LAB SAFETY MANUAL

PHONE NUMBERS

FOR EMERGENCY CALL: 911

When reporting an emergency:

- Give the building and room number
- Nature of the emergency
- The number you are calling from
- Your name

OTHER NUMBERS:

The Science Support Center:	6489	Lab I, 2059
Security / Police Services:	6140	Sem I, 2150
Poison Control Center:	9-1-800-542-6319	

If using a hall phone, dial "0", tell the operator it is an emergency, and ask them to dial the above number

Environmental Health and Safety:	6111	Lab II, 1265
Building Maintenance Problems:	6120	(8 am to 5 pm) Facilities
	6318	(after hours) Steam Plant

I. PURPOSE

Laboratory work is an important component of science and science education. It is in the laboratory where one learns and observes the application of theory and experimentation. Careful, logical thinking can make laboratory work a joyful and enriching experience. This manual has been written to ensure that this experience is safe and healthy. While there are state and federal safety regulations that apply specifically to employees of The Evergreen State College, our intent is to protect everyone's health and well being.

The most current edition of the Laboratory Safety Manual will be the online edition.

It is required that all individuals read and be familiar with the rules and guidelines outlined in this Laboratory Safety Manual before beginning work in any science or art lab, regardless of the nature of the work being performed.

Lab Safety Quizzes are a requirement for all programs with a science lab component and for all students working in a laboratory space. Safety quizzes must be completed at the beginning of each science program. These quizzes are only good for the current academic year.

Safety communication is mandated by state and federal regulations. These include Washington State's Hazard Communication (GHS) Rule (WAC 296-901) and Laboratory Standard "Hazardous Chemicals in Laboratories" (WAC 296-828). The Hazard Communication Standard establishes the means by which employees are informed of the health and safety hazards associated with products used on the job. The Laboratory Standard addresses hazards specifically associated with working in laboratories. Any person wanting more information on the two safety regulations may call the college's Environmental Health and Safety Office at x6111.

II. MANDATORY LAB AND STUDIO RULES

These rules apply to all individuals utilizing the science and art labs at The Evergreen State College. Violation of any of the following rules is cause for disciplinary action including forfeiture of laboratory use privileges, which may further result in loss of academic credit. Everyone is responsible for complying with the safe practices and rules set forth in this manual in addition to complying with all legal regulations governing laboratory work and the handling and disposal of chemicals and hazardous materials. If any of these rules are unclear, ask the lab staff for clarification.

Dress Code

- Shoes are required in the Lab I and Lab II buildings at all times. This includes hallways, breakout areas, and the office wing.
- Closed toed shoes and clothing providing leg covering to the knee when standing, (eg. long shorts or knee-length skirts) are mandatory in all science lab spaces, regardless of the lab activity. Footwear impermeable to liquid spills is recommended.
- Safety goggles must be worn when doing chemical work and in chemical handling and storage areas. When there is a possibility of violent reaction, a face shield or portable explosion shield must be used. Full leg covering (eg. long pants/skirts) is required when working with chemicals. Lab coats and protective gloves are recommended at all times when handling chemicals. You must limit exposed skin as much as possible. If you wear inappropriate clothing for lab, you will not be allowed to participate. Faculty may enforce more stringent clothing guidelines than those outlined here.
- During work with chemicals, flame, or biological or mechanical hazards, hair that is shoulder length or longer must be pulled back. Long, loose sleeves, jewelry, etc. must also be secured to prevent accidents.

Food, Drink, and other Personal Items

- Eating, drinking, smoking, chewing gum or tobacco, applying cosmetics or lip balm, and handling contact lenses is prohibited in the laboratory spaces.
- Do not store food or beverages in the laboratories or laboratory refrigerators. Shelves are provided in hallways to store these items. Refrigerated food storage is available in the office wings and in the Science Support Center lounge, in refrigerators labeled with " FOR FOOD STORAGE ONLY ". You or your food may be removed from the lab, and your lab privileges suspended, if this rule is not followed.
- Backpacks and coats should not be stored on lab tables or on the floor. Cubbies are

provided for storage of personal items. In order to keep the cubbies clean, no chemicals, glassware, specimens, etc. may be stored in them.

Working in the Laboratory

- It is the responsibility of the individual using chemicals or equipment to know the associated hazards of each and to handle them accordingly.
- Individuals are responsible for cleaning their workspace and properly storing chemicals, biological specimens, and supplies. Spills and glassware breakage must be dealt with immediately. Storage guidelines must be followed for long and short-term storage of chemicals (see Section V and VI).
- All chemical storage containers must be clearly labeled with contents, date, hazards and a HMIS rating label including the SDS number (see Section IV-B and IV-C). When you transfer chemicals to a new storage container, label the new container with your name and date as well as the above information. When transferring chemicals to a container for immediate use (eg. beakers, flasks, or test tubes), the container must be labeled with the contents (including concentration, where applicable), the date, and your name. For long term storage add hazards including HMIS information, and the name of the program or contract in which the work is occurring. These labels are required for all containers, including ones containing only water or other benign substances.
- Mouth pipetting is prohibited in all labs.
- Gas cylinders in the lab must be strapped or chained to a wall or bench.
- All refrigerator/freezers must be marked for one of the following:
    - FOR CHEMICAL STORAGE ONLY; or FOR STORAGE OF BIOLOGICAL SPECIMENS ONLY.
- Unauthorized work is prohibited. This includes working after hours without proper authorization and performing procedures that have not been expressly authorized by laboratory staff or faculty. Performing chemical work while alone in the lab is prohibited. When working in the labs someone must be within shouting range.
- Work areas must be prominently labeled as to the type of activity occurring and hazards associated with the area along with contact information of the individuals performing the work.
- Unattended operations continuing for several hours or overnight may occur only if approved by laboratory staff. Operations must be fail-safe in the event of a failure in power, water, gas, etc. Room lights must be left on and a warning sign posted. The warning sign must include a description of the reaction, the identity and hazards of all chemicals, and your

emergency contact information.

- It is the responsibility of anyone performing chemical work to insure proper disposal of their waste. Waste chemicals must never be disposed of in the drain or in the garbage unless permitted by law and deemed environmentally safe. Persons generating waste must abide by the waste disposal guidelines as outlined in Section VIII. If unsure of proper disposal methods, check with your lab staff or the Science Support Center.
- Wash hands thoroughly after working in the lab.

Accidents and Injuries

- All accidents, including spills and personal injuries, no matter how minor, must be reported to the lab staff or the Science Support Center, and an accident report must be submitted to the Environmental Health and Safety Officer.

SAFE & RESPONSIBLE LAB PRACTICES

On an individual case-by-case basis, exceptions may be made to the Mandatory Lab and Studio rules by the supporting lab staff. For example, when using a microscope in a chemistry lab, under certain circumstances splash goggles may be removed. In such instances, it is the responsibility of the individual requesting the exception to demonstrate that the procedure is safe.

It is the responsibility of the person supervising or sponsoring a lab activity to insure that all participants are

- Informed of the lab hazards
- Properly trained in the safe handling of chemicals and equipment
- Are following the Mandatory Lab Rules and using safe procedures.

Anyone working in a laboratory area must be familiar with emergency safety procedures. This includes knowing the location of safety equipment and how to use it, the location of the nearest phone, and specific hazards associated with any equipment and chemicals in use. See Emergency Procedures Section III.

An effort should be made toward recycling and waste reduction. In an attempt to reduce stress on the environment and limit waste and disposal costs, all materials including chemicals, glass, metals, paper and plastics should be reused and/or recycled if possible. See TESC's policy on recycling.

Reduction of the scale of chemical procedures is recommended and substitution of less toxic and/or hazardous substances is recommended.

Do not reuse chemical bottles for anything but chemicals. Used chemical bottles should be put in the yellow “used chemical bottle” buckets located in every laboratory space. They will be picked up by the Science Support Center staff, removed from the chemical inventory, washed and reused or recycled.

A NOTE TO ARTISTS

Safety applies to all disciplines, including both science and art. Many materials and procedures commonly used by artists are quite hazardous. In addition to the required reading (Section II Lab Rules and Section III Emergency Procedures), Section IV on Chemical Classes and Section VIII on Waste Disposal are important in understanding the safe handling of chemicals commonly used in the arts.

Any chemical, including solvents, dyes, glazes, etc., obtained must have a SDS (see Section IV) supplied by the manufacturer that describes any hazards of that chemical. This is required whether you obtain the chemicalthrough TESC or another source. SDS's are kept on file at the Science Support Center. Distributors are required by law to be able to provide an SDS.

There are reference books listing specific hazards associated with different procedures and processes; check the Reference list. *The Artist's Complete Health and Safety Guide* available at the TESC library is recommended. If you don't know or understand something, ask your area's staff or faculty or go to the Science Support Center in Lab I, room 2059.

In brief, the following practices are recommended:

- Know your hazards.
- Substitute with less hazardous materials, such as when using solvents (paint thinner, cleaners, etc.) whenever possible. Appendix 4 Common Solvent Properties and "The Artist's Complete Health and Safety Guide" have some examples.
- Be properly trained in the use of specialized equipment and emergency procedures specific to that equipment.
- Use appropriate safety apparatus. Personal protection includes:
    - For your eyes and face, use safety goggles and/or face shields. These are available for purchase at the bookstore, or for rental from the Science Support Center.
    - For exposed skin, use gloves and wear protective clothing. Gloves are available for purchase at the Science Support Center.
    - Protect your hearing from high noise levels.

      For respiratory protection from chemicals and dust, use proper ventilation, hoods, or respirators. Respirators must be medically fitted, and are not available for student use. However, you can work with your faculty and support staff to be assigned hood space.

III. EMERGENCY PROCEDURES

Know the locations and proper use of each piece of emergency equipment in the area:

Spill Kits	Exits
Eye Washes	First Aid Kits
Emergency Showers	Telephone
Fire Extinguishers	Fire Alarms
Emergency Gas Shut Off	

A lab reconnoiter will accompany each Lab Safety lecture. This exercise will allow you to map out the lab room you are working in, and find emergency equipment, as well as general lab equipment.

III-A. GENERAL EMERGENCY PROCEDURES

If an emergency occurs, the first concern is for the health and safety of people in the area; property damage is secondary.

- Alert co-workers in the area of the danger.
- Assess the severity of the emergency.
- Based upon the severity of the emergency, call for help

McLane Fire Dept.	**Ambulance**	**911**
The Science Support Center	**M-F 8:30am-4:30pm**	**6489**
Security / Police Services	**Evenings and Weekends**	**6140**

Evacuate the area and discourage people from re-entering before help arrives.

Campus Police Services (6140) can initiate a 911 response for you, and provide you guidance while Emergency Services are responding.

IF UNSURE OF THE SEVERITY, CALL 911.

Don't hesitate to ask for immediate help.

If you are personally involved in an emergency, send someone to the hall phone to dial 911. This person will have to stay on the line to give the operator the building name, the floor, the room number, and the nature of the emergency. Tell the person to return and tell you when emergency personnel are on the way. Do not attempt to move an unconscious person unless you know the nature of the emergency.

III-B. FIRE

PREVENTION

Fires can be prevented by eliminating the source of ignition. When working with flammable materials, consider all potential sources of ignition: open flames, sparks, electrical sparks from motors, etc. If an extremely flammable material is being used (HMIS rating of 3 or 4; see Section IV-B for information on HMIS) observe the following procedures:

- Use a fume hood
- Ensure no one in the surrounding area is using an open flame

GENERAL - WHEN A FIRE OCCURS

Prompt action may prevent small fires from getting out of control. Alert others in the area of the fire and send someone for help.

Placing an inverted beaker or a watch glass over the fire can smother small fires in glassware.

If the fire is too large to smother, evacuate the area. Only people trained in fire extinguisher use should attempt to fight the fire.

NEVER ATTEMPT TO FIGHT A FIRE ALONE.

When fighting a fire, put yourself between the fire and the exit to ensure a means of escape. If the fire can't be immediately controlled, call the fire department at **911**. Pull the alarm located by the exits and stairways in each lab building. Try to contain the fire to the lab area by closing fume hood sashes, windows, and the doors to the lab as you leave.

PEOPLE

If clothing, skin, or hair catches fire, drop to the ground and roll to smother the flames. You may need to help push the person to the ground to prevent them from running and fanning the flames. Safety showers are in or near all lab rooms, and can also be used to put out a fire. Send someone to call **911** for help.

METALS

Metal fires **cannot** be extinguished with regular extinguishers. Use a Class D fire extinguisher or sand to smother the fire (CO_2 and dry chemical extinguishers will intensify some types of metal fires). Before starting work with metals such as sodium, potassium, magnesium or powdered aluminum , check that there is sand or a Class D fire extinguisher located in your area.

Class D fire extinguishers are located in Lab 1 Room 2065 (the Science Support Center Prep Room) and Lab 2 Room 3233 (the Chemical Prep Room). You will have to coordinate with a staff member for access.

III-C. CHEMICAL SPILLS

Consider what to do in the event of a spill before starting a project. Spills may cause serious health and environmental problems if not handled correctly. Familiarity with chemical hazards and the proper spill control measures will help minimize the effects of a chemical spill. Again, the first concern is for the health and safety of the people in the area; property damage is secondary.

CHEMICAL SPILLS, GENERAL PROCEDURES

Alert co-workers in the area of the danger.

Assess the severity of the emergency. Consider the possibility of exposure through contact, inhalation, and the increased fire hazard associated with flammable materials.

Based upon your best judgment of priorities, and knowledge of the chemical, **call for help**

Emergency	**McLane Fire Dept.**	**911**
M-F 8:30am to 4:30pm	**The Science Support Center**	**6489**
Evenings and Weekends	**Security / Police Services**	**6140 or 0**

If necessary, you may need to pull the fire alarm, and/or evacuate the area and keep people from re-entering before help arrives.

The person spilling the chemical is responsible for contacting lab staff/faculty as soon as the severity of the spill allows. Minor spills not involving human contact should be contained whenever possible. Depending on the hazard and size of the spill, lab staff/faculty will either direct the person responsible to clean up the spill or perform the clean up themselves.

Anyone noticing a leak or spill is also responsible for contacting lab staff/faculty to initiate the clean up process.

Spill kits are located in every lab room. These should be found in the lab reconnoiter exercise that accompanies the safety quiz. Before any chemical experiment begins, learn how to use the spill kits: that is, the proper absorbent and the proper neutralizer for the type of spill.

CHEMICAL SPILLS ON PEOPLE

If a chemical is spilled on a person, IMMEDIATELY rinse the exposed area of the body and continue rinsing for 15 minutes. Use an eyewash station, emergency shower, or the sink to rinse the exposed area. Consult the SDS for information on any delayed bodily reactions. Notify the person in charge to fill out an Accident Report.

Eyes are extremely susceptible to chemical burns. Prompt and continued rinsing (for 15 minutes) can prevent severe eye damage. If your lab partner has a chemical splashed in their eye, you should assist them to the eyewash and ensure they rinse for the full 15 minutes, even if it is uncomfortable. Seek medical attention as soon as possible, and bring the SDS with you to the emergency room or physician's office.

In the event the spill contaminates clothing, remove all contaminated clothing and rinse the exposed area for 15 minutes. Extra clothing is available at The Science Support Center.

If the exposure is severe, someone in the area must call 911 to get paramedics on the scene. Be sure to continue rinsing the exposed areas until directed to stop by the paramedics.

In the case of minor exposures: rinse affected areas for a minimum of 15 minutes, seek medical attention, and bring the SDS with you.

SPILLS OF FLAMMABLE MATERIALS

If flammable materials have been spilled, immediately eliminate all sources of ignition. Unplug all electrical devices, extinguish open flames, etc. Absorb the material quickly with the appropriate spill absorbent, and notify your lab staff and/or faculty.

IV. CHEMICAL CLASSIFICATION

Chemical classification systems are designed to communicate hazards. The two classification systems you will see used at the Evergreen State College are the OSHA Globally Harmonized System for Classifying and Labeling Chemicals (GHS) which was recently adopted and implemented under the OSHA Hazard Communication Standard, and the Hazardous Materials Information System (HMIS)**.** These classification systems are used by chemical manufacturers when creating safety data sheets and chemical labels, which make it important for the Evergreen State College staff, faculty, and students to understand the basic elements of each classification system.

IV-A Global Harmonized System of Classification and Labeling of Chemicals (GHS)

What is the GHS?

The Globally Harmonized System for Classifying and Labeling Chemicals (GHS) is a world-wide system for standardizing and harmonizing the classification and labeling of chemicals. OSHA has adopted the GHS as the new Hazard Communication Standard (HCS) and the final deadline for compliance is June 15th, 2016.

The objectives of the GHS are to:

- Define health, physical, and environmental hazards of chemicals;
- Create classification processes that use available data on chemicals for comparison with the defined hazard criteria; and
- Communicate hazard information, as well as protective measures, on labels and Safety Data Sheets (SDS), formerly known as Material Safety Data Sheets (MSDS).

GHS Classes of Hazardous Chemicals

Chemicals can be divided into several different hazard classes. The hazard class provides information to help determine how a chemical can be safely stored and handled. Each chemical container, whether supplied by a chemical manufacturer or produced in the laboratory, must have a label that clearly identifies the chemical constituents. In addition to a specific chemical label, more comprehensive hazard information can be found by referencing the SDS for that chemical. The OSHA Laboratory Standard defines a hazardous chemical as any element, chemical compound, or mixture of elements and/or compounds which is a physical or health hazard. This definition of a hazardous chemical and the GHS primary classes of physical hazards and health hazards are briefly discussed below.

Physical Hazards

A chemical is a physical hazard if there is scientifically valid evidence that it is flammable, combustible, compressed gas, explosive, organic peroxide, oxidizer, pyrophoric, self-heating, self-reactive, or water-reactive. Each physical hazard is briefly defined below.
Refer to Appendix 1A for detailed information on each physical hazard.

- Explosives: A liquid or solid which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings.
- Flammable Liquids: Materials which under standard conditions can generate sufficient vapor to cause a fire in the presence of an ignition source and have a flash point no greater than 93 °C (200 °F).
- Flammable Solid: A solid which is readily combustible, or may cause or contribute to a fire through friction.
- Gases under Pressure: Gases which are contained in a receptacle at a pressure not less than 280 kPA at 20 °C or as a refrigerated liquid.
- Organic Peroxide: A liquid or solid which contains the bivalent -0-0- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals.
- Oxidizer: A liquid or solid, while in itself is not necessarily combustible, may generally by yielding oxygen, cause or contribute to the combustion of other material.
- Pyrophoric Substance (also called Spontaneously Combustible): A liquid or solid

that even in small quantities and without an external ignition source can ignite after coming in contact with the air.

- Self-Heating Substance: A liquid or solid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat.
- Self-Reactive Substance: A liquid or solid that is liable to undergo strong exothermic thermal decomposition even without participation of oxygen (air).
- Water-Reactive Substance: A liquid or solid that reacts violently with water to produce a flammable or toxic gas, or other hazardous conditions.

Health Hazards

A chemical is a health hazard if 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. Each health hazard is briefly defined below. Refer to Appendix 1B for detailed information on each health hazard.

- Carcinogens: Substances that cause cancer. Generally they are chronically toxic substances; that is, they cause damage after repeated or long-duration exposure, and their effects may only become evident after a long latency period. Carcinogens are separated into two classes: select carcinogens and regulated carcinogens.
- Corrosives: Substances that cause destruction of living tissue by chemical corrosion at the site of contact and can be either acidic or caustic (basic).
- Hazardous Substances with Toxic Effects on Specific Organs: Substances that pose adverse health effects to specific organs such as the liver, kidneys, lungs, etc.
- High Acute Toxicity Substances: Substances that may be fatal or cause damage to target

organs as the result of a single exposure or exposures of short duration. Acute toxins are quantified by a substance's lethal dose-50 (LD50) or lethal concentration-50 (LC50), which is the lethal dose of a compound to 50% of a laboratory tested animal population (e.g., rats, rabbits) over a specified time period.

- Irritant: Substances that cause reversible inflammatory effects on living tissue by chemical action at the site of contact.
- Reproductive Toxins: Substances that may affect the reproductive capabilities, including

chromosomal damage (mutations) and effects on fetuses (teratogens).

- Sensitizer (also called allergen): A substance that causes exposed individuals to develop an allergic reaction in normal tissue after repeated exposure to the substance.

GHS Chemical Labeling

The standardized GHS label must contain the following elements

- **Name, Address and Telephone Number** of the chemical manufacturer, importer or other responsible party
- **Product Identifier** is how the hazardous chemical is identified. The same product identifier must be both on the label and in section 1 of the SDS.
- **Signal Word** either “Danger” for more severe hazards or “Warning” for less severe hazards)
- **Hazard Statements** describe the nature of the hazards of the chemical including where appropriate the degree of hazard. For example: “Causes damage to kidneys through prolonged or repeated exposure when absorbed through the skin.”
- **Precautionary Statements** describe recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to the hazardous chemical or improper storage of handling. There are four types of statements: prevention; response; storage; and disposal.
- **Pictograms** are graphic symbols used to communicate specific information about the hazards of a chemical

GHS Pictograms and Hazards

Health Hazard 	**Flame** 	**Exclamation Mark** 
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity (harmful) • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non Mandatory)
Gas Cylinder 	**Corrosion** 	**Exploding Bomb** 
• Gases under Pressure	• Skin Corrosion/ burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame over Circle 	**Environment *(Non Mandatory)** 	**Skull and Crossbones** 
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

GHS Safety Data Sheets

The SDS is the definitive resource for the safe handling of a particular hazardous chemical as provided by the chemical manufacturer. Staff, faculty and students should familiarize themselves with the information contained in this resource, including hazards and their associated safety precautions. Chemical manufacturers are now required by the GHS to use a standard format for their SDSs. The standardized SDS contains 16 parts listed below:

1. Identification of the substance or mixture and of supplier

2. Hazards Identification

3. Composition/information on ingredients

4. First aid measures

5. Firefighting measures

6. Accidental release measures

7. Handling and storage

8. Exposure controls/personal protection

9. Physical and chemical properties

10. Stability and reactivity

11. Toxicological information

12. Ecological information

13. Disposal considerations

14. Transport considerations

15. Regulatory information

16. Other information

Especially pertinent is Section 4: First aid measures.

See Appendices X for an example of a GHS/HCS SDS

IV-B Hazardous Materials Information System (HMIS)

The Hazardous Materials Information System (HMIS) was developed by the American Coatings Association, Inc (ACA) to communicate chemical hazard information. Its labeling system uses colors, numbers, and symbols to accomplish this goal. It is currently on its third iteration HMIS® III. HMIS labels contain information on Health, Flammability, Physical Hazards (Reactivity), and Personal Protection.

The HMIS® III rating definitions in the Health, Flammability, Physical Hazards (Reactivity) categories are as follows:

HEALTH HAZARD - BLUE

* CHRONIC HAZARD - Chronic (long-term) health effects may result from repeated overexposure
0. MINIMAL HAZARD - No significant risk to health
1. SLIGHT HAZARD - Irritation or minor reversible injury possible
2. MODERATE HAZARD - Temporary or minor injury may occur
3. SERIOUS HAZARD - Major injury likely unless prompt action is taken and medical treatment is given
4. SEVERE HAZARD - Life threatening major or permanent damage may result from single or repeated overexposures

FLAMMABILITY HAZARD - RED

0. MINIMAL HAZARD - Materials that will not burn.
1. SLIGHT HAZARD - Materials that must be preheated before ignition will occur. Includes liquids, solids, and semi solids having a flash point at or above 94C (200F). (NFPA Class IIIB)
2. MODERATE HAZARD - Material which must be moderately heated or exposed to high ambient temperatures before ignition will occur. Includes flammable liquids with flash points at or above 60C (100F) but below 94C (200F). (NFPA Class II & Class IIIA)
3. SERIOUS HAZARD - Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points below 23C (73F) and boiling points above 100F as well as liquids with flash points between 23C (73F) and 60C (100F). (NFPA Classes IB and IC)

4. SEVERE HAZARD - Flammable gases or very volatile flammable liquids with flash points below 23C (73F) and boiling points below 60C (100F). (NFPA Class IA)

PHYSICAL HAZARD (REACTIVITY) – ORANGE (YELLOW)

0. MINIMAL HAZARD - Materials that are normally stable, even under fire conditions, and will NOT react with water, polymerize, decompose, condense, or self-react. Non-Explosives.
1. SLIGHT HAZARD - Materials that are normally stable but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.
2. MODERATE HAZARD - Materials that are unstable and may undergo violent chemical changes at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.
3. SERIOUS HAZARD - Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong initiating source. Materials may polymerize, decompose, self-react, or undergo other chemical change at normal temperature and pressure with moderate risk of explosion.
4. SEVERE HAZARD - Materials that are readily capable of explosive water reaction, detonation orexplosive decomposition, polymerization, or self-reaction at normal temperature and pressure.

Similarly, The Evergreen State College (TESC) uses a numerical rating for Personal Protective Equipment (PPE).

PERSONAL PROTECTION – WHITE

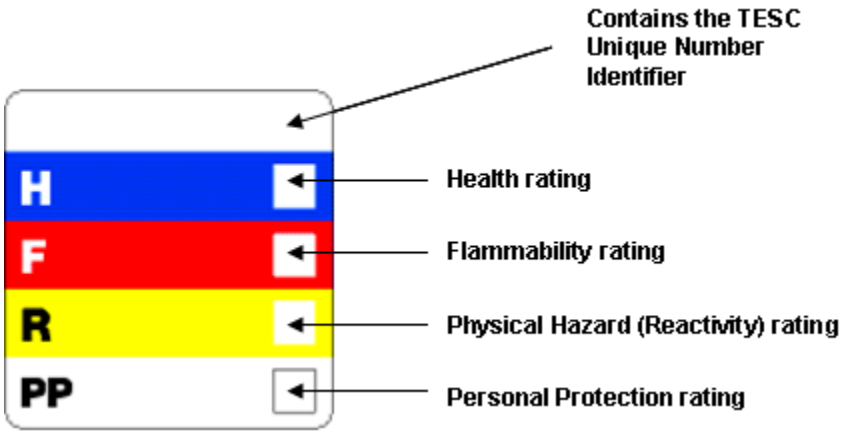
IMPORTANT: You should always use the appropriate PPE for the associated chemical hazard. Ask the lab faculty/staff or your supervisor if you have questions regarding the PPE requirements for a particular chemical.

0. MINIMAL HAZARD – No Personal Protection equipment required.
1. SLIGHT HAZARD – Chemical safety goggles and gloves recommended.
2. MODERATE HAZARD – Chemical safety goggles and gloves required. Chemical apron or lab coat recommended. Fume hood ventilation recommended.
3. SERIOUS HAZARD – Chemical safety goggles and gloves required. Chemical apron or lab coat recommended. Fume hood ventilation required.
4. SEVERE HAZARD – Chemical safety goggles and gloves required. Chemical apron or

lab coat required. Fume hood ventilation required. Depending on the hazard, a blast shield, face shield, or respirator may also necessary.

At TESC, HMIS labels also contain a unique chemical number identifier. This information can be used to look up a chemical in our database or find a Safety Data Sheet (SDS) (formerly Material Safety Data Sheet, MSDS). A complete collection of SDS's are located in the Science Support Center.

Below is a standard HMIS label you would find on a chemical bottle here at TESC.



As an example, a HMIS label for acetone with a rating of Health = 2 (chronic hazard), Flammability = 3, Physical Hazard (Reactivity) = 0, Physical Protection = 2,, and a SDS number of 5014 would look like:

Other Classification Systems

Other classification systems exist and also provide useful information. Different systems are

used by different chemical manufacturers and may be present in addition to the GHS and HMIS information. These include the National Fire Protection Association system (NFPA), the Department of Transportation placards (DOT), the United National Labeling System, and the American National Standards Institute (ANSI) labeling system.

References

American Coatings Association, Inc. (2001). HMIS® III Implementation Manual, 3rd ed. Retrieved from http://www.paint.org/component/docman/doc_download/32-general-information-on-the-new-hmisr-iii.html

American Coatings Association, Inc. (2001). Explanation of the HMIS® Ratings. Retrieved from http://www.paint.org/component/docman/doc_download/33-hmisr-ratings.html

IV-C. OBTAINING CHEMICALS CHEMICAL FACT SHEETS

A student requesting chemicals is required to complete a **Chemical Fact Sheet** (see Appendix 3 Example of the Chemical Fact Sheet). This form requires the student to identify the dangers associated with the particular chemical (as noted in the SDS and other references), and to obtain faculty or staff authorization for their work with that chemical. It also requires the student to determine the proper disposal method for the chemical. (see Section VIII on Waste Disposal)

IV-D LABELING

All chemical containers, such as bottles, flasks, beakers, or vials, must be thoroughly labeled. You should label the container before anything is added to avoid confusion.

Each chemical container (including water) must be labeled with the following information:

- **NAME OF CHEMICAL**
- **CONCENTRATION** (if applicable)
- **DATE**
- **YOUR NAME**

For long-term storage (storage longer than a lab session), you must also have the following information:

- **PROGRAM NAME**
- **HAZARDS AND HANDLING PRECAUTIONS**
- **HMIS LABEL WITH THE SDS NUMBER AND HAZARD RATINGS**

Depending on the situation, other information that may be required by the science faculty/staff.

- Your contact information
- Hold until date
- Project completion date

It is best to label the container with a numerical rating supplemented by cautionary words. For example, a compound labeled with the rating H=3, F=0, R=3 is certain to be a health hazard and a compound you wouldn't want on your skin, but if you know it is concentrated sulfuric acid and it is labeled CORROSIVE, CONCENTRATED ACID, CAUSES SEVERE BURNS, you could make some additional educated decisions about how to handle it. You know that it will react with certain classes of materials (you wouldn't store it in a metal container) and you should know how to handle strong acids and acid spills. The label information however, does not replace reading the SDS or other reference material.

V. BIOLOGICAL MATERIALS

HUMAN BLOOD AND OTHER POTENTIALLY INFECTIOUS HUMAN MATERIALS

The bloodborne pathogens regulations found in the Washington Administrative Code, Part 296-823, are applicable to a number of materials related to human blood and some laboratory activities at the Evergreen State College.

The list of materials included under the Bloodborne Pathogens Standard includes the following

- Human blood
- Human blood components
- Products made from human blood
- Semen
- Vaginal secretions
- Cerebrospinal fluid
- Synovial fluid
- Pleural fluid
- Pericardial fluid
- Peritoneal fluid
- Saliva in dental procedures
- Any body fluid visibly contaminated with blood
- Any unfixed tissue or organ (other than intact skin) from a human, living or dead
- HIV- or HBV- containing cell or tissue cultures, organ cultures, and culture medium or other solutions
- Blood, organs, or other tissues from experimental animals infected with HIV or HBV

In accordance with recommendations of the Centers for Disease Control and the National Institutes of Health in the document Biosafety in Microbiological and Biomedical Laboratories (HHS Publication No. 88-8395), laboratory activities involving materials in the above list, and other human clinical specimens, body fluids, and untreated tissues shall be handled using Biosafety Level 2 practices, containment equipment, and facilities.

WORKING WITH HUMAN BODILY FLUIDS

There are specific requirements that must be met before you can begin working with human bodily fluids, including your own.

- Any experimentation on humans must be approved by the Human Subjects Review Committee.
- You must receive blood borne pathogen training through TESC.
- You may only use TESC approved methods.
- You must read and sign the informed consent form.

When working with human bodily fluids, including your own, keep the following in mind.

- Gloves must be worn when working with human blood and potentially infectious human materials.
- All sharp instruments, including blood lancets, needles, scalpels, razor blades, etc., must be placed in a special container for disposal (red plastic "Sharps" container). Empty containers are available from the Science Support Center. Full containers will be shipped for appropriate disposal by lab staff.
- Any labware (beakers, blunt instruments) and equipment in contact with body fluids must be sterilized after use, as directed by staff or faculty.
- Sterilization may be accomplished by autoclaving for minimum of 30 minutes at 121°C and 15psi

CHEMICAL DISINFECTANTS AND THEIR USE IN INFECTION CONTROL

Sodium hypochlorite is readily available and inexpensive. Commercial products are 5-6% aqueous solutions. Sodium hypochlorite is used to decontaminate surfaces; in waste containers for used pipettes, tips and swabs; and to clean up spills. Bleach is corrosive to metals and should be used sparingly on stainless steel. Metal surfaces that have been treated with bleach should be "rinsed" with 70% ethanol.

• **Routine benchtop disinfection**

Ten percent dilutions of commercially available bleach are suitable for general use to disinfect tabletops and work areas. Spray the 10% bleach solution on the benchtop, wipe the entire surface, and allow to air dry. **Mix 100 ml bleach with 900 ml dwater for a 10% solution.**

• **Disinfecting a spill**

A stronger solution of bleach (25% dilution) should be used to clean up spills and in discard containers for used pipettes, tips and swabs. Following a spill, everyone in the lab should be made aware that there is a spill. Cover the spill with paper towels and **pour** disinfectant around and over the spill. Saturate the area with bleach and allow to remain undisturbed for 15 to 30 minutes. After that, place paper towels in the biohazard bag to be autoclaved. Then, spray bleach solution over the entire area and wipe it down one more time. **Mix 250 ml of bleach with 750 ml dwater for a 25% solution.**

Sodium hypochlorite solutions should be mixed fresh weekly.

Alcohols (ethanol and isopropanol) are most effective as 70% solutions. Inactivation of organic debris is a hydrolytic reaction. Alcohols are highly flammable and should not be used near an open flame. Alcohols are effective at decontaminating stainless steel surfaces, such as those in biosafety cabinets. Alcohols can be used to remove residual bleach from metals to minimize corrosion.

Incubators, chemical fume hoods, and biological safety cabinets should be thoroughly disinfected monthly.

(From the American Society for Microbiology's *Appendix to the Guidelines for Biosafety in Teaching Laboratories* 2012)

MICROBIOLOGICAL ORGANISMS

The Evergreen State College follows guidelines published by the American Society of Microbiology (*Guidelines for Biosafety in Teaching Laboratories, ASM 2012*) to establish best practices and safe handling of microbiological organisms. These guidelines are designed to encourage user awareness of potential risks of working with microbiological organisms and to promote the health and wellness of faculty, staff, students, and visitors.

1. Never place books, backpacks, purses, etc., on bench tops. Always place these in the assigned cubicles. Pens and lab notebooks should be kept away from the immediate work area.

2. Clean your work area with dilute bleach solution at the beginning AND end of each lab.

3. Wash your hands with soap and dry with paper towels when entering and leaving the lab.

4. Wear a lab coat at all times while working in the lab to prevent contamination or accidental staining of your clothing.

A. Closed-toe shoes (no sandals) are to be worn in the lab.

B. Long hair must be tied back to prevent exposure to flame and contamination of cultures.

C. Gloves should be worn when staining microbes and handling hazardous chemicals.

5 Do not place anything in your mouth or eyes while in the lab. This includes pencils, food, and fingers. Keep your hands away from your mouth and eyes.

A. Eating and drinking are prohibited in the lab at all times.

B. This includes gum, cough drops, and candy.

C. Do not apply cosmetics in the lab. This includes Chapstick and Blistex.

D. Never pipet by mouth. Use a mechanical pipetting device.

6. Do not remove media, equipment, or bacterial cultures from the laboratory. This is absolutely prohibited and unnecessary.

7. Do not place contaminated instruments such as inoculating loops, needles, and pipettes on bench tops. Loops and needles should be sterilized by incineration, and pipettes should be disposed of in designated receptacles of bleach solution.

8. Carry cultures in a test tube rack when moving around the lab or when keeping cultures on bench tops for use. This prevents accidents and contamination of your person or belongings.

9. Immediately cover spilled cultures or broken culture tubes with paper towels and then saturate them with disinfectant solution. Notify your instructor that there has been a spill. After 15 minutes, dispose of the towels and broken items as indicated by your instructor.

10. Report accidental cuts or burns to the instructor immediately.

11. At the end of each lab session, place all cultures and materials in the proper disposal area.

12. Persons who are immune-compromised (including those who are pregnant or may become pregnant) and students living with or caring for an immune-compromised individual are advised to consult with your physician to determine the appropriate level of participation in the lab. Should your physiciandetermine that you should not participate in this lab, please have him or her write a note stating the concerns. Alternative accommodations may be indicated.

PRESERVED SPECIMENS

Any specimen preserved with a chemical must be treated at the same safety level as that chemical.

If that chemical is toxic, such as formaldehyde, then appropriate safety measures such as eye protection, exposed skin protection, and proper hood use must be followed. In addition to being a suspected carcinogen, formaldehyde is corrosive; specimens must be stored in a non-metal container. For disposal, the specimen must be treated as regulated hazardous waste. Formaldehyde-treated specimens and any other hazardous preserved specimens must be properly bagged and labeled, and then disposal arranged with lab staff (see section IV-A for additional recommendations regarding use of formaldehyde).

Most specimens are now stored in an alcohol that is much less toxic than formaldehyde.

VI. CHEMICAL STORAGE

A properly designed chemical storage area must first address safety and legal issues and then provide a convenient way to organize over 5000 chemicals used in the science labs. First, chemicals are separated by solids, liquids, and gases. Incompatible chemicals are segregated and hazardous chemicals are stored in special systems designed to prevent and control their hazards, such as explosion-proof refrigerators, ventilated flammables cabinets, acid cabinets, etc. Incompatible chemicals are chemicals that have potential for a violent reaction with each other (examples of specific incompatible chemicals are listed in Appendix 7). Hazardous chemicals (for storage definition) are chemicals with any HMIS category rating greater than 2.

Permanent storage areas are in two main designated areas located in Lab II, although chemicals may also be found in many of the research labs. Locations of all chemicals are listed in the Chemical Inventory in the Science Support Center. The permanent storage areas are designed to both ensure safe storage and for convenient organization.

General Guidlelines:

- Date all chemicals when received and opened.
- Inventory annually, checking dates, condition, and amounts. Check particularly for ethers and peroxide forming materials, and discard within one year of opening.
- Avoid storing hazardous chemicals above eye level.
- Do not store chemical containers on the floor.
- Open shelves must have lips or doors to prevent bottles from slipping off.
- Any chemicals left unattended for ANY length of time must be stored in a closed container and properly labeled with name, date, program, chemical name(s), and concentration.
- Keep incompatible chemicals separated.
- Select an appropriate container (see Section IX-B Selection and Use of Equipment and Appendix 8 Maximum Allowable Container Capacity for Flammable Liquids).
- Store away from heat and direct sunlight.
- Segregate bottles of chemicals in plastic tubs to contain any spills and maintain separation.
- For temporary storage, non-hazardous chemicals should be stored at the rear of a counter or in the center of an island.
- Hazardous chemicals are to be stored in a fume hood or vented cabinet.
- Volatiles and flammables requiring refrigeration must be stored in an explosion-proof refrigerator (see the Science Support Center for locations).

- All chemicals must be returned to their permanent designated storage areas. The designated storage areas are indicated on a red sticker on each bottle and also in the Science Support Center's Chemical Inventory.

Hazardous chemicals are segregated into the following special classes and storage facilities:

- **FLAMMABLES** such as **acetone** and **hexane** must be stored in a flammables' cabinet. There are restrictions on the total quantity of flammables that can be stored and in what type of containers. See Appendix 8 Maximum Allowable Container Capacity for Flammable Liquids, for details.
- **INORGANIC ACIDS** such as **hydrochloric acid** and **sulfuric acid** (excluding nitric and perchloric acid) must be stored in designated cabinets. Store hydrofluoric acid in plastic containers.
- **NITRIC ACID** must be stored in a separate, dedicated cabinet with spill trays.
- **PERCHLORIC ACID** must be stored in a separate, dedicated cabinet.
- **ORGANIC ACIDS**, such as **acetic acid**, must be stored in designated cabinets.
- **BASES**, such as **sodium hydroxide** and **ammonia,** must be stored in designated cabinets. Store strong bases (NaOH) in plastic containers.
- **REFRIGERATED FLAMMABLES** and **VOLATILES** including **ether** and **epoxides,** must be stored in explosion-proof refrigerators.
- **OTHER REFRIGERATED NON-VOLATILE, NON-FLAMMABLE CHEMICALS** such as **water samples** or **vitamins** can be stored in a standard refrigerator labeled "FOR CHEMICALS ONLY".
- **REFRIGERATED BIOLOGICAL SAMPLES**, including **preserved specimens**, should be stored in a refrigerator labeled "FOR BIOLOGICAL SAMPLES ONLY".
- **ORGANIC POISONS, TOXINS, CARCINOGENS** such as **benzene** should be stored in a secured area.
- **INORGANIC POISONS, TOXINS, CARCINOGENS** such as **mercury** should be stored in a secured area with spill containers.
- **WATER REACTIVE CHEMICALS**, including **sodium metal** and **hydrides** must be stored under kerosene or away from water.
- **COMPRESSED GASES** such as **helium** and **oxygen** should be stored in a dry, well ventilated, and secured area. Cylinders must be stored in a secured, upright position with caps on. Gases are separated from each other by hazard classes (oxidizers, etc.).

VII. TRANSPORTING CHEMICALS

The level of care and protection needed to transport a chemical must match the potential hazards of the chemical. This requires knowledge of the hazards associated with the chemical in transport and knowledge of protective measures.

BOTTLES AND JARS

Secondary containment containers are available for transportation. Acid buckets, carts, and plastic tubs are available at The Science Support Center. All chemicals must be placed in secondary containment while in transport. Acid buckets and plastic tubs are available from The Science Support Center. Transport incompatible chemicals separately; place incompatible chemicals in separate carriers. All concentrated acids and bases must be carried in acid carriers. Use care when crossing the thresholds between the lab buildings. It is recommended to use the connecting basement level between Lab I and Lab II to avoid thresholds, extra doors, uneven surfaces and inclement weather.

Do not ride the elevator when transporting volatile chemicals. Label the cart "Do not ride with this elevator," send the cart up the elevator, and walk up the stairs to meet it. **If the elevator breaks down, you do not want to be trapped in a small space with volatile and hazardous chemicals.**

GAS CYLINDERS

Never transport cylinders with the regulator on. Before moving gas cylinders, insure that the valve cap is on. Use a gas cylinder hand truck for transport, and secure the cylinder to the truck with strap or chain. If the cylinder cart is collapsible, make sure you always push the cart instead of pull. The yellow carts can collapse when pulled over a threshold if you are not careful. Secure the cylinder to a counter or table before removing the valve cover.

Never ride the elevator with self-venting gas tanks (typically gases in liquid form). You could suffocate if trapped in the elevator with the tank.

DRY ICE

When transporting dry ice in a vehicle, keep it cool in the trunk, and **keep the windows open at all times.** The solid CO_2 is constantly subliming and could potentially suffocate you.

VIII. WASTE DISPOSAL

INTRODUCTION

A hazardous waste is a solid, liquid, or gas that poses a danger to human health or the environment. The generation and proper disposal of hazardous chemical waste is an issue of important legal and moral concern for this college. The college has an obligation to provide a safe environment for students and employees and to ensure that our hazardous waste is safely disposed of or treated.

REGULATORY BACKGROUND

Several federal, state, and local agencies may regulate laboratory hazardous wastes. These agencies could include the federal Environmental Protection Agency, the state Department of Ecology and Department of Labor and Industries, local fire department, and local sewer district.

Laboratories in non-compliance with hazardous waste regulations can be assessed significant fines and penalties. The college has established and supports a laboratory waste management policy. The Environmental Health and Safety Officer has the responsibility for coordinating hazardous materials management and ensuring regulatory compliance. Management activities include training of staff, faculty, and students, record keeping, supervision of the waste treatment laboratory, and acting as an information resource to the lab area.

All generators of hazardous waste at the college should adopt management practices, which ensure careful management of chemicals and waste liquids. Staff and faculty can greatly reduce the quantity of waste generated through substitution of less hazardous chemicals and/or reduction of quantities used. In-lab treatments of waste by methods such as evaporation, separation, and neutralization can also help reduce the quantity of waste.

HAZARDOUS WASTE

In a lab program, the lab staff will decide whether waste must be collected for hazardous waste disposal. If you are involved in a project, you will determine what needs to be done with the waste before you start the project. When your experiment is completed or when the waste container is full, contact the lab staff for pick up. DO NOT BRING YOUR WASTE TO THE SCIENCE SUPPORT CENTER. Make sure your waste is well labeled at all times.

Pack your waste in a labeled, clean, non-leaking, capped container suitable for each particular waste products. Don't use stoppers (rubber or ground glass) or corks. Solid waste may be stored in a properly labeled Ziploc freezer bag. Waste is accumulated and temporarily stored in the waste lab. When sufficient quantities are in hand, it is packaged for disposal by a commercial waste disposal vendor.

IX. SAFE LAB TECHNIQUES

Safe lab technique requires knowledge of the correct type and use of equipment along with proper procedures. While each experiment will have specific procedures and cautions, some common equipment and techniques are listed here. Always know the proper techniques BEFORE starting any experiment.

IX-A. EQUIPMENT

Lab glassware is either SOFT or HARD glass. Below are characteristics of each:

SOFT GLASS

- Also called Flint glass
- Made from straight silicate
- Susceptible to thermal shock
- Softens easily in flame
- Costs less
- Should never be heated
- Best for chemical storage
- Comes in clear or brown
- Easily recycled

HARD GLASS

- Also called Pyrex or Kimax
- Made from boro- or alumino-silicate
- Resistant to thermal shock
- Needs oxygen-gas flame to manipulate
- Costs more
- Can be heated safely
- Best for lab work
- Generally comes in clear only
- Cannot be recycled

****See Appendix 9, "COMMON GLASSWARE," for further information.**

TYPES OF PLASTIC AND RUBBER

PLASTICS

The two most common plastics used in labware are polyethylene (PE, LDPE, HDPE) and polypropylene (PP). Other plastics sometimes used in labware are polycarbonate (PC), polystyrene (PS), Teflon (PTFE) and polyallomer (PPCO). Both PE and PP are resistant to most common lab chemicals. See Appendix 10 or online (one example: http://www.millerplastics.net/chemical_resistance_chart.html) for more complete information.

AUTOCLAVABLE PLASTICS

Not all types of plastics are autoclavable. Generally for experiments that require the sterilization of your plastic containers, use polypropylene (PP). A useful mnemonic is that, for autoclaving, **"Polypropylene is proper".**

Not only is Teflon chemically resistant to most everything, it can be heated up to around 200 °C. It is used for such things as cap liners, special bottles, beakers for digestions, and sealer in gas lines. However it is significantly more expensive than other plastics and has very limited availability at the Science Support Center.

Polycarbonate and Mylar can also be autoclaved, but polystyrene, Polyvinyl chloride (PVC), and most other plastics will melt at 121°C. See the list next to the autoclave in Lab I, 2052, or ask lab staff for assistance if you have questions.

RUBBER/LATEX

Rubber in the lab is found primarily in the following five places:

- Gloves
- Flexible tubing
- Rubber stoppers
- Gaskets and septa
- Bottle-cap liners

The most common rubber and plastic compounds used in the lab are the following:

- Natural rubber – Black, Red, or Amber (most often called Latex)

- Nitrile – Blue, Purple, Green, or Black
- Neoprene – Blue or Black
- Poly Vinyl Chloride or PVC – Clear; PVC tubing also known as Tygon

It is imperative that you choose carefully which compounds to use in each situation. Latex gloves, for instance, will dissolve in many organic liquids (solvents); the wrong time to discover this is as it is happening to you. Similarly, PVC tubing or polyvinyl bottle-cap liners might not be the best materials to use with your chemical compounds. See Appendix 10 and the resistance charts for more information.

IX-B. SELECTION AND USE OF EQUIPMENT

- Know your equipment
- Know your procedure
- Take your time
- Don't compromise the safety of yourself or your equipment

ASSEMBLING APPARATUS

- Know all pieces you are using and be sure they are compatible with each other.
- Properly clamp and support all pieces of equipment.
- Do not place equipment on the floor.
- Choose an appropriate location for your set-up, ensuring there is sufficient space and access to needed facilities (such as water lines, air lines, etc.) and safety equipment.
- Assemble in a hood and/or use explosion shields for any hazardous operations. Use hood if any flammable or toxic vapors are generated.
- Plan for utilities failure and fluctuations. Secure by wiring on water tubing lines; anticipate a power failure and surge.

HEATING

- Use hot plate/stirrers, heating mantles, sand baths, and/or water baths for heating. Avoid using Bunsen burners. DO NOT use Bunsen burners when flammable materials (including vapors) are present.
- Use only hard glass, (Pyrex or Kimax). Make sure it is the appropriate size, is stable or clamped, and that it is properly vented. Wide mouthed containers such as beakers allow quicker and less violent evaporation
- Use hood if evolved products are flammable, explosive, or toxic.
- Use boiling chips or stones to prevent bumping and spattering. Check that the chips are compatible with your solution - some types CANNOT be used with certain strong acids, etc.

MIXING

- Use a container such as a beaker, Erlenmeyer flask, or round bottom flask for mixing and/or heating.
- Volumetric glassware, such as volumetric flasks, are designed only for measuring. Heating volumetric glassware may compromise the accuracy of the calibration.
- Volumetric glassware should not be used with anything that could scratch its inner surfaces such as glass stirring rod.

STORING

- Chemical resistance charts will help determine proper storage containers.
- Don't store solutions in volumetric glassware.
- Use plastic-coated glass safety bottles when storing strong acids or especially hazardous chemicals.
- Always ensure that the lid or stopper is made of material resistant to attack by the stored chemical. Don't use metal-foil lined lids when storing strong acids, or plastic lids when storing xylene.
- Standard taper ground glass stoppers stick easily in bottles, especially when used with strong bases or concentrated salts.

WEIGHING

- Use a container that will not react with what you are weighing.
- Use a completely clean container.
- If weighing a hazardous chemical (HMIS > 2), use a balance in a hood, along with appropriate eye protection and gloves.
- When weighing a volatile compound, be sure container is covered.

USING REDUCED PRESSURE (VACUUM)

- PROTECT YOUR EYES! LAB GLASSES TOGETHER WITH A FULL-FACE SHIELD ARE BEST.
- Inspect glassware before using, looking for star cracks and lines.
- Use thick-walled containers and vacuum tubing. This will make implosion less likely.
- Glassware can be wrapped in heavy tape to minimize hazards in the event of implosion.
- Always use a vacuum trap with a vent. This will protect your sample from contamination, and will minimize the likelihood of blowback.
- Always secure the apparatus with lab clamps.
- Know when it is necessary to use lubricating grease, keeping in mind the compatibility of the grease with chemicals being used.
- Consider working behind an explosion shield or in a hood if necessary, especially if explosive chemicals are involved.
- For larger volumes, a round bottom flask is recommended rather than an Erlenmeyer due to greater structural strength.

USING HIGH PRESSURE

- PROTECT YOUR EYES! LAB GLASSES TOGETHER WITH A FULL-FACE SHIELD ARE BEST.
- Inspect glassware before using, looking for star cracks and lines.
- Use thick-walled containers.
- Use reinforced-wall tubing.
- Use plastic if possible. It's less strong than glass, but won't shatter.
- ALWAYS SECURE THE APPARATUS, INCLUDING TUBING, WITH LAB CLAMPS.

USING A FUME HOOD

- If you are unfamiliar with any of the hood functions, request instruction from your faculty or staff.
- Be sure the hood is working, and if the flow rate for the velocity controller is adjustable, set it at the normal rate of 100 ft/min.
- A sash height of 18 inches is the maximum recommended. Keep the sash opening height as low as possible for maximum user safety.
- Never put your head into the hood for any reason while working.
- To conserve energy, close the sash when not in use. If you can adjust the velocity controller, set it to 50 ft/min.

ELECTRICAL

- Electrical equipment must be properly grounded.
- Do not use electrical wires as supports.
- Inspect all equipment before use, checking for plugs and cords in good condition (not frayed), and that plugs are three wire grounded.
- Be aware of sources of sparks and static electricity when around or using any flammable materials and vapors. These sources include equipment with switches and running motors. If you need to turn equipment off under these conditions, unplug it.

CENTRIFUGE

- Students must be trained by faculty or lab staff before using floor models.
- Use centrifuge tubes (not test tubes) and balance them properly by placing balance tubes of equal weight on opposite sides of the sample tubes.
- Do not open centrifuge lid during operation. DO NOT open lid until centrifuge rotor has come to a complete stop.
- Be sure rotor is properly attached and secured with retaining nut.
- Turn off centrifuge immediately if it starts to vibrate or move across the table.
- Clean the centrifuge chamber after use, if needed. Ice or oil collects quickly in some

centrifuges.

AUTOCLAVE

- Students must be trained by faculty or lab staff before using.
- Only use appropriate containers, hard glass, and polypropylene. See Appendix 10.
- Only autoclave items in wire racks or PP tubs (no loose loads).
- Report all spills or steam leaks to lab staff or The Science Support Center.

UV LAMPS

UV lamps produce radiation that is damaging to the eye and skin and can cause severe sunburns. These lamps also can get hot and can cause burns.

- Wear goggles or glasses with side shields and brow bar. Be sure they are approved for UV use.
- Intense UV lamps produce ozone and must be used in a ventilated area.
- Do not touch glass portions of UV lamps. The oils from your skin can cause the lamps to overheat and crack.

LASERS

- Never look directly into the beam or pump source. Be sure you know what type of laser you are using (visible or invisible).
- Beware of objects that will reflect laser beam. Never point the laser into the room or out a window (lasers reflect off glass).
- Keep room light level HIGH. Low levels dilate pupils and increase eye damage hazard.

APPENDIX 1A GHS PHYSICAL HAZARDS

What are the GHS Physical Hazards?

The GHS physical hazards criteria, developed by the ILO and UNCETDG, were largely based on the existing criteria used by the UN Model Regulation on the Transport of Dangerous Goods. Therefore, many of the criteria are already being used on a worldwide basis. However, some additions and changes were necessary since the scope of the GHS includes all target audiences. The physical hazards classification process provides specific references to approved test methods and criteria for classification. The GHS physical hazard criteria apply to mixtures. It is assumed that mixtures will be tested for physical hazards.

In general, the GHS criteria for physical hazards are quantitative or semi-quantitative with multiple hazard levels within an endpoint. This is different from several of the existing systems that currently have qualitative criteria for various physical hazards (e.g., organic peroxide criteria under WHMIS and OSHA HCS). This could make classification under the GHS more consistent.

In developing GHS criteria for physical hazards it was necessary to define physical states. In the GHS,

- a **gas** is a substance or mixture which at 50°C has a vapor pressure greater than 300 kPa; or is completely gaseous at 20°C and a standard pressure of 101.3 kPa.
- a **liquid** is a substance or mixture that is not a gas and which has a melting point or initial melting point of 20°C or less at standard pressure of 101.3 kPa.
- a **solid** is a substance or mixture that does not meet the definitions of a liquid or a gas.

The GHS physical hazards are briefly described below. For many of the physical hazards the GHS Document contains Guidance Sections with practical information to assist in applying the criteria.

Physical Hazard
▪ Explosives ▪ Flammable Gases ▪ Flammable Aerosols ▪ Oxidizing Gases ▪ Gases Under Pressure ▪ Flammable Liquids ▪ Flammable Solids ▪ Self-Reactive Substances ▪ Pyrophoric Liquids ▪ Pyrophoric Solids ▪ Self-Heating Substances ▪ Substances which, in contact with water emit flammable gases ▪ Oxidizing Liquids ▪ Oxidizing Solids ▪ Organic Peroxides ▪ Corrosive to Metals

Explosives

An explosive substance (or mixture) is a solid or liquid which is in itself capable by chemical reaction of producing gas at such a temperature and pressure and at such a speed as to cause damage to the surroundings. Pyrotechnic substances are included even when they do not evolve gases. A pyrotechnic substance (or mixture) is designed to produce an effect by heat, light, sound, gas or smoke or a combination of these as the result of non-detonative, self-sustaining, exothermic chemical reactions.

Classification as an explosive and allocation to a division is a three-step process:

- Ascertain if the material has explosive effects (Test Series 1);
- Acceptance procedure (Test Series 2 to 4);
- Assignment to one of six hazard divisions (Test Series 5 to 7).

Explosives

Division	Characteristics
1.1	Mass explosion hazard
1.2	Projection hazard
1.3	Fire hazard or minor projection hazard
1.4	No significant hazard
1.5	Very insensitive substances with mass explosion hazard
1.6	Extremely insensitive articles with no mass explosion hazard

Explosive properties are associated with certain chemical groups that can react to give very rapid increases in temperature or pressure. The GHS provides a screening procedure that is aimed at identifying the presence of such reactive groups and the potential for rapid energy release. If the screening procedure identifies the substance or mixture to be a potential explosive, the acceptance procedure has to be performed.

Substances, mixtures and articles are assigned to one of six divisions, 1.1 to 1.6, depending on the type of hazard they present. See, *UN Manual of Tests and Criteria* Part I Test Series 2 to 7. Currently, only the transport sector uses six categories for explosives.

Flammable Gases

Flammable gas means a gas having a flammable range in air at 20°C and a standard pressure of 101.3 kPa. Substances and mixtures of this hazard class are assigned to one of two hazard categories on the basis of the outcome of the test or calculation method (ISO 10156:1996).

Flammable Aerosols

Aerosols are any gas compressed, liquefied or dissolved under pressure within a non-refillable container made of metal, glass or plastic, with or without a liquid, paste or powder. The container is fitted with a release device allowing the contents to be ejected as solid or liquid particles in suspension in a gas, as a foam, paste or powder or in a liquid or gaseous state.

Aerosols should be considered for classification as either a Category 1 or Category 2 Flammable Aerosol if they contain any component classified as flammable according to the GHS criteria for flammable liquids, flammable gases, or flammable solids. Classification is based on:

- Concentration of flammable components;
- Chemical heat of combustion (mainly for transport/storage);
- Results from the foam test (foam aerosols) (mainly for worker/consumer);
- Ignition distance test (spray aerosols) (mainly for worker/consumer);
- Enclosed space test (spray aerosols) (mainly for worker/consumer).

Aerosols are considered:

- Nonflammable, if the concentration of the flammable components ≤ 1% and the heat of combustion is < 20 kJ/g.
- Extremely flammable, if the concentration of the flammable components >85% and the heat of combustion is ≥ 30 kJ/g to avoid excessive testing.

See the *UN Manual of Tests and Criteria* for the test method.

Oxidizing Gases

Oxidizing gas means any gas which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does. Substances and mixtures of this hazard class are assigned to a single hazard category on the basis that, generally by providing oxygen, they cause or contribute to the combustion of other material more than air does. The test method is ISO 10156:1996. Currently, several workplace hazard communication systems cover oxidizers (solids, liquids, gases) as a class of chemicals.

Gases under Pressure

Gases under pressure are gases that are contained in a receptacle at a pressure not less than 280 Pa at 20°C or as a refrigerated liquid. This endpoint covers four types of gases or gaseous mixtures to address the effects of sudden release of pressure or freezing which may lead to serious damage to people, property, or the environment independent of other hazards the gases may pose.

For this group of gases, the following information is required:

- vapor pressure at 50°C;
- physical state at 20°C at standard ambient pressure;
- critical temperature.

Criteria that use the physical state or compressed gases will be a different classification basis for some workplace systems.

Gases under Pressure

Group	Criteria
Compressed gas	Entirely gaseous at -50°C
Liquefied gas	Partially liquid at temperatures > -50°C
Refrigerated liquefied gas	Partially liquid because of its low temperature
Dissolved gas	Dissolved in a liquid phase solvent

Data can be found in the literature, and calculated or determined by testing. Most pure gases are already classified in the UN Model Regulations. Gases are classified, according to their physical state when packaged, into one of four groups as shown in Table 3.2.

Flammable Liquids

Flammable liquid means a liquid having a flash point of not more than 93°C. Substances and mixtures of this hazard class are assigned to one of four hazard categories on the basis of the flash point and boiling point. Flash Point is determined by closed cup methods as provided in the GHS document, Chapter 2.5, paragraph 11.

Flammable Liquids Table

Category	Criteria
1	Flash point < 23°C and initial boiling point ≤ 35°C (95°F)
2	Flash point < 23°C and initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C and ≤ 60°C (140°F)
4	Flash point ≥ 60°C (140°F) and ≤ 93°C (200°F)

Flammable Solids

Flammable solids are solids that are readily combustible, or may cause or contribute to fire through friction. Readily combustible solids are powdered, granular, or pasty substances which are dangerous if they can be easily ignited by brief contact with an ignition source, such as a burning match, and if the flame spreads rapidly.

Substances and mixtures of this hazard class are assigned to one of two hazard categories on the basis of the outcome of the UN Test N.1 (*UN Manual of Tests and Criteria*). The tests include burning time, burning rate and behavior of fire in a wetted zone of the test sample.

Flammable Solids Table

Category	Criteria
1	Metal Powders: burning time ≤ 5 minutes Others: wetted zone does not stop fire & burning time < 45 seconds or burning > 2.2 mm/second
2	Metal Powders: burning time > 5 and ≤ 10 minutes Others: wetted zone stop fire for at least 4 minutes & burning time < 45 seconds or burning rat > 2.2mm/second

Self-Reactive Substances

Self-reactive substances are thermally unstable liquids or solids liable to undergo a strongly exothermic thermal decomposition even without participation of oxygen (air). This definition excludes materials classified under the GHS as explosive, organic peroxides or as oxidizing. These materials may have similar properties, but such hazards are addressed in their specific endpoints. There are exceptions to the self-reactive classification for material: (i) with heat of decomposition <300 J/g or (ii) with self-accelerating decomposition temperature (SADT) > 75°C for a 50 kg package.

Substances and mixtures of this hazard class are assigned to one of the seven 'Types', A to G, on the basis of the outcome of the UN Test Series A to H (*UN Manual of Tests and Criteria*). Currently, only the transport sector uses seven categories for self-reactive (See Self-Reactive Table.)

Self-Reactive Substances Table

Type	Criteria
A	Can detonate or deflagrate rapidly, as packaged.
B	Possess explosive properties and which, as packaged, neither detonates nor deflagrates, but is liable to undergo a thermal explosion in that package.
C	Possess explosive properties when the substance or mixture as package cannot detonate or deflagrate rapidly or undergo a thermal explosion.
D	▪ Detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or ▪ Does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or ▪ Does not detonate or deflagrate at all and shows a medium effect when heated under confinement.
E	Neither detonates nor deflagrates at all and shows low or no effect when heated under confinement.
F	Neither detonates in the cavitated bubble state nor deflagrates at all and shows only a low or no effect when heated under confinement as well as low or no explosive power.
G	Neither detonates in the cavitated state nor deflagrates at all and shows non effect when heated under confinement nor any explosive power, provided that it is thermally stable (self-accelerating decomposition temperature is 60°C to 75°C for a 50 kg package), and, for liquid mixtures, a diluent having a boiling point not less than 150°C is used for desensitization.

Pyrophorics

Pyrophoric Liquids

A pyrophoric liquid is a liquid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air. Substances and mixtures of this hazard class are assigned to a single hazard category on the basis of the outcome of the UN Test N.3 (UN Manual of Tests and Criteria).

Pyrophoric Solids

A pyrophoric solid is a solid which, even in small quantities, is liable to ignite within five minutes after coming into contact with air. Substances and mixtures of this hazard class are assigned to a single hazard category on the basis of the outcome of the UN Test N.2 (*UN Manual of Tests and Criteria*).

Self-Heating Substances

A self-heating substance is a solid or liquid, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat. This endpoint differs from a pyrophoric substance in that it will ignite only when in large amounts (kilograms) and after long periods of time (hours or days). Substances and mixtures of this hazard class are assigned to one of two hazard categories on the basis of the outcome of the UN Test N.4 (*UN Manual of Tests and Criteria*).

Substances which on Contact with Water Emit Flammable Gases

Substances that, in contact with water, emit flammable gases are solids or liquids which, by interaction with water, are liable to become spontaneously flammable or to give off flammable gases in dangerous quantities. Substances and mixtures of this hazard class are assigned to one of three hazard categories on the basis of test results (UN Test N.5 *UN Manual of Tests and Criteria*) which measure gas evolution and speed of evolution.

Substances which on Contact with Water Emit Flammable Gases Table

Category	Criteria
1	≥10 L/kg/1 minute
2	≥20 L/kg/ 1 hour + < 10 L/kg/1 min
3	≥1 L/kg/1 hour + < 20 L/kg/1 hour
Not classified	< 1 L/kg/1 hour

Oxidizing Liquids

An oxidizing liquid is a liquid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material. Substances and mixtures of this hazard class are assigned to one of three hazard categories on the basis of test results (UN Test O.2 *UN Manual of Tests and Criteria*) which measure ignition or pressure rise time compared to defined mixtures.

Oxidizing Solids

An oxidizing solid is a solid which, while in itself not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material. Substances and mixtures of this hazard class are assigned to one of three hazard categories on the basis of test results (UN Test O.1 *UN Manual of Tests and Criteria*) which measure mean burning time and re compared to defined mixtures. Currently, several workplace hazard communication systems cover oxidizers (solids, liquids, gases) as a class of chemicals.

Organic Peroxides

An organic peroxide is an organic liquid or solid which contains the bivalent -0-0- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term also includes organic peroxide formulations (mixtures). Such substances and mixtures may:

- be liable to explosive decomposition;
- burn rapidly;
- be sensitive to impact or friction;
- react dangerously with other substances.

Substances and mixtures of this hazard class are assigned to one of seven 'Types', A to G, on the basis of the outcome of the UN Test Series A to H (*UN Manual of Tests and Criteria*). Currently, only the transport sector uses seven categories for organic peroxides.

Organic Peroxides Table

Type	Criteria
A	Can detonate or deflagrate rapidly, as packaged.
B	Possess explosive properties and which, as packaged, neither detonates nor deflagrates rapidly, but is liable to undergo a thermal explosion in that package.
C	Possess explosive properties when the substance or mixture as packaged cannot detonate or deflagrate rapidly or undergo a thermal explosion.
D	▪ Detonates partially, does not deflagrate rapidly and shows no violent effect when heated under confinement; or ▪ Does not detonate at all, deflagrates slowly and shows no violent effect when heated under confinement; or ▪ Does not detonate or deflagrate at all and shows a medium effect when heated under confinement.
E	Neither detonates nor deflagrates at all and shows low or no effect when heated under confinement.
F	Neither detonates in the caviated bubble state nor deflagrates at all and shows only a low or no effect when heated under confinements as well as low or non explosive power.
G	Neither detonates in the caviated state nor deflagrates at all and shows no effect when heated under confinement nor any explosive power, provided that it is thermally stable (self-accelerating decomposition temperature is 60°C to 75°C for a 50 kg package), and, for liquid mixtures, a diluent having a boiling point not less than 150°C is used for desensitization.

Substances Corrosive to Metal

A substance or a mixture that by chemical action will materially damage, or even destroy, metals is termed 'corrosive to metal'. These substances or mixtures are classified in a single hazard category on the basis of tests (Steel: ISO 9328 (II): 1991 - Steel type P235; Aluminum: ASTM G31-72 (1990) - non-clad types 7075-T6 or AZ5GU-T66). The GHS criteria are a corrosion rate on steel or aluminum surfaces exceeding 6.25 mm per year at a test temperature of 55°C.

The concern in this case is the protection of metal equipment or installations in case of leakage (e.g., plane, ship, tank), not material compatibility between the container/tank and the product. This hazard is not currently covered in all systems.

APPENDIX 1B GHS HEALTH HAZARDS

What are the GHS Health Hazards?

The GHS health hazard criteria represent a harmonized approach for existing classification systems. The work at the OECD to develop the GHS criteria included:

- A thorough analysis of existing classification systems, including the scientific basis for a system and its criteria, its rationale and an explanation of the mode of use;
- A proposal for harmonized criteria for each category. For some categories the harmonized approach was easy to develop because the existing systems had similar approaches. In cases where the approach was different, a compromise consensus proposal was developed.
- Health criteria were established for substances and mixtures.

Health Hazard
▪ Acute Toxicity ▪ Skin Corrosion/Irritation ▪ Serious Eye Damage/Eye Irritation ▪ Respiratory or Skin Sensitization ▪ Germ Cell Mutagenicity ▪ Carcinogenicity ▪ Reproductive Toxicology ▪ Target Organ Systemic Toxicity - Single Exposure ▪ Target Organ Systemic Toxicity - Repeated Exposure ▪ Aspiration Toxicity

The GHS Health Endpoints

The following paragraphs briefly describe the GHS health and environmental endpoints. The criteria for classifying substances are presented first. Then the GHS approach to classifying mixtures is briefly discussed. It is recommended that the person responsible for GHS implementation consult the GHS Document or "Purple Book" for more complete information.

Acute Toxicity

Five GHS categories have been included in the GHS Acute Toxicity scheme from which the appropriate elements relevant to transport, consumer, worker and environment protection can be selected. Substances are assigned to one of the five toxicity categories on the basis of LD_{50} (oral, dermal) or LC_{50} (inhalation). The LC_{50} values are based on 4-hour tests in animals. The GHS provides guidance on converting 1-hour inhalation test results to a 4-hour equivalent. The five categories are shown in the Acute Toxicity Table.

Acute Toxicity Table

Acute toxicity	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Category 5
Oral (mg/kg)	≤ 5	> 5 ≤ 50	> 50 ≤ 300	> 300 ≤ 2000	Criteria: ▪ Anticipated oral LD50 between 2000 and 5000 mg/kg; ▪ Indication of significant effect in humans;* ▪ Any mortality at class 4;* ▪ Significant clinical signs at class 4;* ▪ Indications from other studies.* *If assignment to more hazardous class is not warranted.
Dermal (mg/kg)	≤ 50	> 50 ≤ 200	> 200 ≤ 1000	> 1000 ≤ 2000	
Gases (ppm)	≤ 100	> 100 ≤ 500	> 500 ≤ 2500	> 2500 ≤ 5000	
Vapors (mg/l)	≤ 0.5	> 0.5 ≤ 2.0	> 2.0 ≤ 10	> 10 ≤ 20	
Dust & mists (mg/l)	≤ 0.05	> 0.05 ≤ 0.5	> 0.5 ≤ 1.0	> 1.0 ≤ 5	

Category 1, the most severe toxicity category, has cut-off values currently used primarily by the transport sector for classification for packing groups. Some Competent Authorities may consider combining Acute Categories 1 and 2. Category 5 is for chemicals which are of relatively low acute toxicity but which, under certain circumstances, may pose a hazard to vulnerable populations. Criteria other than LD50/LC50 data are provided to identify substances in Category 5 unless a more hazardous class is warranted.

Skin Corrosion

Skin corrosion means the production of irreversible damage to the skin following the application of a test substance for up to 4 hours. Substances and mixtures in this hazard class are assigned to a single harmonized corrosion category. For Competent Authorities, such as transport packing groups, needing more than one designation for corrosivity, up to three subcategories are provided within the corrosive category. See the Skin Corrosion/IrritationTable.

Several factors should be considered in determining the corrosion potential before testing is initiated:

- Human experience showing irreversible damage to the skin;
- Structure/activity or structure property relationship to a substance or mixture already classified as corrosive;
- pH extremes of £ 2 and ^{3} 11.5 including acid/alkali reserve capacity.

Skin Irritation

Skin irritation means the production of reversible damage to the skin following the application of a test substance for up to 4 hours. Substances and mixtures in this hazard class are assigned to a single irritant category. For those authorities, such as pesticide regulators, wanting more than one designation for skin irritation, an additional mild irritant category is provided. See the Skin Corrosion/IrritationTable.

Several factors should be considered in determining the irritation potential before testing is initiated:

- Human experience or data showing reversible damage to the skin following exposure of up to 4 hours;
- Structure/activity or structure property relationship to a substance or mixture already classified as an irritant.

Skin Corrosion/Irritation Table

<table>
<tr><th colspan="3">Skin Corrosion
Category 1</th><th>Skin Irritation
Category 2</th><th>Mild Skin Irritation
Category 3</th></tr>
<tr><td colspan="3">Destruction of dermal tissue: visible necrosis in at least one animal</td><td rowspan="2">Reversible adverse effects in dermal tissue

Draize score: ≥ 2.3 < 4.0
or persistent inflammation</td><td>Reversible adverse effects in dermal tissue</td></tr>
<tr><td>Subcategory 1A
Exposure < 3 min.
Observation < 1hr,</td><td>Subcategory 1B
Exposure < 1hr.
Observation < 14 days</td><td>Subcategory 1C
Exposure < 4 hrs.
Observation < 14 days</td><td>Draize score: ≥ 1.5 < 2.3</td></tr>
</table>

Eye Effects

Several factors should be considered in determining the *serious eye damage* or *eye irritation* potential before testing is initiated:

- Accumulated human and animal experience;
- Structure/activity or structure property relationship to a substance or mixture already classified;
- pH extremes like < 2 and > 11.5 that may produce serious eye damage.

Eye Effects Table

<table>
<tr><td>Category 1
Serious eye damage</td><td colspan="2">Category 2
Eye Irritation</td></tr>
<tr><td>Irreversible damage 21 days after exposure

Draize score:
Corneal opacity ≥ 3
Iritis > 1.5</td><td colspan="2">Reversible adverse effects on cornea, iris, conjunctiva

Draize score:
Corneal opacity ≥ 1
Iritis > 1
Redness ≥ 2
Chemosis ≥ 2</td></tr>
<tr><td></td><td>Irritant
Subcategory 2A
Reversible in 21 days</td><td>Mild Irritant
Subcategory 2B
Reversible in 7 days</td></tr>
</table>

Serious eye damage means the production of tissue damage in the eye, or serious physical decay of vision, following application of a test substance to the front surface of the eye, which is not fully reversible within 21 days of application. Substances and mixtures in this hazard class are assigned to a single harmonized category.

Eye irritation means changes in the eye following the application of a test substance to the front surface of the eye, which are fully reversible within 21 days of application. Substances and mixtures in this hazard class are assigned to a single harmonized hazard category. For authorities, such as pesticide regulators, wanting more than one designation for eye irritation, one of two subcategories can be selected, depending on whether the effects are reversible in 21 or 7 days.

Sensitization

Respiratory sensitizer means a substance that induces hypersensitivity of the airways following inhalation of the substance. Substances and mixtures in this hazard class are assigned to one hazard category.

Skin sensitizer means a substance that will induce an allergic response following skin contact. The definition for "skin sensitizer" is equivalent to "contact sensitizer". Substances and mixtures in this hazard class are assigned to one hazard category. Consideration should be given to classifying substances which cause immunological contact urticaria (an allergic disorder) as contact sensitizers.

Germ Cell Mutagenicity

Mutagen means an agent giving rise to an increased occurrence of mutations in populations of cells and/or organisms. Substances and mixtures in this hazard class are assigned to one of two hazard categories. Category 1 has two subcategories. See the Germ Cell Mutagenicity Table below.

Germ Cell Mutagenicity Table

<table>
<tr><th colspan="2">Category 1
Known/Presumed</th><th>Category 2
Suspected/Possible</th></tr>
<tr><td colspan="2">Known to produce heritable mutations in human germ cells</td><td>▪ May include heritable mutations in human germ cells</td></tr>
<tr><td>Subcategory 1A

Positive evidence from epidemiological studies</td><td>Subcategory 1B

Positive results in:
▪ In vivo heritable germ cell tests in mammals
▪ Human germ cell tests
▪ In vivo somatic mutagenicity tests, combined with some evidence of germ cell mutagenicity</td><td>▪ Positive evidence from tests in mammals and somatic cell tests
▪ In vivo somatic genotoxicity supported by in vitro mutagenicity</td></tr>
</table>

Carcinogenicity

Carcinogen means a chemical substance or a mixture of chemical substances which induce cancer or increase its incidence. Substances and mixtures in this hazard class are assigned to one of two hazard categories. Category 1 has two subcategories. The Carcinogenicity Guidance Section in the GHS Document includes comments about IARC.

Carcinogenicity Table

Category 1 **Known or Presumed Carcinogen**		**Category 2** **Suspected Carcinogen**
Subcategory 1A **Known Human Carcinogen** Based on human evidence	Subcategory 1B **Presumed Human Carcinogen** Based on demonstrated animal carcinogenicity	Limited evidence of human or animal carcinogenicity

Reproductive Toxicity

Reproductive toxicity includes adverse effects on sexual function and fertility in adult males and females, as well as developmental toxicity in offspring. Substances and mixtures with reproductive and/or developmental effects are assigned to one of two hazard categories, 'known or presumed' and 'suspected'. Category 1 has two subcategories for reproductive and developmental effects. Materials which cause concern for the health of breastfed children have a separate category, Effects on or Via Lactation.

Reproductive Toxicity Table

Category 1		**Category 2** **Suspected**	**Additional Category**
Known or presumed to cause effects on human reproduction or on development		Human or animal evidence possibly with other information	Effects on or via lactation
Category 1A **Known** Based on human evidence	**Category 1B** **Presumed** Based on experimental animals		

Target Organ Systemic Toxicity (TOST): Single Exposure & Repeated Exposure

The GHS distinguishes between single and repeat exposure for Target Organ Effects. Some existing systems distinguish between single and repeat exposure for these effects and some do not. All significant health effects, not otherwise specifically included in the GHS, that can impair function, both reversible and irreversible, immediate and/or delayed are included in the non-lethal target organ/systemic toxicity class (TOST). Narcotic effects and respiratory tract irritation are considered to be target organ systemic effects following a single exposure.

Substances and mixtures of the single exposure target organ toxicity hazard class are assigned to one of three hazard categories in the TOST: Single Exposure Table.

TOST: Single Exposure Table

Category 1	**Category 2**	**Category 3**
Significant toxicity in humans - Reliable, good quality human case studies or epidemiological studies Presumed significant toxicity in humans - Animal studies with significant and/or severe toxic effects relevant to humans at generally low exposure (guidance)	Presumed to be harmful to human health - Animal studies with significant toxic effects relevant to humans at generally moderate exposure (guidance) - Human evidence in exceptional cases	Transient target organ effects - Narcotic effects - Respiratory tract irritation

Substances and mixtures of the repeated exposure target organ toxicity hazard class are assigned to one of two hazard categories in the TOST: Repeated Exposure Table.

TOST: Repeated Exposure Table

Category 1	**Category 2**
Significant toxicity in humans - Reliable, good quality human case studies or epidemiological studies Presumed significant toxicity in humans - Animal studies with significant and/or severe toxic effects relevant to humans at generally low exposure (guidance)	Presumed to be harmful to human health - Animal studies with significant toxic effects relevant to humans at generally moderate exposure (guidance) - Human evidence in exceptional cases

In order to help reach a decision about whether a substance should be classified or not, and to what degree it would be classified (Category 1 vs. Category 2), dose/concentration 'guidance values' are provided in the GHS. The guidance values and ranges for single and repeated doses are intended only for guidance purposes. This means that they are to be used as part of the weight of evidence approach, and to assist with decisions about classification. They are not intended as strict demarcation values. The guidance value for repeated dose effects refer to effects seen in a standard 90-day toxicity study conducted in rats. They can be used as a basis to extrapolate equivalent guidance values for toxicity studies of greater or lesser duration.

Aspiration Hazard

Aspiration toxicity includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration. Aspiration is the entry of a liquid or solid directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Some hydrocarbons (petroleum distillates) and certain chlorinated hydrocarbons have been shown to pose an aspiration hazard in humans. Primary alcohols, and ketones have been shown to pose an aspiration hazard only in animal studies.

Aspiration Toxicity Table

Category 1: Known (regarded) human - human evidence - hydrocarbons with kinematic viscosity ? 20.5 mm^2/s at 40° C.	**Category 2:** Presumed human - Based on animal studies - surface tension, water solubility, boiling point - kinematic viscosity ? 14 mm^2/s at 40°C & not Category 1

Substances and mixtures of this hazard class are assigned to one of two hazard categories this hazard class on the basis of viscosity.

APPENDIX 2

A GHS Standardized Safety Data Sheet is on the pages that follow.

SAFETY DATA SHEET

Version 3.15
Revision Date 06/18/2014
Print Date 09/25/2014

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name	:	Acetone
Product Number	:	650501
Brand	:	Sigma-Aldrich
Index-No.	:	606-001-00-8
CAS-No.	:	67-64-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses	:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #	:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)
Flammable liquids (Category 2), H225
Eye irritation (Category 2A), H319
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336

For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word: Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.

P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P312	Call a POISON CENTER or doctor/ physician if you feel unwell.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

Repeated exposure may cause skin dryness or cracking.

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula	:	C_3H_6O
Molecular Weight	:	58.08 g/mol
CAS-No.	:	67-64-1
EC-No.	:	200-662-2
Index-No.	:	606-001-00-8

Hazardous components

Component	Classification	Concentration
Acetone		
	Flam. Liq. 2; Eye Irrit. 2A; STOT SE 3; H225, H319, H336	90 - 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice

Move out of dangerous area.Consult a physician. Show this safety data sheet to the doctor in attendance.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Wash off with soap and plenty of water. Consult a physician.

In case of eye contact

Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed

Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

no data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment.Keep away from sources of ignition - No smoking.Take measures to prevent the build up of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Acetone	67-64-1	TWA	500 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Eye & Upper Respiratory Tract irritation Central Nervous System impairment Hematologic effects Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		

		STEL	750 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Eye & Upper Respiratory Tract irritation Central Nervous System impairment Hematologic effects Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		STEL	1,000 ppm 2,400 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		The acetone STEL does not apply to the cellulose acetate fiber industry. It is in effect for all other sectors.		
		TWA	1,000 ppm 2,400 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		
		TWA	250 ppm 590 mg/m3	USA. NIOSH Recommended Exposure Limits
		TWA	750 ppm 1,800 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Acetone	67-64-1	Acetone	50 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			

8.2 Exposure controls

Appropriate engineering controls
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested:Butoject® (KCL 897 / Aldrich Z677647, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
impervious clothing, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a)	Appearance	Form: liquid, clear Colour: colourless
b)	Odour	no data available
c)	Odour Threshold	no data available
d)	pH	no data available
e)	Melting point/freezing point	Melting point/range: -94 °C (-137 °F)
f)	Initial boiling point and boiling range	56 °C (133 °F) at 1,013 hPa (760 mmHg)
g)	Flash point	-17.0 °C (1.4 °F) - closed cup
h)	Evapouration rate	no data available
i)	Flammability (solid, gas)	no data available
j)	Upper/lower flammability or explosive limits	Upper explosion limit: 13 %(V) Lower explosion limit: 2 %(V)
k)	Vapour pressure	533.3 hPa (400.0 mmHg) at 39.5 °C (103.1 °F) 245.3 hPa (184.0 mmHg) at 20.0 °C (68.0 °F)
l)	Vapour density	no data available
m)	Relative density	0.791 g/mL at 25 °C (77 °F)
n)	Water solubility	completely miscible
o)	Partition coefficient: n-octanol/water	log Pow: -0.24
p)	Auto-ignition temperature	465.0 °C (869.0 °F)
q)	Decomposition temperature	no data available
r)	Viscosity	no data available
s)	Explosive properties	no data available
t)	Oxidizing properties	no data available

9.2 Other safety information

Surface tension	23.2 mN/m at 20.0 °C (68.0 °F)

10. STABILITY AND REACTIVITY

10.1 Reactivity
no data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapours may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials
Bases, Oxidizing agents, Reducing agents, Acetone reacts violently with phosphorous oxychloride.

10.6 Hazardous decomposition products
Other decomposition products - no data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - rat - 5,800 mg/kg
Remarks: Behavioral:Altered sleep time (including change in righting reflex). Behavioral:Tremor. Behavioral:Headache. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea.

LC50 Inhalation - rat - 8 h - 50,100 mg/m3
Remarks: Drowsiness Dizziness Unconsciousness

LD50 Dermal - guinea pig - 7,426 mg/kg

no data available

Skin corrosion/irritation
Skin - rabbit
Result: Mild skin irritation - 24 h

Serious eye damage/eye irritation
Eyes - rabbit
Result: Eye irritation - 24 h

Respiratory or skin sensitisation
- guinea pig
Result: Does not cause skin sensitisation.

Germ cell mutagenicity
no data available

Carcinogenicity

This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification.

IARC:	No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
no data available

no data available

Specific target organ toxicity - single exposure
May cause drowsiness or dizziness.

Specific target organ toxicity - repeated exposure
no data available

Aspiration hazard
no data available

Additional Information
RTECS: AL3150000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Kidney - Irregularities - Based on Human Evidence
Kidney - Irregularities - Based on Human Evidence
Skin - Dermatitis - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Oncorhynchus mykiss (rainbow trout) - 5,540 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates	LC50 - Daphnia magna (Water flea) - 8,800 mg/l - 48 h
Toxicity to algae	Remarks: no data available

12.2 Persistence and degradability

Biodegradability	Result: 91 % - Readily biodegradable. (OECD Test Guideline 301B)

12.3 Bioaccumulative potential
Does not bioaccumulate.

12.4 Mobility in soil
no data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1090 Class: 3 Packing group: II
Proper shipping name: Acetone
Reportable Quantity (RQ): 5000 lbs

Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1090 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: ACETONE
Marine pollutant: No

IATA
UN number: 1090 Class: 3 Packing group: II
Proper shipping name: Acetone

15. REGULATORY INFORMATION

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
SARA 313: This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Acetone	67-64-1	2007-03-01

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Eye Irrit.	Eye irritation
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.
STOT SE	Specific target organ toxicity - single exposure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

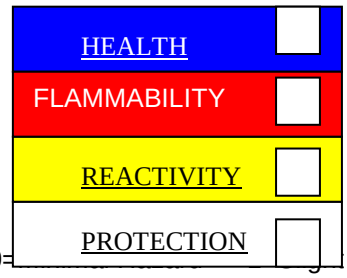
Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Version: 3.15 Revision Date: 06/18/2014 Print Date: 09/25/2014

CHEMICAL FACT WORKSHEET

Student Name filed under: Faculty: Faculty Signature	Chemical Name: SDS: CAS Number: Chemical Formula: Molecular Weight:	Phase (S, L, G): Color: Odor: Density: Boiling Point:

HAZARDS IDENTIFICATION:



Symptoms/Toxicity:_____

Flash Point/Hazards:_____

Incompatibles:_____

Protective Equipment:_____

0= Hazard 2=Moderate Hazard 3=Serious Hazard 4=Severe Hazard

Storage Instructions:

Spill Response:

APPENDIX 4

COMMON SOLVENT PROPERTIES

SOLVENT CLASS	TLV/ TWA	Flash Point	Boiling Point	HMIS Ratings			HAZARDS,TOXICITY
	ppm	°F	°F	F	H	R	
ALCOHOLS (most polar)							
Ethanol: Grain alcohol, ethyl alcohol	1000	60	173	1	3	1	Flammable
Isopropyl alcohol	400	53	82	1	3	1	Flammable
Isoamyl alcohol	100	109	270	2	2	1	Flammable
Methanol: Wood alcohol, wood naphtha	200	54	149	3	3	1	**POISON**, Flammable
KETONES / ESTERS							
Acetone	750	0	133	2	4	1	**VERY FLAMMABLE**
Ethyl acetate	400	24	171	2	3	0	Flammable
Ethyl ether: Ether, anhydrous ether	400	-49	95	2	4	2	**VERY FLAMMABLE**
Methyl ethyl ketone(MEK)	200	20	176	2	4	2	**VERY FLAMMABLE**
Dimethyl formamide (DMF)	10	136	307	3	2	1	**POISON**
CHLORINATED HYDROCARBONS							
Chloroform	10	NA	142	3	0	1	PROBABLE CARCINOGEN
Methylene chloride	50	NA	104	3	1	1	PROBABLE CARCINOGEN
Carbon tetrachloride	5	NA	171	3	0	1	PROBABLE CARCINOGEN
AROMATICS							
Toluene	100	40	232	2	3	0	Flammable

Xylene	100	80	279	2	3	0	Flammable
Benzene	10	12	176	4	3	0	**KNOWN CARCINOGEN**, Flammable
HYDROCARBONS (least polar)							
Gasoline (may contain benzene)	300	-45	102	2	4	1	**VERY FLAMMABLE**
Hexane	50	-7	156	1	3	0	Flammable
Heptane	400	25	208	1	3	0	Flammable
Kerosene ~80% paraffins, ~20% aromatics	200	100	170-300	1	2	0	
Mineral spirits Heavier fractions: ~80% saturate hydrocarbons, ~20% aromatics and olefins. Benzin, benzine, benzoline, canadol, ligroin, mineral thinner, mineral turpentine, painter's naphtha,refined solvent naphtha, solvent naphtha, Stoddard solvent, VM&P naphtha, white spirits. There are further divisions of minerals spirits based on F.P. and B.P.	300	100-120	250-350	2	2	0	
Petroleum spirits Lighter fractions of hydrocarbon mixtures - mostly pentanes and hexanes. Light ligroin, petroleum naphtha, petroleum distillate, petroleum ether.	400	-50 to -20	30-90	1	4	0	**VERY FLAMMABLE**
Limonene Terpene hydrocarbon; "Citra-safe"	NA	NA	176	2	1	1	
Turpentine Gum spirits	100	90-115	310-340	1	2	0	

Linseed oil	NA	252	343	0	1	1	

When selecting a solvent, choose one that minimizes hazards. To substitute, select one that is in the same solvent class, or is close to that solvent class in polarity: alcohols are most polar, then ketones/esters, chlorinated hydrocarbons, aromatics, and hydrocarbons as the least polar.

APPENDIX 5

COMMON OXIDIZING AND REDUCING AGENTS

OXIDIZING AGENTS	REDUCING AGENTS
Bleach	Alkali metals
Chromates	Diborane
Dichromates	Hydrogen
Halates	Magnesium
Halogens	Metal hydrides (NaBH4, LiALH4)
Hydrogen peroxide	Nickel (finely divided)
Hydroperoxides	Organometal hydrides
Nitrates	Phosphorous (white)
Nitric acid	Zinc
Nitrites	
Oxygen	
Ozone	
Perchloric acid	
Perhalates	
Permanganates	
Peroxides	
Persulfates	
Sulfuric acid	
Cleaning solutions such as alcoholic KOH	

APPENDIX 6

SOME KNOWN OR SUSPECTED CARCINOGENS

Taken from: http://ptcl.chem.ox.ac.uk/SDS/carcinogens.html

A-alpha-C (2-Amino-9H-pyrido[2,3-b]indole)
Acetaldehyde
Acetamide
Acetochlor
2-Acetylaminofluorene
Acifluorfen
Acridine
Acrolein
Acrylamide
Acrylonitrile
Actinomycin D
Adriamycin (Doxorubicin hydrochloride)
AF-2;[2-(2-furyl)-3-(5-nitro-2-furyl)]acrylamide
Aflatoxins
Agaritine
Alachlor
Aldrin
Allyl chloride
Allyl glycidyl ether
Allyl isothiocyanate
Allyl isovalerate
Aluminium products
2-Aminoanthraquinone
p-Aminoazobenzene
o-Aminoazotoluene [solvent yellow 3]
4-Aminobiphenyl (4-aminodiphenyl)
3-Amino-9-ethylcarbazole hydrochloride
1-Amino-2-methylanthraquinone
Amitrole
Ammonium dichromate
Analgesic mixtures containing phenacetin
Androgenic (anabolic) steroids
Aniline
ortho-Anisidine
ortho-Anisidine hydrochloride
para-anisidine
anthanthrene
Antimony oxide (antimony trioxide)
Aramite
Arsenic (inorganic arsenic compounds)
Asbestos
Auramine
Azaserine
Azathioprine
Azacitidine
Azobenzene
Azathioprine

Benz[a]anthracene
Benzene
Benzidine [and its salts]
Benzidine-based dyes
Benzo[b]fluoranthene
Benzo[j]fluoranthene
Benzo[k]fluoranthene
Benzofuran
Benzo[a]pyrene
Benzotrichloride
Benzyl chloride
Benzyl violet 4B
Beryllium and beryllium compounds
Bis(2-chloroethyl)ether
N,N-Bis(2-chloroethyl)-2-naphthylamine (Chlornapazine)
Bischloroethyl nitrosourea (BCNU) (Carmustine)
Bis(chloromethyl)ether and technical-grade chloromethyl methyl ether
Bitumens, extracts of steam-refined and air refined
Bleomycins
Bracken fern
Bromodichloromethane
2-bromoethyl ether
Bromoform
1,3-Butadiene
1,4-Butanediol dimethanesulfonate (Busulfan, myleran)
Butylated hydroxyanisole (BHA)
t-butyl methyl ether
beta-Butyrolactone

Cadmium and cadmium compounds
Caffeic acid
Captafol
Captan
Carbazole
Carbon tetrachloride

Carbon-black extracts
Carrageenan, degraded
Ceramic fibers (airborne particles of respirable size)
Chlorambucil
Chloramphenicol
chlorbenzilat
Chlordane
Chlordecone (Kepone)
Chlordimeform
Chlorendic acid
Chlorinated Parrafins
alpha-Chlorinated toluenes
p-Chloroaniline
Chlormadinone aceate
Chlornaphazine[n,n-bis(2-chloroethyl)-2-naphthylamine]
Chlorodibromomethane
Chloroethane (ethyl chloride)
1-(2-Chloroethyl)-3-cyclohexyl-1-nitrosourea (CCNU) (Lomustine)
1-(2-Chloroethyl)-3-(4-methylcyclohexyl)-1-nitrosourea (Methyl-CCNU)
Chloroform
Chloromethyl methyl ether
3-Chloro-2-methylpropene
4-Chloro-ortho-phenylenediamine
p-Chloro-o-toluidine
Chlorophenols
Chlorophenoxy herbicides
Cloroprene
Chlorothalonil
Chlorozotocin
Chromium
Chromium (hexavalent compounds)
Chrysene
C.I. Acid Red 114
C.I. Basic Red 9 monohydrochloride
Ciclosporin (Cyclosporin A; Cyclosporine)
Cinnamyl anthranilate
Cisplatin
Citrus Red No. 2
Clofibrate
Coal gasification products
Coal-tars and pitches
Cobalt metal powder
Cobalt [II] oxide
Conjugated estrogens
Copper acetoarsenite
Creosotes
Crystal violet
para-Cresidine
Cupferron
Cycasin
Cyclamates
1,4-cyclohexadiene
Cyclophosphamide (anhydrous)
Cyclophosphamide (hydrated)

D&C Orange No. 17
D&C Red No. 8
D&C Red No. 9
D&C Red No. 19
Dacarbazine
Daminozide
Dantron (Chrysazin; 1,8-Dihydroxyanthraquinone)
dapsone
Daunomycin
DCM
DDD (Dichlorodiphenyldichloroethane)
DDE (Dichlorodiphenyldichloroethylene)
DDT (Dichlorodiphenyltrichloroethane)
DDVP (Dichlorvos)
Decabromodiphenyl ether
N,N'-Diacetylbenzidine
2,4-Diaminoanisole
2,4-Diaminoanisole sulfate
4,4'-Diaminodiphenyl ether (4,4'-Oxydianiline)
2,4-Diaminotoluene
Diaminotoluene (mixed)
Dibenz[a,h]acridine
Dibenz[a,j]acridine
Dibenz[a,h]anthracene
7H-Dibenzo[c,g]carbazole
Dibenzo[a,e]pyrene
Dibenzo[a,h]pyrene
Dibenzo[a,i]pyrene
Dibenzo[a,l]pyrene
1,2-Dibromo-3-chloropropane (DBCP)
1,2-Dibromoethane
2,3-Dibromo-1-propanol
p-Dichlorobenzene
3,3'-Dichlorobenzidine
3,3'-Dichlorobenzidine dihydrochloride
1,4-Dichloro-2-butene
3,3'-Dichloro-4,4'-diaminodiphenyl ether
1,1-Dichloroethane
1,2-Dichloroethane
Dichloromethane (Methylene chloride)
1,2-Dichloropropane
1,3-Dichloropropene

Dieldrin
Dienestrol
Diepoxybutane
Di(2-ethylhexyl)phthalate
1,2-Diethylhydrazine
Diethyl sulfate
DES, Diethylstilbestrol
Diglycidyl resorcinol ether (DGRE)
Dihydrosafrole
Diisopropyl sulfate
3,3'-Dimethoxybenzidine (ortho-Dianisidine)
3,3'-Dimethoxybenzidine dihydrochloride (ortho-dianisidine dihydrochloride)
para-Dimethylaminoazobenzene
4-Dimethylaminoazobenzene
trans-2-[(Dimethylamino)methylimino]-5-[2-(5-nitro-2-furyl)vinyl]-1,3,4-oxadiazole
7,12-Dimethylbenz(a)anthracene
3,3'-Dimethylbenzidine (ortho-Tolidine)
3,3'-Dimethylbenzidine dihydrochloride
Dimethylcarbamoyl chloride
1,1-Dimethylhydrazine (UDMH)
1,2-Dimethylhydrazine
Dimethyl sulfate
Dimethylvinyl Chloride
2,4-dinitrofluorobenzene
1,6-Dinitropyrene
1,8-Dinitropyrene
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,4-Dioxane
1,2-diphenylhydrazine (hydrazobenzene)
Diphenylhydantoin (Phenytoin)
Diphenylhydantoin (Phenytoin), sodium salt
Direct Black 38
Direct Blue 6
Direct Brown 95
Disperse Blue 1

Epichlorohydrin
Erionite
Estradiol 17B
Estrogens (not conjugated)

- Estradiol-17
- Estrone
- Ethinylestradiol
- Mestranol

Estrone
Ethinylestradiol
Ethyl acrylate
Ethyl methanesulfonate
Ethyl-4,4'-dichlorobenzilate
Ethylene dibromide
Ethylene dichloride (1,2-Dichloroethane)
N-Ethyl-N-nitrosourea
Ethylene oxide
Ethylene thiourea
Ethyleneimine
Folpet
Formaldehyde (gas or aqueous solution)
2-(2-Formylhydrazino)-4-(5-nitro-2-furyl) thiazole
Furan
Furazolidone
Furmecyclox
Fusarin C

Glasswool fibers (airborne particles of respirable size)
Glu-P-1 (2-Amino-6-methyldipyrido[1,2- a:3', 2'-d]imidazole)
Glu-P-2 (2-Aminodipyrido[1,2-a:3',2'-d]imidazole)
Glycidaldehyde
Glycidol
Griseofulvin
Gyromitrin (Acetaldehyde methylformylhydrazone)

HC Blue 1
Heptachlor
Heptachlor epoxide
Hexachlorobenzene
Hexachlorocyclohexanes
Hexachlorodibenzodioxin
Hexachloroethane
Hexamethylphosphoramide
Hydrazine
Hydrazine dihydrobromide
Hydrazine sulfate
Hydroquinone
Hydroxybutyric acid lactone

Indeno [1,2,3-cd]pyrene
Indium trichloride
IQ (2-Amino-3-

methylimidazo[4,5-f]quinoline)
Iron dextran complex
Isosafrole

Kepone (Chlordecone)

Lactofen
Lasiocarpine
Lead
Lead acetate
Lead phosphate
Lindane and other hexachlorocyclohexane isomers

Mancozeb
Maneb
Me-A-alpha-C (2-Amino-3-methyl-9H-pyrido[2, 3-b]indole)
Medroxyprogesterone acetate
MeIQ(2-Amino-3,4-dimethylimidazo[4,5-f]quinoline)
MeIQx(2-Amino-3,8-dimethylimidazo[4,5-f]quinoxaline)
Melphalan
Merphalan
Mestranol
2-Methylaziridine (Propyleneimine)
Methylazoxymethanol
Methylazoxymethanol acetate
3-Methylcholanthrene
5-Methylchrysene
4,4'-Methylene bis(2-chloroaniline) (MOCA)
4,4'-Methylene bis(N,N-dimethyl)benzenamine
4,4'-Methylene bis(2-methylaniline)
4,4'-Methylenedianiline
4,4'-Methylenedianiline dihydrochloride
Methylhydrazine and its salts
Methyl chloromethyl ether
Methyl-CCNU
Methyl iodide
Methyl methanesulfonate
2-Methyl-1-nitroanthraquinone
N-Methyl-N'-nitro-N-nitrosoguanidine (MNNG)
N-Methyl-N-nitrosourea
N-Methylolacrylamide
Methylthiouracil
Metiram
Metronidazole
Michler's ketone
Mineral Oils, untreated and mildly treated
Mirex
Mitomycin C
MOPP
Monocrotaline
5-(Morpholinomethyl)-3-[(5-nitro-fufurylidene)-amino]-2-oxazolidinone
Mustard gas

Nafenopin
1-Naphthylamine
2-Naphthylamine
3-Naphthylamine
Nickel and certain nickel compounds
Nickel carbonyl
Nickel subsulfide
Niridazole
Nitrilotriacetic acid
Nitrilotriacetic acid, trisodium salt monohydrate
5-Nitroacenaphthene
5-Nitro-o-anisidine
o-Nitroanisole
4-Nitrobiphenyl
6-Nitrochrysene
Nitrofen
2-Nitrofluorene
Nitrofurazone
1-[(5-Nitrofurfurylidene)amino]-2-imidazollidinone
1-[(5-Nitrofurfurylidene)-N-[4-(5-Nitro-2-furyl)-2 thiazolyl]acetamide
Nitrogen mustard (Mechlorethamine)
Nitrogen mustard hydrochloride (Mechlorethamine hydrochloride)
Nitrogen mustard N-oxide
Nitrogen mustard N-oxide hydrochloride
2-Nitropropane
4-Nitropyrene
N-Nitrosodi-n-butylamine
N-Nitrosodiethanolamine
N-Nitrosodiethylamine
N-Nitrosodimethylamine
p-Nitrosodiphenylamine
N-Nitrosodiphenylamine
N-Nitrosodi-n-propylamine
N-Nitroso-N-ethylurea
3-(N-Nitrosomethylamino)propionitrile
4-(N-Nitrosomethylamino)-1-(3-pyridyl)-1-butanone

(NNK)
N-Nitrosomethylethylamine
N-Nitroso-N-methylurea
N-Nitroso-N-methylurethane
N-Nitrosomethylvinylamine
N-Nitrosomorpholine
N-Nitrosonornicotine
N-Nitrosopiperidine
N-Nitrosopyrrolidine
N-Nitrososarcosine
Norethisterone (Norethindrone)

Ochratoxin A
Oestrogen, nonstreoidal
Oestrogen, steroidal
Oil Orange SS
4,4'-Oxydianiline
Oxadiazon
Oxymetholone
Oxazepam

Panfuran S
Pentachlorophenol
Perylene
Phenacetin
Phenazopyridine hydrochloride
Phenesterin
Phenobarbital
Phenolphthalein
Phenoxybenzamine
Phenoxybenzamine hydrochloride
Phenyl glycidyl ether
Phenylhydrazine and its salts
o-Phenylphenate, sodium
2-phenylphenol
Phenytoin
PhiP(2-Amino-1-methyl-6-phenylimidazol[4,5-b]pyridine)
Polybrominated biphenyls
Polychlorinated biphenyls
Polychlorinated dibenzo-p-dioxins
Polychlorinated dibenzofurans
Polycyclic aromatic hydrocarbons
Polygeenan
Ponceau MX
Ponceau 3R
Potassium bromate
Potassium dichromate
Procarbazine
Procarbazine hydrochloride
Procymidone
Progesterone
Progestins
1,3-Propane sultone
Progargite
beta-Propiolactone
Propylene oxide
Propylthiouracil
Pyridinium chlorochromate

Radionuclides
Radon
Reserpine
Residual (heavy) fuel oils
Rhodamine 101

Saccharin
Saccharin, sodium
Safrole
Selenium sulfide
Shale-oils
Silica, crystalline (airborne particles of respirable size)
Sodium chromate tetrahydrate
Sodium dichromate
Sodium hexafluoroarsenate(V)
Sodium ortho-phenylphenate
Sterigmatocystin
Streptozotocin
Strontium chromate
Styrene
Styrene oxide
Sulfallate
Sulfur trioxide
Sulphur trioxide N,N-dimethylformamide complex

Talc containing asbestiform fibers
Terrazole
Testosterone and its esters
2,3,7,8-Tetrachlorodibenzo-para-dioxin (TCDD)
1,1,2,2-Tetrachloroethane
Tetrachloroethylene (Perchloroethylene)
p-a,a,a-Tetrachlorotoluene
3,3',5,5'-tetramethylbenzidine
Tetranitromethane
Thioacetamide
4,4'-Thiodianiline
Thiourea
Thorium dioxide
Tobacco, oral use of smokeless products
Tobacco smoke
Toluene diisocyanate
p-toluenesulphonic acid

ortho-Toluidine
ortho-Toluidine hydrochloride
para-Toluidine
Toxaphene
Treosulfan (Tresoluphan)
Trichlormethine (Trimustine hydrochloride)
2,4,6-Trichlorophenol
1,2,3-Trichloropropane
Triphenyltin hydroxide
Trichloroethylene
Tris(aziridinyl)-para-benzoquinone (Triaziquone)
Tris(1-aziridinyl)phosphine sulfide (Thiotepa)
Tris(2-chloroethyl) phosphate
Tris(2,3-dibromopropyl)phosphate
TRIZMA base
Trp-P-1 (Tryptophan-P-1) (3-Amino-1,4-dimethyl-5H-pyrido[4,3-b]indole)
Trp-P-2 (Tryptophan-P-2) (3-Amino-1-methyl-5H-pyrido[4,3-b]indole)
Trypan blue

Uracil mustard
Urethane (Ethyl carbamate)
Vinyl bromide
Vinyl chloride
4-Vinyl-1-cyclohexene diepoxide (Vinyl cyclohexene dioxide)
n-vinyl pyrollidone
Vinyl pivalate
Vinyl trichloride (1,1,2-Trichloroethane)

2,6-Xylidine (2,6-Dimethylaniline)

Zineb

This list is by no means complete and is continually being tested and updated.

APPENDIX 7

EXAMPLES OF INCOMPATIBLE CHEMICALS IN STORAGE FACILITIES

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

O-O peroxide	-N= imino	-ONO2 nitrate ester
-NO2 nitro	-N3 azide	-NHNO2 nitramine
-N=N- Azo	-N=O nitroso	-N-NO2 nitroamine

CHEMICAL	CHEMICALS INCOMPATIBLE TO STORE WITH
Acetic acid	Nitric acid, peroxides, permanganates, ethylene, glycol, hydroxyl compounds, perchloric acid, or chromic acid
Acetone	Concentrated sulfuric and nitric acid
Acetylene	Bromine, chlorine, fluorine, copper, silver, mercury and their compounds
Alkali metals	Carbon tetrachloride, carbon dioxide, water, halogens
Aluminum or magnesium metal (powdered)	Carbon tetrachloride, or other chlorinated hydrocarbons, halogens, carbon dioxide
Ammonia, liquid	Mercury, hydrogen fluoride, calcium hypochlorite, chlorine, bromine
Ammonium nitrate	Acids, flammable liquids, metal powders, sulfur, chlorates, any finely divided organic or combustible substance.
Aniline	Nitric acid and hydrogen peroxide
Bromine, chlorine	Ammonia, petroleum gases, hydrogen, sodium, benzene, finely divided metals
Carbon, activated	Calcium hypochlorite and all oxidizing agents
Chlorates	Ammonium salts, acids, metal powders, sulfur, and finely divided organic or combustible substance
Copper	Acetylene and hydrogen peroxide
Flammable liquids	Ammonium nitrate, chromic acid, hydrogen peroxide, sodium peroxide, nitric acid, and the halogens

Hydrocarbons (hexane, gasoline)	Fluorine, chlorine, bromine, sodium peroxide and chromic acid
Hydrofluoric acid	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Most metals and their salts, alcohols, organic substances, any flammable substance
Hydrogen sulfide	Oxidizing gases, fuming nitric acid
Iodine	Acetylene, ammonia, hydrogen
Mercury	Acetylene, ammonia
Nitric acid (concentrated)	Acetic acid, hydrogen sulfide, flammable liquids and gases, aniline
Oxygen	Oils, grease, hydrogen, flammable liquids, solids and gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohols, paper, wood, and other organic material
Phosphorus pentoxide	Water
Potassium chlorate	Sulfuric and other acids, any organic material
Potassium permanganate	Sulfuric acid, glycerine, ethylene glycol
Silver	Acetylene, ammonia compounds, oxalic acid, tartaric acid
Sodium peroxide	Ethyl or methyl alcohol, glacial acetic acid, carbon disulfide, glycerine, ethylene glycol, ethyl acetate
Sulfuric acid	Potassium chlorate, potassium perchlorate, potassium permanganate, similar compounds of other metals

APPENDIX 8

MAXIMUM ALLOWABLE CONTAINER CAPACITY FOR FLAMMABLE LIQUIDS

	Flammable Liquids			Combustible Liquids
CLASS:	**IA**	**IB**	**IC**	**II and IIIA**
Flash Point Range (°C):	fp <23	fp <23	fp 23-38	fp >38
Boiling Point Range (°C):	bp <38	bp >38	bp --	bp --

CONTAINER TYPE MAXIMUM ALLOWABLE CAPACITY

CLASS:	IA	IB	IC	II & IIIA
Glass	0.5 L	1 L	4 L	4 L
Metal (other than DOT drum) or Approved Plastic	4 L	20 L	20 L	20 L
Safety cans	7.5 L	20 L	20 L	20
Metal Drums (DOT)	Not allowed	225 L	225 L	225 L

APPENDIX 9

COMMON GLASSWARE

Beaker:
Material type: Hard glass
Common sizes: 50-2000ml
Common uses: Heating, mixing, dissolving, pouring.

Erlenmeyer:
Material type: Hard glass
Common sizes: 50-2000ml
Common uses: Mixing; dissolving.

Filter flask:
Material type: Hard glass
Common sizes: 125-2000ml
Common uses: Vacuum filtration; vacuum trap.

Round BottomBoiling flask:
Material type: Hard glass
Common sizes: 50-5000ml; 1-, 2-, or 3-hole type
Common uses: Refluxing, distillations.

Graduated cylinder:
Material type: Hard glass
Common sizes: 10-1000ml
Common uses: Measuring with moderate accuracy.

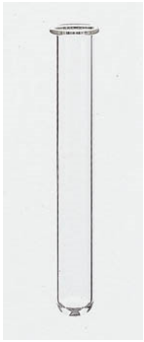
Volumetric flask:
Material type: Hard glass
Common sizes: 1.00 - 2000.00ml
Common uses: Measuring with great accuracy; predetermined volume.

Volumetric pipet:
Material type: Hard glass
Common sizes: 1.00 - 50.00ml
Common uses: Accurate measurement of single volume.

Serological pipet:
Material type: Hard glass, soft glass, or plastic
Common sizes: 0.1 -10ml
Common uses: Transferring solutions; moderately accurate measurement.

Pasteur pipets:(disposable)

Material type: Hard glass
Common sizes: 5.25", 9"
Common uses: Non-accurate transfer of small volumes.



Test tube:
Material type: Hard glass
Common sizes: 10x100-15x175mm (width x length)
Common uses: Mixing small amounts; temporary storage of small volumes.

Centrifuge tubes:
Material type: Hard glass; plastic
Common sizes: 3-500ml; thicker walled than test tubes
Common uses: Separating components of sample with centrifuge.

Culture tube:
Material type: Soft glass, hard glass, plastic
Common sizes: (6x50)-(20x200)mm (width x length)
Common uses: Growing cultures; general purpose small containers.

Petri dish:
Material type: Hard glass; plastic
Common sizes: 60x15-150x15mm (diameter x height)
Common uses: Growing cultures.

Cuvettes:
Material type: Glass, quartz, UV-transparent plastic
Common sizes: 1-10mm path length
Common uses: Spectrophotometric analysis.

Glass tubing:
Material type: Hard glass; soft glass
Common sizes: 0.5-35mm I.D.; 4-37mm O.D.
(I.D.=Inside Diameter, O.D.=Outside Diameter)
Common uses: Constructing special-use apparatus.

Glass rod:
Material type: Soft glass
Common sizes: 6" to 12"
Common uses: Stirring, transferring.

APPENDIX 10

CONTAINER CHEMICAL RESISTANCE CHART

Taken from: http://www.vp-scientific.com/Chemical_Resistance_Chart.htm

PTFE = Polytetrafluoroethylene (Teflon®)

SS = Stainless Steel

LDPE = Convenional Polyethylene

HDPE = Rigid Polyethylene

PP = Polypropylene

PVC = Polyvinylchloride

E = Excellent

G = Good

F = Fair

N = Not Recommended

Chemical	PTFE	SS	LDPE	HDPE	PP	PVC
Acetaldehyde	E	E	G	G	G	G
Acetamide	E	E	E	E	E	N
Acetic Acid, 5%	E	E	E	E	E	E
Acetic Acid, 50%	E	E	E	E	E	E
Acetone	E	E	E	E	E	E
Aluminum Hydroxide	E	E	E	E	E	E
Ammonia	E	E	E	E	E	E
Ammonium Hydroxide	E	E	E	E	E	E
Ammonium Oxalate	E	E	E	E	E	E
n-Amyl Acetate	E	E	G	E	G	F
Amyl Chloride	E	--	N	F	N	N
Aniline	E	E	E	E	G	N

Benzaldehyde	E	--	E	E	E	N
Benzene	E	E	F	G	G	N
Benzoic Acid, Sat.	E	E	E	E	E	E
Benzyl Acetate	E	--	E	E	E	F
Boric Acid	E	F	E	E	E	E
Bromine	E	N	N	F	N	G
Bromobenzene	E	--	N	F	N	F
n-Butyl Acetate	E	F	G	E	G	N
sec-Butyl Alcohol	E	--	E	E	E	G
Butyric Acid	E	E	N	F	N	G
Calcium Hypochlorite	E	F	E	E	E	G
Carbazole	E	--	E	E	E	N
Carbon Disulfide	E	E	N	N	E	N
Carbon Tetrachloride	E	G	F	G	G	G
Chlorine	E	G	G	G	G	E
Chloroacetic Acid	E	F	E	E	E	F
Chloroform	E	E	F	G	G	N
Chromic Acid	E	G	E	E	E	E
Citric Acid	E	E	E	E	E	G
Cresol	E	E	N	F	E	N
Cyclohexane	E	E	G	E	G	G
Decalin	E	--	G	E	G	E
o-Dichlorobenzene	E	--	F	F	F	G
p-Dichlorobenzene	E	--	F	G	E	N
Diethyl Benzene	E	--	N	F	N	N
Diethyl Ether	E	--	N	F	N	F

Diethyl Ketone	E	--	G	G	G	N
Diethyl Malonate	E	--	E	E	E	G
Dimethyl Formamide	E	--	E	E	E	F
Ether	E	E	N	F	N	F
Ethyl Acetate	E	E	E	E	E	F
Ethyl Benzene	E	--	F	G	F	N
Ethyl Benzoate	E	--	F	G	G	N
Ethyl Butyrate	E	--	G	G	G	N
Ethyl Chloride, Liquid	E	E	F	G	F	N
Ethyl Cyanoacetate	E	--	E	E	E	NF
Ethyl Lactate	E	--	E	E	E	F
Ethylene Chloride	E	E	G	G	G	N
Ethylene Glycol	E	E	E	E	E	E
Ethylene Oxide	E	--	F	G	F	F
Fluorine	G	--	F	G	G	N
Formic Acid, 50%	E	F	E	E	E	G
Formic Acid, 90-100%	E	N	E	E	E	F
Fuel Oil	E	E	F	G	E	E
Gasoline	E	E	F	G	E	G
Glycerine	E	E	E	E	E	E
n-Heptane	E	E	F	G	E	F
Hexane	E	E	N	G	E	G
Hydrochloric Acid, 1-5%	E	N	E	E	E	E
Hydrochloric Acid, 35%	E	N	E	E	E	G
Hydrofluoric Acid, 4%	E	N	E	E	E	G
Hydrofluoric Acid, 48%	E	N	E	E	E	G

Hydrogen	E	--	E	E	E	E
Hydrogen Peroxide	E	F	E	E	E	E
Isopropyl Acetate	E	--	G	E	G	N
Isopropyl Benzene	E	--	F	G	F	N
Kerosene	E	E	F	G	G	E
Lactic Acid, 3%	E	G	E	E	E	G
Lactic Acid, 85%	E	F	E	E	E	G
Magnesium Salts	E	G	E	E	E	E
Methoxyethyl Oleate	E	--	E	E	E	N
Methyl Ethyl Ketone	E	E	E	E	E	N
Methyl Isobutyl Ketone	E	E	G	E	G	N
Methyl Propyl Ketone	E	--	G	E	G	N
Methylene Chloride	E	E	F	G	F	N
Nitric Acid, 50%	E	G	E	G	G	G
Nitric Acid, 70%	E	N	E	G	G	F
Nitrobenzene	E	E	F	G	F	N
n-Octane	E	--	E	E	E	F
Orange Oil	E	--	F	G	G	F
Perchloric Acid	E	--	G	G	G	G
Perchloroethylene	E	E	N	N	N	N
Phenol, Crystals	E	E	G	G	G	F
Phosphoric Acid, 1-5%	E	E	E	E	E	E
Phosphoric Acid, 85%	E	G	E	E	E	E
Potassium Hydroxide	E	G	E	E	E	E
Propane Gas	E	E	N	F	N	E
Propylene Glycol	E	E	E	E	E	F

Propylene Oxide	E	--	E	E	E	F
Resorcinol	E	--	E	E	E	F
Salicylaldehyde	E	--	E	E	E	F
Sulfuric Acid, 1-6%	E	F	E	E	E	E
Sulfuric Acid, 20%	E	N	E	E	E	E
Sulfuric Acid, 60%	E	N	E	E	E	E
Sulfuric Acid, 98%	E	N	E	E	E	N
Sulfur Dioxide, Liq.	E	E	N	F	N	F
Sulfur Salts	E	E	F	G	F	N
Tartaric Acid	E	G	E	E	E	E
Tetrahydrofuran	E	E	F	G	G	N
Thionyl Chloride	E	--	N	N	N	N
Toluene	E	E	F	G	G	F
Trichloroethane	E	E	N	F	N	N
Trichloroethylene	E	E	N	F	N	N
Turpentine	E	E	F	G	G	G
Vinylidene Chloride	E	--	N	F	N	N
Xylene	E	E	G	G	F	N
Zinc Salts/Stearate	E	G	E	E	E	E

GLOVE RESISTANCE CHART

Taken from: http://www.abcsafetymart.com/workgloves/chem.html

E - Excellent: Fluid has very little degrading effect.				
G - Good: Fluid has minor degrading effect.				
F - Fair: Fluid has moderate degrading effect.				
P - Poor: Fluid has pronounced degrading effect.				
Nr - Not Recommended: for work with this chemical.				
GLOVE RESISTANCE CHART				
	Nitrile	**Neoprene**	**PVC**	**Latex**
Acetaldehyde	P	E	Nr	E
Acetic Acid, Glacial	G	E	F	E
Acetone	Nr	G	Nr	E
Acrylonitrile	F	G	F	G
Ammonium Fluoride, 40%	E	E	E	E
Ammonium Hydroxide, Conc	E	E	E	E
Amyl Acetate	E	Nr	P	P
Amyl Alcohol	E	E	Nr	E
Aniline	Nr	G	F	G
Animal Fats	E	E	G	P
Aqua Regia	F	G	G	G
Banana Oil	E	Nr	P	P
Benzaldehyde	Nr	Nr	Nr	F
Benzene	P	Nr	Nr	Nr
Benzol	P	Nr	Nr	Nr
Butyl Acetate	F	Nr	Nr	P
Butylene	E	E	F	F
	Nitrile	**Neoprene**	**PVC**	**Latex**
Carbon Disulfide	G	Nr	Nr	Nr

Carbon Tetrachloride	G	Nr	F	Nr
Castor Oil	E	E	E	E
Cello Solve	G	E	P	E
Cellosolve Acetate	F	G	Nr	G
Chlorobenzene	Nr	Nr	Nr	Nr
Chloroform	Nr	Nr	Nr	Nr
Chloronaphthalene	P	Nr	Nr	Nr
Chlorothene Vg	F	Nr	P	Nr
Chromic Acid, 50%	F	Nr	G	Nr
Citric Acid, 10%	E	E	E	E
Coal Tar Distillate	G	F	F	P
Cotton Seed Oil	E	G	G	P
Creosote	G	G	F	G
Cutting Oil	E	E	G	F
Cyclohexanol	E	E	E	E
Di-Isobutyl Ketone	E	P	P	P
Di-Isocyanate	G	G	F	P
Dibutyl Phthalate	G	F	Nr	G
Dichlorethane	F	P	P	Nr
Diethylamine	F	P	Nr	Nr
Dimethyl Formamide, Dmf	Nr	G	Nr	E
Dimethyl Sulfoxide, Dmso	E	E	Nr	E
Dioctyl Phthalate, Dop	G	G	Nr	F
Dioxane	Nr	N	Nr	F
Electroless Copper	E	E	E	E
	Nitrile	**Neoprene**	**PVC**	**Latex**
Electroless Nickel	E	E	E	E
Epoxy Resins, Dry	E	E	E	E

Ethyl Acetate	Nr	F	Nr	G
Ethyl Alcohol	E	E	G	E
Ethyl Ether	E	E	Nr	Nr
Ethyl Formate	G	G	P	F
Ethylene Dichloride	Nr	N	Nr	P
Ethylene Glycol	E	E	E	E
Formaldehyde	E	E	E	E
Formic Acid, 90%	F	E	E	E
Freon, Tf	E	E	Nr	Nr
Freon, Tmc	Nr	N	Nr	Nr
Furfural	Nr	G	Nr	E
Gasoline (White)	E	Nr	P	Nr
Glycerine	E	E	E	E
Grain Alcohol	E	E	G	E
Hexane	E	E	Nr	Nr
Hydraulic Fluid, Ester	G	E	P	P
Hydraulic Fluid, Petrol	E	G	F	P
Hydrazine, 65%	E	E	E	G
Hydrochloric Acid, 10%	E	E	E	E
Hydrofluoric Acid, 48%	E	E	G	G
Hydrogen Peroxide, 30%	E	E	E	E
Hydroquinone, Saturated	E	E	E	G
Iso-Octane	E	E	P	Nr
Isobutyl Alcohol	E	E	F	E
	Nitrile	**Neoprene**	**PVC**	**Latex**
Isopropyl Alcohol	E	E	G	E
Kerosene	E	E	F	E
Lacquer Thinner	G	G	F	F

Lactic Acid, 85%	E	E	E	E
Lauric Acid, 36%/etoh	E	E	F	G
Linoleic Acid	E	E	G	P
Linseed Oil	E	G	F	P
Maleic Acid, Saturated	E	E	G	E
Methyl Alcohol	E	E	G	E
Methyl Ethyl Ketone, Mek	Nr	P	Nr	G
Methyl Isobutyl Ketone, Mibk	P	N	Nr	F
Methyl Methacrylate	P	N	Nr	P
Methylamine	E	G	E	E
Methylene Bromide	Nr	Nr	Nr	Nr
Methylene Chloride	Nr	Nr	Nr	Nr
Mineral Oils	E	E	F	F
Mineral Spirits, Rule 66	E	G	F	Nr
Monoethanolamine	E	E	E	E
Morpholine	Nr	P	Nr	E
Muriatic Acid	E	E	E	G
Naphtha vm&p	E	G	F	Nr
Nitric Acid, 10%	E	E	G	G
Nitric Acid, 70%	Nr	G	F	Nr
Nitrobenzene	Nr	N	Nr	F
Nitromethane, 95.5%	F	E	P	E
Nitropropane, 95.5%	Nr	G	Nr	E
	Nitrile	**Neoprene**	**PVC**	**Latex**
Octyl Alcohol	E	E	F	E
Oleic Acid	E	E	F	F
Oxalic Acid, Saturated	E	E	E	E
Paint & Varnish Removers	G	G	P	F

Paint Thinner	G	G	F	F
Palmitic Acid, Saturated	G	E	G	G
Pentachlorophenol	E	E	F	Nr
Pentane	E	E	Nr	P
Perchloric Acid, 60%	E	E	E	F
Perchloroethylene	G	N	Nr	Nr
Permachlor	G	G	Nr	P
Petroleum Spirits	E	E	P	F
Phenol	Nr	E	G	E
Phosphoric Acid	E	E	G	G
Phosphoric Acid, Conc	E	E	G	G
Pickling Acid	E	E	G	G
Picric Acid, Sat./Etoh	E	E	E	G
Pine Oil	E	E	G	P
Plating Solutions	E	E	E	E
Potassium Hydroxide/koh 50%	E	E	E	E
Printing Inks	E	E	F	G
Propyl Acetate	F	P	Nr	F
Propyl Alcohol	E	E	F	E
Propylene Oxide	Nr	Nr	Nr	P
Rubber Solvent	E	G	Nr	Nr
Silicon Etch	Nr	G	F	Nr
	Nitrile	**Neoprene**	**PVC**	**Latex**
Skydrol 500	P	P	P	F
Sodium Hydroxide/naoh, 50%	E	E	G	E
Stearic Acid	E	E	G	E
Stoddard Solvent	E	E	F	Nr
Styrene	Nr	Nr	Nr	Nr

Sulfuric Acid, 10%	G	E	G	E
Sulfuric Acid, 95%	Nr	F	G	Nr
Tannic Acid, 65%	E	E	E	E
Tetrahydrofuran, thf	Nr	Nr	Nr	Nr
Toluene	F	Nr	Nr	Nr
Toluene Di-isocyanate, tdi	Nr	Nr	Nr	Nr
Toluol	F	Nr	Nr	Nr
Trichlorethylene, tce	Nr	Nr	Nr	Nr
Tricresyl Phosphate, tcp	E	F	F	E
Triethanolamine, 85% tea	E	E	E	G
Trinitro Toluol	E	G	G	P
Triptane	E	E	P	P
Tung Oil	E	E	F	P
Turpentine	E	Nr	P	Nr
Vegetable Oils	E	G	F	F
Wood Alcohol	E	E	G	E
Wood Preservative, penta	G	G	F	F
Xylene	G	Nr	Nr	Nr

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GLOSSARY

DEFINITIONS and ACRONYMS OF COMMON SAFETY ITEMS

AGENCIES and CODES

ACGIH - American Conference of Governmental Industrial Hygienists

CFR - Code of Federal Regulations

DOSH – Washington State Department of Labor & Industries, Division of Occupational Safety and Health (Washington State equivalent of OSHA)

FDA - U.S. Food and Drug Administration

IARC - International Agency for Research on Cancer

OSHA - U.S. Occupational Safety and Health Administration

NFPA - National Fire Protection Association

NFPA Code - A numerical code that rates chemicals under fire conditions, exists for a limited number of chemicals and doesn't represent hazards under normal laboratory use.

NIOSH - National Institute for Occupational Safety and Health

NIOSH -RTECS - Registry of Toxic Effects of Chemical Substances -Found in major libraries

WISHA - Washington Industrial Safety and Health Act Chapter 49.17 of the Revised Code of Washington (RCW) enacted in 1973 by Washington State legistlation. Administered by the Washington State Department of Labor & Industries (L&I), Division of Occupational Safety and Health (DOSH)

DEFINITIONS

ALC - The Approximate Lethal Concentration in air for experimental animals: The test animal and the test condition should be specified; the value is expressed in mg/liter, mg/m3, or ppm.

HMIS/HMIG - Hazardous Materials Identification System/Guide - A chemical label system utilizing a numerical code rating of chemicals for health, flammability, and reactivity hazards, and designating personal protective equipment.

IDLH - Immediately Dangerous to Life or Health level representing a maximum concentration from which one could escape within 30 minutes without any escape impairing symptoms or any irreversible health effects

LC - Lethal Concentration, a measure of acute inhalation toxicity.

LC50 - The concentration in air that causes death of 50% of the test animals: The test animal and the test conditions should be specified; the value is expressed in mg/liter, mg/m3, or ppm. The higher the number, the lower the toxicity.

LD - Lethal Dose, a measure of acute oral and dermal toxicity.

LD50 - The quantity of material that when ingested, injected, or applied to the skin as a single dose will cause death of 50% of the test animals: The test conditions should be specified; the value is expressed in g/kg or mg/kg of body weight. The higher the number, the lower the toxicity.

SDS - Safety Data Sheet. A form produced by the chemical product's manufacturer that lists the physical, chemical, and physiological hazards of that chemical.

OEL - Occupational Exposure Limit is the allowable exposure to a substance for a specified amount of time.

PEL - Permissible Exposure Limits over an 8 hour time-weighted average to which any employee may be exposed without adverse effects. It is set by regulation and enforced by OSHA; most of these limit values were originally set by consensus by ACGIH to assist industrial hygienists in implementing exposure control programs.

STEL - Short Term Exposure Limit (15 minutes unless otherwise noted) which should not be exceeded during a work day.

TLV (TWA) - The Threshold Limit Value established by ACGIH: The Time Weighted Average concentration for a normal 8-hour workday or 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.

Carcinogenic - Causing malignant (cancerous) tumors. OSHA, NIOSH, and FDA consider any tumor to be either a cancer or a precursor of cancer.

Embryotoxic - Poisonous to an embryo (without necessarily poisoning the mother).

Experimental Carcinogen - A substance that has been shown by valid, statistically significant experimental evidence to induce cancer in animals.

Human Carcinogen - A substance that has been shown by valid, statistically significant epidemiological evidence to be carcinogenic to humans.

Mutagenic - Causing a heritable change in gene structure

Oncogenic - Causing tumors

Teratogenic - Producing a malformation of the embryo

Tumorigenic - Causing tumors

AGENCIES DEALING WITH CHEMICAL HAZARDS

FEDERAL

OSHA - Occupational Safety and Health Administration - regulates worker exposure.

RIGHT-TO-KNOW (RTK) or **FEDERAL HAZARD COMMUNICATION STANDARD** -a set of rules to carry out the Worker Right to Know Act updated 1987. Ensures employers evaluate chemical hazards, distribute proper information.

EPA - Environmental Protection Agency - regulates chemicals in air, water, and land, under the following Acts of Congress:

RCRA - Resource Conservation and Recovery Act of 1976, as amended (Federal Hazardous Waste Laws).

CERCLA -Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund Laws).

SARA - Superfund Amendments and Reauthorization Act (1986). SARA Title III is also known as the Emergency Planning and Community Right-to-Know Act (CRTK).

DOT - Dept. of Transportation - shipping, transport on public roads.

STATE

L & I - Department of Labor and Industries - will help you meet the requirements of the Hazard communication Standard (RTK).

DOE - Dept. of Ecology - administers the Community Right-to-Know Act (CRTK) -- administers the Hazardous Waste Laws (RCRA).

DSHS - Dept. of Social and Health Services - Environmental Health

For student safety, the DSHS administers The School Safety **WAC** (248-64-350) which provides guidelines for safety in the lab.

HOT LINE/INFORMATION PHONE NUMBERS

POISON CONTROL CENTER	800-542-6319
HAZARDOUS SUBSTANCE/WASTE (DOE)	800-633-7585
WORKER RIGHT TO KNOW (L&I)	800-423-7233
WASTE REDUCTION & RECYCLING (DOE)	206-438-7541
RECYCLE	800-732-9253
Also county health departments	
COMMUNITY RIGHT TO KNOW (Title III/SARA) (DOE)	800-535-0200
ASBESTOS	800-272-3780
CHEM TREC - Chemical Transportation Emergency Center	800-424-9300