monitoring reveals an exposure level routinely above the action level
    c. 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.
2. 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.
3. A requirement to ensure laboratory chemical hoods and other protective equipment are installed and functioning properly.
4. Information for persons working with hazardous substances should include
    a. the hazards of the chemicals in the work area
    b. the location of the CHP
    c. signs and symptoms associated with hazardous chemical exposures
    d. the permissible or recommended exposure limits of the chemicals
    e. 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**
    a. Purpose of the plan
    b. Applicability of the plan
2. **District Organization and Responsibilities (if applicable)**
    a. Superintendent
    b. Principal
    c. Science department head
    d. District officers
    e. School employees
    f. Chemical hygiene personnel including the designation of a Chemical Hygiene Officer
    g. Students
3. **General Principles**
    a. Preparation for emergencies
    b. Adherence to rules and procedures
    c. Avoiding exposure to hazardous materials
    d. Risk evaluation including criteria for implementing control measures
    e. Exposure limits
    f. Ventilation
    g. MSDSs
4. **Standard Operating Procedures for Safety and Health**
    a. General rules for laboratory work
    b. Working alone prohibited
    c. Personal protective devices
    d. Planning for safe work habits
    e. Behavior in the laboratory
    f. Personal hygiene
    g. Housekeeping
    h. Food handling
    i. Glassware
    j. Flammability hazards
    k. Electrical hazards
    l. Compressed gases
    m. Prior approval for new operations/processes/activities
5. **Record Keeping**
    a. Results of air monitoring

b. MSDSs
c. Training records
d. Exposure testing records
e. Medical records
f. Prior approval records
g. Incident reports
h. Chemical inventory records
i. Waste disposal records
j. Safety inspection results

6. **Laboratory Safety Procedures**
    a. Employee protection
    b. Facilities
    c. Ventilation
    d. Medical consultation/examination including the following requirements:
        i. 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.
        ii. Obtain a written opinion from the physician for all medical consultations.
    e. Reagent purchasing
    f. Chemical storage
    g. Inventory control
    h. Labeling
    i. MSDSs
    j. Waste disposal
7. **Inspections**
    a. Laboratory equipment including ventilation hood performance evaluations
    b. Safety audits
8. **Exposure Control Including Monitoring**
    a. Toxins
    b. Flammables
    c. Reactives
    d. Corrosives
    e. Reproductive toxins
    f. Carcinogens including the handling of "select carcinogens" to provide for:
        i. establishing designated areas
        ii. determining containment devices
        iii. establishing methods of disposal
        iv. instituting methods of decontamination
    g. Exposure potential

9. **Employee Information and Training**
    a. The existence and content of the OSHA Laboratory Standard
    b. The location and availability of the Chemical Hygiene Plan
    c. Occupational exposure standards, such as OSHA Permissible Exposure Limits
    d. Signs and symptoms associated with the overexposure to chemicals
    e. The location of reference materials such as MSDSs
    f. The methods and observations that employees may use to detect the presence or release of hazardous chemicals
    g. Work practices, emergency response procedures, and protective equipment to be used
    h. Training of students
10. **Emergency Procedures**
    a. Response procedures including an evacuation plan
    b. First aid
    c. Emergency equipment
    d. Fire prevention
    e. Fire fighting
    f. Injuries involving fire
    g. Chemical spills on personnel
    h. Eye splashes
    i. Medical help
    j. Injury to personnel
    k. Chemical spills
    l. Accident reports
11. **Spill response**
    a. Personal injury
    b. Identification of the spilled material
    c. Containment of the spilled material
    d. Cleanup of the spilled material
    e. Protective equipment
    f. Training for emergencies
    g. Disposal of cleanup materials
    h. 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 Volume

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
    a. 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.
    b. 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.
    c. 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.
    a. Place the tip of the pipet below the surface of the liquid to be dispensed.
    b. 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.

c. Slowly release pressure on the bulb so that liquid is drawn into the pipet to a level about 2 cm above the calibration mark.
d. 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.
e. 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.
f. 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.
g. 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**
   a. Place the glass tubing or glass rod on a flat surface (such as the laboratory bench).
   b. Hold the glass tightly with one hand close to the area to be cut.
   c. Using a firm stroke, make a single deep scratch with a triangular file.
   CAUTION: Do not use a sawing motion or repeated scratching.
   d. Grasp the glass in both hands with the scratch facing away from you and both thumbs directly behind the scratch.
   e. 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.
   f. 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.
   g. 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.
2. **Bending Glass Tubing**
   a. Put a wing top or flame spreader on your gas burner.
   b. Light the burner and adjust the flame to produce an even blue (hot) flame across the wing top.
   c. 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.
   d. Rotate the tubing in the flame to heat approximately a 5-cm section uniformly, until it becomes soft and just begins to sag.

e. Remove the tubing from the flame and bend it to the desired shape in one movement.
f. 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

Flammable

Poison

Explosive

Radioactive

Corrosive

Compressed Gas

The above safety symbols may be replaced by the following symbols that are internationally accepted*:

Flammable

Oxidizer

Explosive

Low Level Hazard

Corrosive

Severe Chronic Hazard

Poison

Environmental Hazard

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)

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, diethylzinc). Includes pyrophoric substances. 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)
1	Normally stable, but can become unstable at elevated temperatures and pressures (e.g. 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, potassium, 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, chlorine trifluoride)
4	Readily capable of detonation or explosive decomposition at normal temperatures and pressures (e.g., nitroglycerin, chlorine azide, 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 (e.g., potassium perchlorate, ammonium nitrate, hydrogen peroxide)
~~W~~	Reacts with water in an unusual or dangerous manner (e.g., cesium, sodium, sulfuric acid)
SA	Simple asphyxiant gas. Specifically limited to the following gases: nitrogen, helium, neon, argon, krypton and xenon.[2]