The chemistry laboratory can be a place of discovery and learning. However, by the very nature of laboratory work, it can be a place of danger if proper common-sense precautions aren't taken. While every effort has been made to eliminate the use of explosive, highly toxic, and carcinogenic substances from the experiments which you will perform, there is a certain unavoidable hazard associated with the use of a variety of chemicals and glassware. You are expected to learn and adhere to the following general safety guidelines to ensure a safe laboratory environment for both yourself and the people you may be working near. Additional safety precautions will be announced in class prior to experiments where a potential danger exists. Students who fail to follow all safety rules may be asked to leave the lab or suffer grading penalties.

Attire

1. Safety goggles **must be worn at all times** while in the laboratory. This rule must be followed whether you are actually working on an experiment or simply writing in your lab notebook. You must wear safety goggles provided by the chemistry department.
2. Contact lenses are not allowed. Even when worn under safety goggles, various fumes may accumulate under the lens and cause serious injuries or blindness.
3. Closed toe shoes and long pants must be worn in the lab. Sandals and shorts are not allowed.
4. Long hair must be tied back when using open flames.
5. Lab Coats must be worn during the lab hours.

Conduct

6. Eating, drinking, and smoking are strictly prohibited in the laboratory.
7. No unauthorized experiments are to be performed. If you are curious about trying a procedure not covered in the experimental procedure, consult with your laboratory instructor.
8. Never taste anything. Never directly smell the source of any vapor or gas; instead by means of your cupped hand, waft a small sample to your nose. Do not inhale these vapors but take in only enough to detect an odor if one exists.
9. Coats, backpacks, etc., should not be left on the lab benches and stools. There is a hook rack along the back wall at either end of the lab. There are coat racks just inside the each entrance to the balance room at the back of the lab. Beware that lab chemicals can destroy personal possessions.
10. Always wash your hands before leaving lab.
11. Learn where the safety and first-aid equipment is located. This includes fire extinguishers, fire blankets, and eye-wash stations.
12. Notify the instructor immediately in case of an accident.

Proper Handling of Chemicals and Equipment

13. Consider **all** chemicals to be hazardous unless you are instructed otherwise. Material Safety Data Sheets (MSDS) are available in lab for all chemicals in use. These will inform you of any hazards and precautions of which you should be aware.
14. Know what chemicals you are using. Carefully read the label *twice* before taking anything from a bottle. Chemicals in the lab are marked with NFPA hazardous materials diamond labels. Learn how to interpret these labels.
15. Excess reagents are **never** to be returned to stock bottles. If you take too much, dispose of the excess.
16. Many common reagents, for example, alcohols and acetone, are highly flammable.

Do not use them anywhere near open flames.

17. Always pour acids into water. If you pour water into acid, the heat of reaction will cause the water to explode into steam, sometimes violently, and the acid will splatter.
18. If chemicals come into contact with your skin or eyes, **flush immediately** with copious amounts of water and consult with your instructor.
19. Never point a test tube or any vessel that you are heating at yourself or your neighbor--it may erupt like a geyser.
20. Dispose of chemicals properly. Waste containers will be provided and their use will be explained by your TA. Unless you are explicitly told otherwise, assume that only water may be put in the lab sinks.
21. Clean up all broken glassware immediately and dispose of the broken glass properly.
22. Contact the stockroom for clean-up of mercury spills.
23. Never leave burners unattended. Turn them off whenever you leave your workstation. Be sure that the gas is shut off at the bench rack when you leave the lab.
24. Beware of hot glass--it looks exactly like cold glass.

Glove Selection Guideline

Skin contact is a potential source of exposure to toxic materials; it is important that the proper steps be taken to prevent such contact. Most accidents involving hands and arms can be classified under four main hazard categories: chemicals, abrasions, cutting, and heat. There are gloves available that can protect workers from any of these individual hazards or any combination thereof.

Gloves should be replaced periodically, depending on frequency of use and permeability to the substance(s) handled. Gloves overtly contaminated should be rinsed and then carefully removed after use.

Gloves should also be worn whenever it is necessary to handle rough or sharp-edged objects, and very hot or very cold materials. The type of glove materials to be used in these situations include leather, welder's gloves, aluminum-backed gloves, and other types of insulated glove materials.

Careful attention must be given to protecting your hands when working with tools and machinery. Power tools and machinery must have guards installed or incorporated into their design that prevent the hands from contacting the point of operation, power train, or other moving parts. To protect hands from injury due to contact with moving parts, it is important to:

- Ensure that guards are always in place and used.
- Always lock-out machines or tools and disconnect the power before making repairs.
- Treat a machine without a guard as inoperative; and
- Do not wear gloves around moving machinery, such as drill presses, mills, lathes, and grinders.

The following is a guide to the most common types of protective work gloves and the types of hazards they can guard against:

a. **Disposable Gloves**. Disposable gloves, usually made of light-weight plastic, can help guard against mild irritants.
b. **Fabric Gloves**. Made of cotton or fabric blends are generally used to improve grip when handling slippery objects. They also help insulate hands from mild heat or cold.
c. **Leather Gloves**. These gloves are used to guard against injuries from sparks or scraping against rough surfaces. They are also used in combination with an insulated liner when working with electricity.

d. **Metal Mesh Gloves**. These gloves are used to protect hands form accidental cuts and scratches. They are used most commonly by persons working with cutting tools or other sharp instruments.

e. **Aluminized Gloves**. Gloves made of aluminized fabric are designed to insulate hands from intense heat. These gloves are most commonly used by persons working molten materials.

f. **Chemical Resistance Gloves**. These gloves may be made of rubber, neoprene, polyvinyl alcohol or vinyl, etc. The gloves protect hands from corrosives, oils, and solvents. The following table is provided as a guide to the different types of glove materials and the chemicals they can be used against. When selecting chemical resistance gloves, be sure to consult the manufacturers' recommendations, especially if the gloved hand will be immersed in the chemical.

Glove Chart

Type	Advantages	Disadvantages	Use Against
Natural rubber	Low cost, good physical properties, dexterity	Poor vs. oils, greases, organics. Frequently imported; may be poor quality	Bases, alcohols, dilute water solutions; fair vs. aldehydes, ketones.
Natural rubber blends	Low cost, dexterity, better chemical resistance than natural rubber vs. some chemicals	Physical properties frequently inferior to natural rubber	Same as natural rubber
Polyvinyl chloride (PVC)	Low cost, very good physical properties, medium cost, medium chemical resistance	Plasticizers can be stripped; frequently imported may be poor quality	Strong acids and bases, salts, other water solutions, alcohols
Neoprene	Medium cost, medium chemical resistance, medium physical properties	NA	Oxidizing acids, anilines, phenol, glycol ethers
Nitrile	Low cost, excellent physical properties, dexterity	Poor vs. benzene, methylene chloride, trichloroethylene, many ketones	Oils, greases, aliphatic chemicals, xylene, perchloroethylene, trichloroethane; fair vs. toluene
Butyl	Speciality glove, polar organics	Expensive, poor vs. hydrocarbons, chlorinated solvents	Glycol ethers, ketones, esters
Polyvinyl alcohol (PVA)	Specialty glove, resists a very broad range of organics, good physical properties	Very expensive, water sensitive, poor vs. light alcohols	Aliphatics, aromatics, chlorinated solvents, ketones (except acetone), esters, ethers
Fluoro-elastomer (Viton) ™ *	Specialty glove, organic solvents	Extremely expensive, poor physical properties, poor vs. some ketones, esters, amines	Aromatics, chlorinated solvents, also aliphatics and alcohols
Norfoil (Silver Shield)	Excellent chemical resistance	Poor fit, easily punctures, poor grip, stiff	Use for Hazmat work

*Trademark of DuPont Dow Elastomers

Glove Type and Chemical Use

*Limited service	VG= Very Good	G= Good	F=Fair	P=Poor (not recommended)

Chemical	Neoprene	Natural Latex or Rubber	Butyl	Nitrile Latex
*Acetaldehyde	VG	G	VG	G
Acetic acid	VG	VG	VG	VG
*Acetone	G	VG	VG	P
Ammonium hydroxide	VG	VG	VG	VG
*Amyl acetate	F	P	F	P
Aniline	G	F	F	P
*Benzaldehyde	F	F	G	G
*Benzene	F	F	F	P
Butyl acetate	G	F	F	P
Butyl alcohol	VG	VG	VG	VG
Carbon disulfide	F	F	F	F
*Carbon tetrachloride	F	P	P	G
Castor oil	F	P	F	VG
*Chlorobenzene	F	P	F	P
*Chloroform	G	P	P	P
Chloronaphthalene	F	P	F	F
Chromic Acid (50%)	F	P	F	F
Citric acid (10%)	VG	VG	VG	VG
Cyclohexanol	G	F	G	VG
*Dibutyl phthalate	G	P	G	G
Diesel fuel	G	P	P	VG
Diisobutyl ketone	P	F	G	P
Dimethylformamide	F	F	G	G
Dioctyl phthalate	G	P	F	VG
Dioxane	VG	G	G	G
Epoxy resins, dry	VG	VG	VG	VG
*Ethyl acetate	G	F	G	F
Ethyl alcohol	VG	VG	VG	VG
Ethyl ether	VG	G	VG	G
*Ethylene dichloride	F	P	F	P
Ethylene glycol	VG	VG	VG	VG
Formaldehyde	VG	VG	VG	VG
Chemical	**Neoprene**	**Natural Latex or Rubber**	**Butyl**	**Nitrile**
Formic acid	VG	VG	VG	VG
Freon 11	G	P	F	G

Freon 12	G	P	F	G
Freon 21	G	P	F	G
Freon 22	G	P	F	G
*Furfural	G	G	G	G
Gasoline, leaded	G	P	F	VG
Gasoline, unleaded	G	P	F	VG
Glycerine	VG	VG	VG	VG
Hexane	F	P	P	G
Hydrochloric acid	VG	G	G	G
Hydrofluoric acid (48%)	VG	G	G	G
Hydrogen peroxide (30%)	G	G	G	G
Hydroquinone	G	G	G	F
Isooctane	F	P	P	VG
Isopropyl alcohol	VG	VG	VG	VG
Kerosene	VG	F	F	VG
Ketones	G	VG	VG	P
Lacquer thinners	G	F	F	P
Lactic acid (85%)	VG	VG	VG	VG
Lauric acid (36%)	VG	F	VG	VG
Lineoleic acid	VG	P	F	G
Linseed oil	VG	P	F	VG
Maleic acid	VG	VG	VG	VG
Methyl alcohol	VG	VG	VG	VG
Methylamine	F	F	G	G
Methyl bromide	G	F	G	F
*Methyl chloride	P	P	P	P
*Methyl ethyl ketone	G	G	VG	P
*Methyl isobutyl ketone	F	F	VG	P
Methyl methacrylate	G	G	VG	F
Monoethanolamine	VG	G	VG	VG
Morpholine	VG	VG	VG	G
Chemical	**Neoprene**	**Natural Latex or Rubber**	**Butyl**	**Nitrile**
Naphthalene	G	F	F	G
Naphthas, aliphatic	VG	F	F	VG
Naphthas, aromatic	G	P	P	G
*Nitric acid	G	F	F	F
Nitromethane (95.5%)	F	P	F	F
Nitropropane (95.5%)	F	P	F	F
Octyl alcohol	VG	VG	VG	VG
Oleic acid	VG	F	G	VG
Oxalic acid	VG	VG	VG	VG

Palmitic acid	VG	VG	VG	VG
Perchloric acid (60%)	VG	F	G	G
Perchloroethylene	F	P	P	G
Petroleum distillates (naphtha)	G	P	P	VG
Phenol	VG	F	G	F
Phosphoric acid	VG	G	VG	VG
Potassium hydroxide	VG	VG	VG	VG
Propyl acetate	G	F	G	F
Propyl alcohol	VG	VG	VG	VG
Propyl alcohol (iso)	VG	VG	VG	VG
Sodium hydroxide	VG	VG	VG	VG
Styrene	P	P	P	F
Stryene (100%)	P	P	P	F
Sulfuric acid	G	G	G	G
Tannic acid (65%)	VG	VG	VG	VG
Tetrahydrofuran	P	F	F	F
*Toluene	F	P	P	F
Toluene diisocyanate	F	G	G	F
*Trichloroethylene	F	F	P	G
Triethanolamine	VG	G	G	VG
Tung oil	VG	P	F	VG
Turpentine	G	F	F	VG
*Xylene	P	P	P	F

***Limited service**	**VG= Very Good**	**G= Good**	**F=Fair**	**P=Poor (not recommended)**

NFPA 704 Hazard Identification System

The National Fire Protection Agency (NFPA), in section 704 of the National Fire Code, specifies a system for identifying the hazards associated with materials. Information contained on this and linked pages comes directly from the 1990 edition of NFPA 704. Although the system was developed primarily with the needs of fire protection agencies in mind, it is of value to anyone, including someone enrolled in a chemistry laboratory course, who needs to handle potentially hazardous material.

The hazard identification signal is a color-coded array of four numbers or letters arranged in a diamond shape. An example is shown below. You will see hazard diamonds like this on trucks, storage tanks, bottles of chemicals, and in various other places around campus and around town. The blue, red, and yellow fields (health, flammability, and reactivity) all use a numbering scale ranging from 0 to 4. A value of zero means that the material poses essentially no hazard; a rating of four indicates extreme danger. The fourth value (associated with white) tends to be more variable, both in meaning and in what letters or numbers are written there. Please note that in the introductory chemistry labs at the University of Oregon, we do not use the NFPA-specified symbols in the white field. Instead, we use an alternative set of symbols that indicate the kind of protective gear that should be used when handling the material. These alternative symbols are drawn from the HMIG system, which differs somewhat from the NFPA system.

Select one of the four diamonds to get more information.

Red | Blue | Yellow | White

NFPA Hazard Identification System

Flammability

Susceptibility of Material to Burning.

(Red)

A note about the word inflammable:
Inflammable means the material **will** burn. Think of "inflammation" -- if you have an inflamed wound, it is red and hot to the touch. As recently as about 15 years ago, trucks and containers were marked "inflammable" if they contained material that could burn (material that won't burn is called non-inflammable). The problem was that many people assumed inflammable meant that a material would *not* burn -- a potentially deadly mistake. Today, the word "flammable" has replaced "inflammable" almost entirely, but don't be confused if you encounter the older term.

0	Material will not burn.	Example: water
1	Material must be pre-heated before ignition can occur.	Example: corn oil
2	Material must be moderately heated or exposed to relatively high ambient temperature before ignition can occur.	Example: diesel fuel oil
3	Liquids and solids that can be ignited under almost all ambient temperature conditions.	Example: gasoline
4	Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or that are readily dispersed in air and that will burn readily.	Example: propane gas

NFPA Hazard Identification System Health Hazard

Type of Possible Injury.

(Blue)

A discussion of health hazards and the terminology used to describe them is given in Appendix A of the OSHA Hazard Communication Standard (29 CFR 1910.1200 App A).

0	Material that on exposure under fire conditions would offer no hazard beyond that of ordinary combustible material.	Example: peanut oil
1	Material that on exposure would cause irritation but only minor residual injury.	Example: turpentine
2	Material that on intense or continued but not chronic exposure could cause temporary incapacitation or possible residual injury.	Example: ammonia gas
3	Material that on short exposure could cause serious temporary or residual injury.	Example: chlorine gas
4	Material that on very short exposure could cause death or major residual injury.	Example: hydrogen cyanide

NFPA Hazard Identification System

Reactivity

Susceptibility of Material to Burning.

(Yellow)		
0	Material that in itself is normally stable, even under fire exposure conditions, and is not reactive with water.	Example: liquid nitrogen
1	Material that in itself is normally stable, but which can become unstable at elevated temperatures and pressures.	Example: phosphorus (red or white)
2	Material that readily undergoes violent chemical change at elevated temperatures and pressures or which reacts violently with water or which may form explosive mixtures with water.	Example: calcium metal
3	Material that in itself is capable of detonation or explosive decomposition or reaction but requires a strong initiating source or which must be heated under confinement before initiation or which reacts explosively with water.	Example: fluorine gas
4	Material that in itself is readily capable of detonation or of explosive decomposition or reaction at normal temperatures and pressures.	Example: trinitrotoluene (TNT)

NFPA Hazard Identification System

Special Precautions
Protective Gear Required
(White)

Special Precautions
The fourth, white, field of the hazard signal can have variable content, depending on who prepared the signal. The 1990 edition of the National Fire Codes (section 704, chapter 5) specifies only two symbols. Additional symbols are commonly included. The field may also be left blank if no special hazards are present.

Protective Gear Required
An alternative set of symbols from the Lab Safety Supply Inc. HMIG labeling system is used in the introductory chemistry laboratory at the University of Oregon. These symbols indicate the type(s) of protective equipment that must be used whenever the material in question is handled. The symbols are the letters A - K and X, with 'A' indicating that goggles must be worn, and successive letters indicating progressively greater amounts of protective gear. A full description of the symbols used is found on posters placed at various points around the lab.

Symbols specified in National Fire Codes, section 704		
	Material shows unusual reactivity with water (i.e. don't put water on it).	Example: magnesium metal
OX	Material possesses oxidizing properties.	Example: ammonium nitrate (fertilizer used in Oklahoma City bomb)
Other symbols commonly used		
ACID	Material is an acid.	
ALK	Material is a base (alkaline).	
COR	Material is corrosive.	
	Material is radioactive.	

Material Safety Data Sheets

The Material Safety Data Sheet, or MSDS, is a document that gives detailed information about a material and about any hazards associated with the material. The Hazard Communication Standard sets forth certain responsibilities having to do with MSDSs.

- It is the responsibility of the manufacturer of a material to determine what hazards are associated with the material, to prepare an MSDS for the material, and to provide the MSDS to any recipients of the material.
- It is the responsibility of an employer to provide MSDSs and training in their interpretation to the employees. MSDSs for hazardous materials must be immediately available in the workplace.
- It is the responsibility of the employees to read and understand the MSDSs of any chemicals used on the job.

OSHA specifies that each MSDS must include, at a minimum, the information listed in the twelve sections below. Beyond that, OSHA does not specify the exact format of the MSDS, nor even how the information should be broken into sections, and so MSDSs prepared by different manufacturers tend to look different and contain different information. Even MSDSs for the same chemical can be quite different if they were prepared by different manufacturers.

Material Safety Data Sheets are present in the general chemistry laboratory classroom at the University of Oregon in a yellow three-ring binder. The contents are sorted by lab, so all of the MSDSs for materials used in a particular lab should be grouped together. You are strongly encouraged to inspect these MSDSs before you begin your lab work.

Many MSDSs are also available on the World Wide Web, and from the Office of Environmental Health and Safety located by Onyx Bridge near the entrance to the science library.

OSHA Mandated MSDS Information

Item I: Chemical Identity
The chemical identity as listed on the label, the material's chemical and common names, and a list of all hazardous ingredients.

Item II: Physical Data
Physical and chemical characteristics, such as vapor pressure, flash point, density, boiling point, etc.

Item III: Physical Hazards
Fire and explosion data. Reactivity data. These usually appear as two separate sections on the actual MSDS.

Item IV: Health Hazards

Signs and symptoms of exposure, and any medical conditions generally recognized as being aggravated by exposure to the material.

Item V: Primary Route(s) of Entry
The route(s) by which the material could most likely enter the body.

Item VI: Exposure Limits
Legal exposure limits (OSHA and other recommended limits). This frequently includes toxicity information.

Item VII: Whether the Material is Carcinogenic
States whether the material has been found to be carcinogenic.

Item VIII: Precautions for Safe Handling and Use
Any precautions for safe handling and use know to the party preparing the MSDS, such as appropriate hygienic practices, protective measures required during handling of contaminated equipment, and procedures for clean-up of spills and leaks.

Item IX: Control Measures
Any control measures known to the party preparing the MSDS, such as engineering controls, work practices, or personal protective equipment.

Item X: Emergency and First-Aid Measures
Self explanatory.

Item XI: Revision Data
Date of preparation of the MSDS, and the date of the last change to it.

Item XII: Manufacturer Contact Information
Name, address, and telephone number of the party responsible for the MSDS, who can provide additional information about the material if necessary.