Indus University

IISHLS

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Unit: 4 - Chemical Safety& Ethical Handling of Chemicals

❖ Safe working procedure and protective environment

➢ Safe Working Procedure

→ Section 5(a)(1) of the **Occupational Safety and Health Act of 1970 (OSH Act),** the General Duty Clause, requires that employers "shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or likely to cause death or serious physical harm to his employees."

→ **Safe work practices are generally written methods outlining how to perform a task with minimum risk to people, equipment, materials, environment, and processes.**

→ All safe work practices should be kept in a location central to the work being performed and readily available to the workforce. Some safe work practices will require specific job procedures, which clearly set out in a chronological order each step in a process.

→ Safe work procedures for your facility do not have to follow a format, however, your safe work procedures should include:

- **Name or description of the work task**
- **Date the SWP was created and date it was last reviewed or revised**
- **Hazards that may cause harm to a worker**
- **Common signs and symptoms of a musculoskeletal injury if the hazards of the job task could lead to this type of injury**
- **Equipment / devices, personal protective equipment (PPE), or other safety considerations necessary to perform the task safely**
- **Required training and / or relevant documentation needed to perform the task safely**
- **Steps to perform the task safely including safe body positions and / or movements as appropriate**
- **Indication that workers are to be trained on the SWP and employers must ensure workers follow them**

→ Safe work procedures must be based on a risk assessment. They must also be developed in consultation with your workplace safety and health committee or representative and be approved by management. Workers must be trained in the safe work procedures for your facility so they

understand the steps and equipment they must use to work safely. Supervisors must ensure that safe work procedures are followed. Safe work procedures should be readily available to workers for reference.

❖ Personal Protective Equipment (PPE):

→ Personal protective equipment is equipment worn to minimize exposure to a variety of hazards.

→ Examples of PPE include such items as lab coats, gloves, foot protection (steel-toed shoes),eye protection (safety glasses or goggles), protective hearing devices (earplugs, muffs), hard hats, respirators, fall protection harnesses, etc.

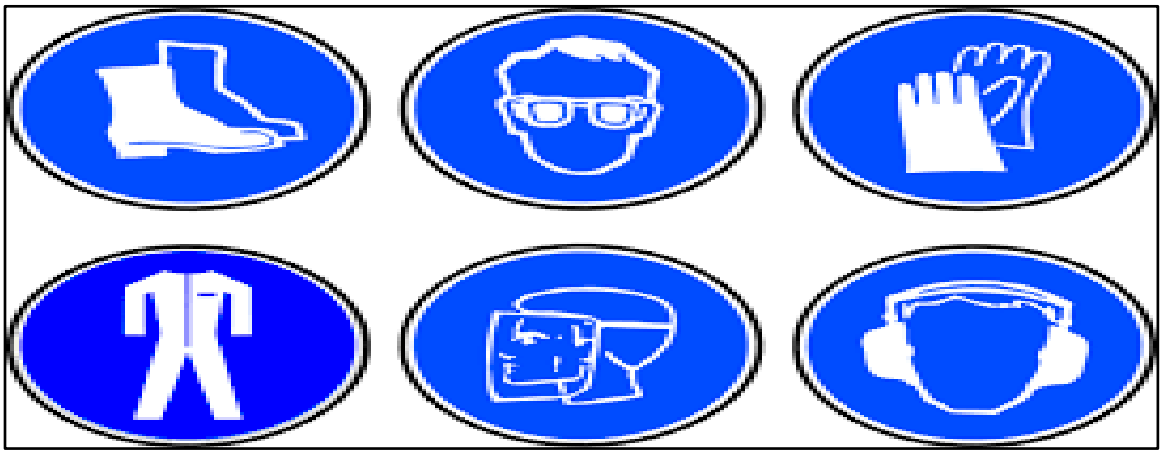
→ Body Protection -Protective clothing, such as lab coats, should be worn when handling hazardous materials. This will prevent the contamination of skin and clothing

→ **Eye/Face Protection -** Equipment designed to provide protection to the face and eyes during exposure to such hazards as flying particles, molten metal or sparks, liquid chemicals, acids or caustic liquids, or potentially injurious light radiation (i.e., lasers, welding, etc.)

→ **Foot Protection -** Equipment designed to provide protection to the feet and toes during exposure to situations with the potential for foot injuries such as falling or rolling objects, chemical or liquid exposures, piercing objects through the sole or uppers, and/or where the employee's feet are exposed to electrical hazards.

→ **Hand Protection -** Equipment designed to provide protection to the hands during exposures to potential hazards such as sharp objects, abrasive surfaces, temperature extremes and chemical contact. Hand protection is selected based upon the hazard and performance characteristics of the gloves.

→ **Respiratory Protection -** Equipment designed to provide protection to the wearer from potential inhalation hazards such as vapors, mists, particulates, and gases.



Applicable PPE	Specific type (example)	Characteristics	Applications
Lab Coats	Knee length lab coats 	Protects skin and clothing from dirt, inks, non-hazardous chemicals, biohazards without aerosol exposure	General use; Chemical, Biological, Radiation, and Physical Hazards
	Flame resistant lab coat 	Flame resistant (e.g. Nomex or flame-resistant cotton)	Working with water or air reactive chemicals, large volumes of organic solvents, potentially explosive chemicals
Gowns	Disposable gowns 	Clothing and skin protection	Working with biohazards
	Tyvek gowns 	High tear resistance, protection from particulates	Working with biohazards with potential for exposure to airborne transmissible disease
Cap	Bouffant caps 	Economical protection for hygienic work environments; protection from dirt, dust	Working with biohazards, especially in animal facilities
Shoe Cover	Disposable shoe covers 	Protection from dirt, dust; maintenance of hygienic work environments. Adjustable fit, non-skid soles	Working with biohazards, especially in animal facilities

Applicable PPE	Specific type (example)	Characteristics	Applications
Light latex, vinyl or nitrile gloves	Disposable latex gloves 	Powdered or un-powdered	Working with biological hazards (known or potentially known infectious materials including work with animals)
	Disposable nitrile gloves 	Puncture, abrasion resistant, protection from splash hazards	Working with biological hazards and chemical splash hazards
	Disposable vinyl gloves 	Economical, durable, similar to latex	Working with biological hazards
Light chemical resistant gloves	Natural rubber latex 	Chemical resistant, liquid-proof	Working with small volumes of corrosive liquids, organic solvents, flammable organic compounds
Light to heavy chemical resistant gloves	Nitrile gloves 	Chemical resistant, good puncture, cut, and abrasion resistance	Apparatus under pressure, air or water reactive chemicals
Heavy chemical resistant gloves	Butyl gloves 	High permeation resistance to most chemicals	Large volumes of organic solvents, small to large volumes of dangerous solvents, acutely toxic or hazardous materials
	Viton® II gloves 	High permeation resistance to most chemicals	Same as butyl gloves, plus hazardous material spills

Applicable PPE	Specific type (example)	Characteristics	Applications
Heavy chemical resistant gloves (cont.)	**Butyl/Silver Shield gloves and apron** 	Extra chemical and mechanical protection	Same as butyl and Viton II gloves, added mechanical protection, hazardous material spills
Insulated gloves	**Terrycloth autoclave gloves** 	Heat resistant	Working with hot liquids and equipment, open flames, water bath, oil bath
	Cryogen gloves 	Water resistant or water proof, protection against ultra-cold temperatures	Cryogenic liquids handling
Wire mesh gloves		Cut resistant	Working with live animals
Chemical resistant apron	**Rubber-coated wash apron** 	Chemical splash protection, good abrasion resistance	Working with apparatus under pressure, air or water reactive chemicals, large volumes of corrosive liquids
	Neoprene apron and sleeves 	Chemical resistant, tear resistant; splash protection	Water or air reactive chemicals, large volumes of corrosive liquids, small to large volumes of acutely toxic corrosives

Applicable PPE	Specific type (example)	Characteristics	Applications
Respirators	**Surgical masks** 	Used for bacterial filtration	Working with live animals; working with infectious material with potential aerosol exposure
	N-95 	Protects against dusts, fumes, mists, microorganisms	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments
	Half face 	Air purifying respirator protects against variety of particulates, vapors, dust, mists, fumes; depends on filter cartridge used	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments; chemical vapors; particulates
	Full face 	Same as half- face, but with greater protection factor, and greater protection of eyes and face; depends on filter cartridge used	Working with live animals or infectious materials with known airborne transmissible disease; dusty environments; chemical vapors; particulates
	PAPR 	Air supplying respirator; delivers steady supply of filtered air with loose fitting hoods	Working in BSL – 3 environments; working in dusty environments; chemical vapors, particulates; used when full- face or half –face respirator doesn't fit individual

❖ Emergency procedure, and first aid

➢ RECOMMENDED SAFETY EQUIPMENT

→ **Plumbed-in eyewash station:** Be advised of the risk of possible bacterial contamination with portable eyewash stations where the bottles may have been unused for long periods of time. Note also that these bottles do not supply a sufficient amount of water to flush the eyes for the recommended 15 minutes.

→ **Safety shower:** Operation must be verified on a regular basis. This includes ensuring the proper flow of clean water.

→ **Chemical splash goggles stored in a UV-sanitizing goggle cabinet:** Some schools may require students to purchase goggles rather than sharing them.

→ **Chemical and flame-resistant laboratory aprons and coats:** There should be written procedures for the handling, storage, cleaning, and disposal of aprons and coats.

→ **Fire extinguisher:** Different types of extinguishers for various classes of fire. Teachers who are authorized to use a fire extinguisher must be trained on its proper use.

→ **First aid kit:** As a general rule, teachers should not provide first aid to students. Call on the school nurse or emergency medical personnel if any student is in need of medical assistance. Follow your school's protocol about requesting the school nurse to come to the site of the accident. Be sure to also notify the student's parents or guardians about the incident.

→ **Broken glass disposal container**

→ **Fire blankets:** These are no longer recommended for the high school laboratory. Practice "Stop, Drop, and Roll" instead.

➢ EXITS AND EMERGENCY DRILLS

→ Exits should be clearly marked, and drills should be conducted to practice emergency response.
→ At the beginning of each semester, students should learn how to use all safety equipment. The teacher should demonstrate appropriate use of the eyewash station and safety shower and explain how spills and broken glass are handled.

➢ EMERGENCY RESPONSE

→ In a school setting, maintenance or custodial staff will be handling much of the laboratory waste and spills. It is vital that anyone who has access to the laboratory is aware of spills, broken glassware, or any other relevant chemical information in the workplace.

➢ Special Considerations in the Laboratory

- **BROKEN GLASSWARE**

→ Handle broken glassware with gloves, and do not allow students to clean it up. A dustpan and brush, reserved for that purpose, may be useful for cleaning up broken glassware. If a dangerous chemical is on the glassware, treat the glassware as contaminated and dispose of it accordingly.
→ Broken, non-contaminated glassware must be disposed of in appropriate containers (i.e., broken glass disposal boxes). Also, if broken glass disposal boxes are used, the entire box must be disposed of, not just the inner plastic bag of broken glass. Do not attempt to reuse the boxes!

- **FIRES**

→ Fires are a special consideration in the laboratory, due to the various kinds of fires that can occur and the different responses necessary.

Types of Fire Extinguishers

Type	Class of Fire
Dry chemical (multipurpose)	A, B, C
Water	A ONLY (will not work for other types of fires)
Foam	B ONLY (will not work for other types of fires)
Carbon dioxide (not to be used in confined areas)	B, C
Halon	B, C
Metal	D
Potassium acetate	K

Note: In most cases, the high school laboratory will require a dry chemical extinguisher, but if you possess solid sodium or other reactive metals, a metal fire extinguisher is also recommended.

Source: OSHA. Fire Protection and Prevention, 2009. www.osha.gov/dte/grant_materials/fy09/sh-18796-09/fireprotection.pdf (accessed June 19, 2015).

- **SPILLS**

→ Prevent the spread of dust and vapors by closing the laboratory door and increasing ventilation.

1. Control the spread of liquid and absorb it with vermiculite, special absorbent material (e.g., Oil-Dri), cat litter, or spill pillows.

Note: Hydrofluoric acid and concentrated sulfuric acid require special materials for absorption. Hydrofluoric acid and perchloric acid should never be present in a high school laboratory.

2. Neutralize acids and bases:

a) Neutralize acids with sodium carbonate (soda ash) or sodium bicarbonate (baking soda);
b) Bases can be neutralized with citric acid or ascorbic acid; and
c) Use pH paper to determine when acid or base spills have been neutralized.

3. Collect and contain residues and place them in a plastic bag or bucket.

4. Dispose of the waste according to the SDS and local ordinances.

5. Decontaminate the area and the affected equipment using standard cleaning supplies (for most spills) or according to the SDS.

➢ What if an Emergency Occurs?

→ Teachers must receive all necessary training in case of an incident or emergency Normally, teachers should not provide medical treatment for students. However, in some cases the teacher may have to act before medical personnel arrive. The emergency training must include how to use an eyewash station and safety shower, for example:

→ 1. **If the chemical is in the eye: Flush water using an eyewash station for at least 15 minutes. Medical attention must be summoned as soon as possible.**

→ 2. **If the chemical is swallowed or ingested: Do not induce vomiting unless the SDS recommends vomiting. Medical attention must be summoned as soon as possible.**

→ 3. **If the chemical comes into contact with skin: Rinse the affected area for 15 minutes with tap water. It may be necessary to use a safety shower. If the safety shower is used, all contaminated clothing should be removed while the person is under the safety shower, and medical attention must be summoned as soon as possible**

❖ Safe storage and use of Hazardous chemicals

When storing hazardous chemicals in your workplace, take the following steps:

1. Read the safety data sheet (SDS) or label carefully, and follow any storage recommendations.
2. Secure the chemicals against unauthorized access or use.
3. Only keep minimal amounts of chemicals onsite. Ensure that all chemicals are clearly and correctly labelled, and that the labels are intact and legible.
4. Do not allow chemicals to be exposed to the sun, excessive heat or sources of ignition.
5. Provide adequate ventilation.
6. Label shelves and cupboards so that chemicals can be stored in the right place.
7. Use important notice where required.
8. Ensure clear segregation schemes are maintained. Chemicals must be separated when being stored to ensure that incompatible chemicals do not mix if there is a spill.
9. Keep the outside of containers clean and the storage area tidy.
10. Do not store liquids above solids to avoid contamination in the event of a leak.
11. Always store corrosives on spill trays.
12. Ensure shelves are not overloaded.
13. Never store flammable liquids in refrigerators or freezers unless they have been modified, i.e. spark-proofed.
14. Separate incompatible chemicals that could react dangerously if stored together.

➢ Storage Don’ts

❌ Don’t store chemicals in a sink or fume hood, except for certain toxic gases that are so dangerous they can only be stored in a gas cabinet or fume hood.

❌ Don’t store chemicals on dirt or grass, near a creek or storm drain entrance, where they could contaminate the environment.

❌ Don’t store chemicals on the floor, window ledges, or balconies

➢ Storage of Chemicals

→ Bulk stocks must be stored in a separate building.

→ A spill or fire involving bulk containers will be difficult to tackle when compared with that involving smaller bottles.

→ Chemicals must not be placed indiscriminately in the storage shelf. They must be grouped based on their compatibility.

→ In the event of an accidental breakage, incompatible chemicals that are stored in close proximity can mix to start a fire, hazardous fumes or explosions.

→ To prevent accidents caused by overreaching do not store chemicals on shelves higher than 1.5 meter (from floor level).

→ Fix the shelf to the wall to prevent its fall.

→ **Chemicals must not be exposed to heat or direct sunlight. Heat and sunlight can degrade chemicals, deteriorate storage containers and labels.**

→ Store heavier or larger bottles on lower racks.

→ Store flammable chemicals in approved safety cabinets.

→ There must be a fixed storage place for each chemical and the same must be returned to that location after each use.

→ Toxic or odoriferous chemicals must be stored in a ventilated cabinet.

→ Chemicals must not be stored at locations where they can be knocked over.

→ Rim guards must be fixed on the edge of shelves to prevent bottles from falling.

➢ Globally Harmonized System (GHS) for Classifying Hazardous Chemicals

→ The Globally Harmonized System (GHS) is an internationally adopted system for the classification and labeling of hazardous chemicals. It includes established criteria for classifying hazards and for further categorizing (or rating) the hazards according to their relative risks. The GHS provides established language and symbols for each hazard class and each category within a class.

GHS Hazard Symbols and Their Definitions

GHS Symbol	GHS Class
	**Explosive** ◆ Explosives ◆ Self-reactive substances ◆ Organic peroxides
	**Flammable** ◆ Flammable gases, aerosols, liquids, and solids ◆ Pyrophoric liquids or solids ◆ Self-heating substances ◆ Self-reactive substances ◆ Substances that emit a flammable gas upon contact with water ◆ Organic peroxides
	**Corrosive** ◆ Skin corrosion/burns ◆ Eye damage ◆ Corrosive to metals
	**Oxidizer** ◆ Oxidizing gases, liquids, and solids
	**Compressed gas** ◆ Gases under pressure

GHS Symbol	GHS Class
	**Toxic Substance** ◆ Acutely toxic substances that may be fatal or toxic if inhaled, ingested, or absorbed through the skin
	**Irritant** ◆ Irritant (skin and eye) ◆ Skin sensitizer ◆ Acute toxins ◆ Narcotic effects ◆ Respiratory tract irritants ◆ Hazardous to ozone layer (non-mandatory)
	**Health Hazard** ◆ Respiratory sensitizers ◆ Carcinogens ◆ Mutagens ◆ Reproductive toxins ◆ Target organ toxins, single exposure or repeated exposure ◆ Aspiration toxins
	**Environmental Hazard (non-mandatory)** ◆ Acute aquatic toxins ◆ Chronic aquatic toxins

➢ National Fire Protection Association Hazard Identification System

→ The National Fire Protection Association (NFPA) developed a hazard identification system for emergency responders that is still in use today. In the past some chemical manufacturers used NFPA diamonds on their products, but now labels are required to use GHS labeling.

→ The NFPA diamond provides a quick visual representation of the health hazard, flammability, reactivity, and special hazards that a chemical may pose during a fire.

→ The NFPA diamond consists of four color-coded fields: **Blue**, **Red**, **Yellow**, and **white.**

→ The blue, red, and yellow fields—which represent **health hazard**, **flammability,** and **reactivity**, respectively use a numbering scale ranging from 0 to 4.

→ A value of **0** means that the material poses essentially **no hazard**, whereas a **rating** of **4** indicates extreme **danger**. The **white field is used to convey special hazards.**

NFPA Hazard Identification System			
BLUE Diamond Health Hazard	**RED Diamond Fire Hazard (Flash Points)**	**YELLOW Diamond Reactivity**	**WHITE Diamond Special Hazard**
4 Deadly	**4** Below 73 °F	**4** May Detonate	**ACID** – Acid
3 Extreme Danger	**3** Below 100 °F	**3** Shock and Heat May Detonate	**ALK** – Alkali
2 Hazardous	**2** Above 100 °F Not Exceeding 200 °F	**2** Violent Chemical Change	**COR** – Corrosive
1 Slightly Hazardous	**1** Above 200 °F	**1** Unstable if Heated	**OXY** – Oxidizer
0 Normal Material	**0** Will Not Burn	**0** Stable	Radioactive
			Use No Water

Common Laboratory Hazards

Common Laboratory Hazards		
Hazards	**Cautions**	**Examples**
Acids and bases	Due to their corrosive nature, they can irritate or even burn the eyes, irritate the skin, and cause respiratory distress. The risk is higher when they are concentrated, but even when diluted they can be hazardous. Protective equipment, including chemical goggles, aprons, and gloves, is essential. The teacher should research the handling of specific acids or bases by studying the SDSs before using them.	*Acids:* hydrochloric acid, nitric acid, sulfuric acid, acetic acid, phosphoric acid *Bases:* sodium hydroxide, potassium hydroxide, ammonia
Biological agents	These are chemicals or organisms that increase the rate at which natural biodegradation occurs. They have the ability to adversely affect human health in a variety of ways, ranging from relatively mild, allergic reactions to serious medical conditions, even death. They should be handled only by teachers with the knowledge and skills to work with them safely. They are not recommended for use in the pre-college setting.	Bacteria, fungi
Compressed gases	These are not common in the pre-college setting. The compressed gas cylinders come in all sizes. High school laboratories generally use lecture bottles rather than large gas cylinders, which require the use of special pressure regulators and valves. The cylinder should always be kept secured. The cap should always be on when not in use. The valves and regulators should be routinely checked for leaks.	Helium, nitrogen, carbon dioxide, hydrogen, oxygen
Corrosives	These can cause severe burns on contact. It is important to minimize exposure to these by wearing chemical goggles, aprons, and gloves to prevent damage to the skin or eyes.	*Acids:* HCl, H_2SO_4, HNO_3 *Bases:* NaOH, KOH, NH_4OH *Gases:* NO_2, NH_3 *Oxidizing agents:* H_2O_2, $KMnO_4$, HNO_3
Cryogenics	These are chemicals stored at very low temperatures. They should be handled with special cryogenic gloves. Only teachers should handle these substances.	Dry ice (solid CO_2), liquid nitrogen

Hazards	Cautions	Examples
Electrical hazards	Electricity has long been recognized as hazardous. It can cause electric shock, electrocution, burns, fires, and even explosions. Ideally, all of the electrical circuits in a science laboratory should include ground fault circuit interrupters (GFCIs), which are designed to protect people from electrical hazards. Any electrical circuits used for measuring conductivity, or similar circuits, unless they are battery-powered, must contain a momentary switch. The teacher should ensure that all electrical devices are functioning properly and that the electrical cords are in good condition.	Hot plates, magnetic stirrers, any equipment plugged into an electrical outlet
Flammables	These are most commonly used in the laboratory as solvents. Never use any type of open flame or any source of ignition around flammable chemicals. *Note: It is the vapors from flammable liquids that are flammable, and when one opens a bottle of flammable liquid, the first thing that leaves the bottle is the vapor (flammable part) from the top of the bottle.*	Acetone, ethanol, ethyl acetate, hexane, methanol
Halogens	These elements are highly reactive, toxic, corrosive, and capable of irritating the skin. In the pre-college setting, they should only be used in small quantities by the teacher in a well-ventilated hood, using appropriate PPE and with an appropriate reducing agent (sodium thiosulfate) present to clean up spills.	Fluorine, chlorine, bromine, iodine *Note: Fluorine is extremely poisonous and requires special equipment and handling.*
Hydrocarbons and volatile organic compounds	These compounds are combustible or flammable and can irritate the skin. Used in a confined space, they can cause asphyxiation. They should always be used in a well-ventilated area or hood, and away from any open flames. Flammables and combustibles must never be heated on a hot plate.	Hexane, pentane, petroleum ether, acetone, methanol, ethanol
Mercury	Mercury is a serious chronic health hazard. Although it is not readily absorbed through the skin, its greatest health hazard is due to inhalation of its vapors, usually as a result of a spill. All mercury or mercury-containing devices should be removed from the pre-college laboratory. Mercury compounds (e.g., alkyl mercury) are extremely toxic and must be handled with extreme care.	Mercury-in-glass thermometers and barometers

Hazards	Cautions	Examples
Oxidizing agents/ oxidizers and reducing agents	An oxidizing agent is a substance that causes oxidation, or the loss of electrons from an atom, compound, or molecule. A reducing agent is a substance that causes reduction, or the gain of electrons. Oxidation and reduction always occur together. Oxidation–reduction reactions tend to release heat, so oxidizers and reducing agents can cause other materials to combust more readily. Always store oxidizing and reducing agents away from each other and from flammable materials. Look up which substances are incompatible in the SDSs. *Note: Mixing oxidizing agents (nitric acid) with organic materials in waste bottles has resulted in many explosions.*	*Oxidizing agents:* chlorates, chromates, dichromates, hypochlorites, nitrates, nitric acid, nitrites, perchlorates, permanganates, peroxides *Reducing agents:* alkali metals, alkaline earth metals, hydrogen gas, carbon monoxide
Peroxides	These are a group of chemicals that have an oxygen-to-oxygen bond (R–O–O–R). Care must be taken when handling inorganic or organic peroxides, since they tend to be unstable and can, depending on the compound, decompose violently. Some peroxides are used as reactants, but peroxides as contaminants in other chemicals are also a concern. Peroxides that contaminate organic solvents are of particular concern. Peroxides form slowly in some organic solvents, and as their concentrations increase they present a greater hazard. At the pre-college level, it is best to avoid using or storing these organic solvents. Should these compounds be needed, only the quantity needed for experiments should be ordered so that there is no need for storage.	*Common peroxides used in the pre-college setting:* hydrogen peroxide, H_2O_2 *Peroxide-forming substances to avoid:* ethers, alkenes, secondary alcohols, ketones, alkali metals
Pyrophorics	These are substances that readily ignite and burn in air spontaneously. These substances have no place in the pre-college setting. They should be handled only by chemists with the knowledge and skills to work with them safely.	White phosphorus, alkali metals and their compounds

❖ General Safety Procedures for Working with Reactive Chemicals

1. Find out as much as possible about the reagents and procedures before the experiment.
2. Investigate the purity of the reactive chemical. Determine whether impurities or spontaneous decomposition products (such as peroxides) will make the experiment more hazardous.
3. Conduct small-scale preliminary experiments to assess the thermodynamic and physical properties of the reaction.
4. Use as little of the reactive chemical or as dilute a solution as possible.
5. Consider all methods of controlling reaction variables. The rate of addition can be controlled as well as the rate at which the energy of activation is supplied. Cool exothermic reactions adequately to control the reaction rate. Remember to provide cooling

arrangements for both liquid and vapor stages if appropriate. Pressure relief valves should be include in pressurized systems and checked before adding chemicals to the system.

6. Determine the proper degree of agitation and mixing rate. Add oxidants slowly with appropriate cooling or mixing.
7. Use a face shield in addition to goggles when appropriate.
8. Work in a fume hood using the sash as a protective shield.
9. Have emergency equipment in the immediate area.
10. Notify people in the laboratory of any new or unique hazards that could potentially be created by use of a reactive chemical.

➢ Special Procedures for Peroxide Forming Chemicals

→ It is important that information on the age of peroxide forming chemicals be maintained and that these chemicals are tested or disposed of on a regular basis.

→ All peroxidizable compounds should be labeled with preprinted labels that read:

→ **PEROXIDIZABLE COMPOUND**

May Become Explosive With Time or Exposure to Air or Light

Date Opened: Discard Date:

→ The date and discard period should be filled in the first time the container is opened, along with test dates and associated results.

→ The level of peroxides can be tested using peroxide test strips. Peroxidizable compounds must be tested for safety every 6 months and the bottled dated with the most recent test date. Do not use these materials if more than six months have passed since the most recent date indicated on the bottle. The lab manager should be made aware of any peroxide forming substances in Cole Science Center.

❖ Compressed Gases

→ Compressed gas cylinders are defined by the U. S. Department of Transportation (DOT) as any materials or mixtures in containers having an absolute pressure in excess of 40 psi at 20ºC (70ºF) or in excess of 104 psi at 54.5ºC (130ºF).

→ Compressed gas cylinders should be considered high-energy sources regardless of the type of gas and all should be treated as potential explosives. Compressed gases have many properties that make them a unique hazard, such as their pressure, diffusivity, low flash points for flammable gases, low boiling points, and, for some, no visual and/or odor warnings.

✶ Compressed Gas Safety Guidelines

[A] Identification "ALWAYS READ THE LABEL"

- The contents of any compressed gas cylinder must be clearly identified. Gas identification should be stenciled or stamped on the cylinder or a label. Commercially available three-part tag systems may be used for identification and inventory.

- No compressed gas cylinder should be accepted for use that does not legibly identify its contents by name. If the labeling on a cylinder becomes unclear the cylinder should be marked "contents unknown" and returned to the supplier.

- Do not rely on the color of the cylinder for identification. Color-coding is not reliable because cylinder colors may vary with supplier. Also, never rely on labels on caps because they are interchangeable.

- All gas lines leading from a compressed gas supply should be clearly labeled to identify the gas and the area served. The labels should be coded to distinguish hazardous gases such as flammable, toxic, or corrosive substances. Signs should be posted in areas where flammable compressed gases are stored or used, identifying the substance and appropriate precautions.

[B] Handling and Use

1. **Before cylinders are first used the following precautions should be taken:**

- Make sure the cylinder is equipped with the correct regulator.
- Inspect the regulator and cylinder valves for grease, oil, dirt, and solvent. Never use grease

or oil to lubricate regulators or cylinder valves because they can cause an explosion.

- The cylinder should be placed so that the valve handle at the top is easily accessible.
- When using toxic or irritating gas, the valve should only be opened while the cylinder is in a working fume hood.
- Only use wrenches or tools that are provided by the cylinder supplier to open or close a valve. Pliers should never be used to open a cylinder valve. Some regulators require washers; this should be checked before the regulator is fitted.
- Refer to Safety Data Sheet [SDS] for the gas being used for information regarding use and toxicity.
- Fire extinguishing equipment should be readily available when combustible materials can be exposed to welding or cutting operations using compressed cylinder gases.

2. Cylinder Storage

- Gas cylinders must be secured at all times to prevent tipping.
- Use appropriate material, such as chain, plastic coated wire cable, commercial straps, etc., to secure cylinders.
- Gas cylinders can not be stored in public hallways or other unprotected areas
- Cylinders must be segregated in hazard classes while in storage. Oxidizers (oxygen) must be separated from flammable gases, and empty cylinders must be isolated from filled cylinders.
- The proper storage for oxygen cylinders requires that a minimum of 20 feet is maintained between flammable gas cylinders and oxygen cylinders or the storage area be separated, at a minimum, by a firewall five (5) feet high with a fire rating of 30 minutes.
- Store out of direct sunlight and away from sources of heat and ignition; temperatures must not exceed 125 F.
- Acetylene cylinders must never be stored on their sides.
- Always place valve protectors on gas cylinders when the cylinders are not connected for use.
- Cylinders must be protected from damage. Do not store cylinders near elevators or gangways, or in locations where heavy-moving objects may strike or fall on them

- Cylinders must be stored where they are protected from the ground to prevent rusting. Cylinders should be protected against tampering by unauthorized individuals.
- Storage areas must be well-ventilated, cool, dry, and free from corrosive materials.

3. Moving Cylinders

- Never drag, slide or roll a cylinder; use a cylinder cart or basket.
- Always have the protective cap covering the valve when transporting the cylinder.
- Never transport the cylinder with the regulator in place.
- Make sure the cylinder is secured to the cart before moving it.
- Do not drop cylinders or strike them against each other or against other surfaces violently.
- Do not use the valve cover to lift cylinders; they could be damaged and become unattached. If the cylinder is dropped on a hard surface it can cause an explosion.

4. Use and Operation

- Only properly trained personal should handle compressed gas cylinders.
- Back off the pressure adjusting screw of the regulator to release spring force before opening the cylinder valve.
- Open the valve slowly and only with the proper regulator in place. Stand with the cylinder between yourself and the regulator (cylinder valve outlet facing away) when opening the cylinder valve.
- Acetylene or other flammable gas cylinder valves should not be opened

more than 1⁄2 turns of the spindle, and preferably no more than 3⁄4 of a turn. This reduces the risk of explosion and allows for the cylinder valve to be closed quickly cutting off the gas flow.

- Never heat a cylinder to raise the pressure of the gas (this can defeat the safety mechanisms built in by the supplier).
- Keep the cylinder clear of all electrical circuits, flame, and sparks.
- Never leave the valve open when equipment is not in use, even when empty; air and moisture may diffuse through an open valve, causing contamination and corrosion within the cylinder.

- **Storage Area**

→ Cylinders must be stored in designated storage areas away from ignition sources, corrosives, electrical supply sources and heat.

→ Store oxidizers away from flammable gases. Oxygen and fuel gases must be separated by a distance of at least 25 feet or by a firewall meeting the standards established by the Compressed Gas Association's CGA P-1. As an alternative, oxygen can be moved directly to the area of use.

→ The valve protection cap must always be kept on , except when a cylinder is in use.

→ Cylinders must be chained or strapped, or otherwise mounted, securely in place to prevent them from falling over. Cylinders must be individually mounted or strapped.

→ Corrosive gases should be stored for the shortest possible time period: under three months is preferable.

→ Cylinders may not be stored in areas not protected from the weather.

→ Cylinders must be clearly labeled with the contents, by the vendor's identification label. If labels are coming off, notify the lab manager immediately. Unlabeled cylinders cannot be returned to the vendor.

❖ Procedures for working with gases at pressures above or below atmospheric pressure

→ Compressed gas cylinders can be extremely hazardous when misused or abused. Compressed gas cylinders can present a variety of hazards due to their pressure and/or content.

→ Compressed Gas Safety Guidelines

→ Without proper use and care compressed gas cylinders can explode killing workers and destroying equipment. Cylinders can also become flying projectiles when cylinder valves are damaged or broken off. Regulators can become bullets that tear through workers if safety precautions are not taken.

✶ Compressed Gas Safety Guidelines

A. Identification "ALWAYS READ THE LABEL"

- The contents of any compressed gas cylinder must be clearly identified. Gas identification should be stenciled or stamped on the cylinder or a label. Commercially available three-part tag systems may be used for identification and inventory.

- No compressed gas cylinder should be accepted for use that does not legibly identify its contents by name. If the labeling on a cylinder becomes unclear the cylinder should be marked "contents unknown" and returned to the supplier.

- Do not rely on the color of the cylinder for identification. Color-coding is not reliable because cylinder colors may vary with supplier. Also, never rely on labels on caps because they are interchangeable.

- All gas lines leading from a compressed gas supply should be clearly labeled to identify the gas and the area served. The labels should be coded to distinguish hazardous gases such as flammable, toxic, or corrosive substances. Signs should be posted in areas where flammable compressed gases are stored or used, identifying the substance and appropriate precautions.

B. Handling and Use

1. Before cylinders are first used the following precautions should be taken:

- Make sure the cylinder is equipped with the correct regulator.
- Inspect the regulator and cylinder valves for grease, oil, dirt, and solvent. Never use grease or oil to lubricate regulators or cylinder valves because they can cause an explosion.
- The cylinder should be placed so that the valve handle at the top is easily accessible.
- When using toxic or irritating gas, the valve should only be opened while the cylinder is in a working fume hood.
- Only use wrenches or tools that are provided by the cylinder supplier to open or close a valve. Pliers should never be used to open a cylinder valve. Some regulators require washers; this should be checked before

the regulator is fitted.

- Refer to Safety Data Sheet [SDS] for the gas being used for information regarding use and toxicity.
- Fire extinguishing equipment should be readily available when combustible materials can be exposed to welding or cutting operations using compressed cylinder gases.

2. Cylinder Storage

- Gas cylinders must be secured at all times to prevent tipping.
- Use appropriate material, such as chain, plastic coated wire cable, commercial straps, etc., to secure cylinders.
- Gas cylinders can not be stored in public hallways or other unprotected areas
- Cylinders must be segregated in hazard classes while in storage. Oxidizers (oxygen) must be separated from flammable gases, and empty cylinders must be isolated from filled cylinders.
- The proper storage for oxygen cylinders requires that a minimum of 20 feet is maintained between flammable gas cylinders and oxygen cylinders or the storage area be separated, at a minimum, by a firewall five (5) feet high with a fire rating of 30 minutes.
- Store out of direct sunlight and away from sources of heat and ignition; temperatures must not exceed 125 F.
- Acetylene cylinders must never be stored on their sides.
- Always place valve protectors on gas cylinders when the cylinders are not connected for use.
- Cylinders must be protected from damage. Do not store cylinders near elevators or gangways, or in locations where heavy-moving objects may

strike or fall on them.

- Cylinders must be stored where they are protected from the ground to prevent rusting. Cylinders should be protected against tampering by unauthorized individuals.
- Storage areas must be well-ventilated, cool, dry, and free from corrosive materials.

3. Moving Cylinders

- Never drag, slide or roll a cylinder; use a cylinder cart or basket.

- Always have the protective cap covering the valve when transporting the cylinder.
- Never transport the cylinder with the regulator in place.
- Make sure the cylinder is secured to the cart before moving it.
- Do not drop cylinders or strike them against each other or against other surfaces violently.
- Do not use the valve cover to lift cylinders; they could be damaged and become unattached. If the cylinder is dropped on a hard surface it can cause an explosion.

4. Use and Operation

- Only properly trained personal should handle compressed gas cylinders.
- Back off the pressure adjusting screw of the regulator to release spring force before opening the cylinder valve.
- Open the valve slowly and only with the proper regulator in place. Stand with the cylinder between yourself and the regulator (cylinder valve outlet facing away) when opening the cylinder valve.
- Acetylene or other flammable gas cylinder valves should not be opened more than 1⁄2 turns of the spindle, and preferably no more

than 3⁄4 of a turn. This reduces the risk of explosion and allows for the cylinder valve to be closed quickly cutting off the gas flow.

- Never heat a cylinder to raise the pressure of the gas (this can defeat the safety mechanisms built in by the supplier).
- Keep the cylinder clear of all-electrical circuits, flame, and sparks.
- Never leave the valve open when equipment is not in use, even when empty; air and moisture may diffuse through an open valve, causing contamination and corrosion within the cylinder.
- Do not refill a cylinder; mixing of residual gases in a confined area may cause a dangerous reaction.

✶ IMPORTANT THINGS TO REMEMBER

- Never use copper fittings or tubing on acetylene tanks – an explosion may result.
- Never use compressed gas to dust off clothing, this could cause injury to the eyes or body and create a fire hazard. Clothing can become saturated and burst into flames if touched off by an ignition source such as a spark or cigarette.
- Never leave pressure in a regulator when it is not in use.
- Valve protection caps should remain in place until ready to withdraw gas, or connect to a manifold.
- Cylinder discharge lines should be equipped with approved check valves to prevent inadvertent contamination of cylinders connected to a closed system.
- Do not force connections that do not fit.
- Close the cylinder valve and release all pressure before removing the

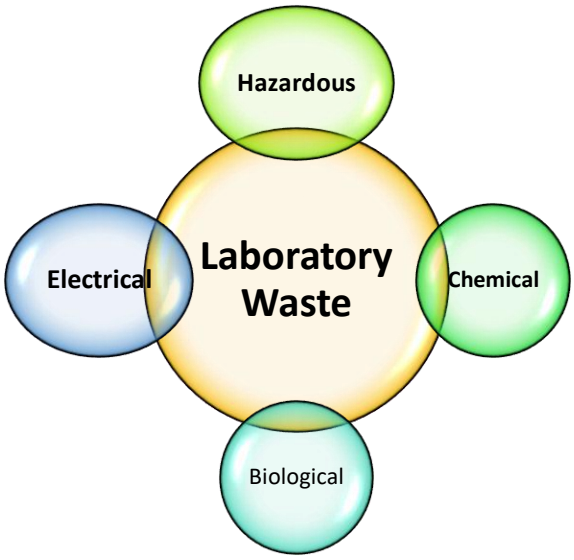
regulator from the cylinder.

- Do not smoke when oxygen or fuel gases are present. Smoking can cause a fire or explosion.
- Do not use acetylene at operating pressures above 15 psi.
- Purge fuel and oxygen hoses individually before lighting up a torch tip.
- Follow the equipment manufacturer's operating instructions at all times.
- If an outlet valve becomes clogged with ice, thaw it with warm water (if the gas is not water reactive), applied only to the valve.
- Use the cylinder valve for turning gas off, not the regulator.

- Workers should wear safety glasses and face shields when handling and using compressed gases, especially when connecting and disconnecting regulators and lines.

❖ Laboratory Waste: Reduce, Reuse, Recycle

- Laboratory waste is waste that is generated from laboratories in industry and in educational centers such as secondary schools and universities. This waste can be broken down into a number of categories:



[Laboratory Waste Categories]

- Reducing laboratory waste will have a number of benefits, saving money and reducing disposal costs while also encouraging safety in the lab.

How to Reduce Laboratory Waste

- Look at purchasing procedures. Buy only what is needed, reducing wastage due to expiry.
- Find a reliable supplier who will deliver small amounts of chemicals at short notice. Ask if they will take back unused chemicals.
- A centralised purchasing programme should be considered. This means that all orders are placed with a delegated person who may be able to take advantage of bulk pricing.
- All chemicals and wastes in the lab should be labelled. A waste chemical has no use. This labelling system should be standardised.

- Separate waste into the following streams for treatment, reuse or disposal:

  - ✓ Sharps including scalpels and syringes;
  - ✓ Glassware;
  - ✓ Biological samples;
  - ✓ General lab waste such as wipes, gloves, tissue;
  - ✓ Chemicals.

✶ How to Reuse Laboratory Waste

- Reusing an item is often the best way of reducing waste.
- Try to incorporate recovery activities during the experiment.
- A chemical swap might be possible with other institutions in your area.
- All wastes should be segregated based on chemical incompatibilities e.g. hazardous and non-hazardous wastes should not be mixed together. The same is true of organic and inorganic waste.
- Waste consisting of the same material type can be segregated.
- Waste streams that are capable of being recycled should be stored separately i.e. recoverable metals or solvents.

✶ How to Recycle Laboratory Waste

- Some material generated in the lab will be non-hazardous waste such as paper and packaging waste that can be recycled. To promote and encourage recycling of this material place recycling bins in the lab.
- Make sure the recycling bin is labelled clearly by placing a label on the bin stating paper only, ensuring that hazardous wastes such as chemicals are not placed in the bin.

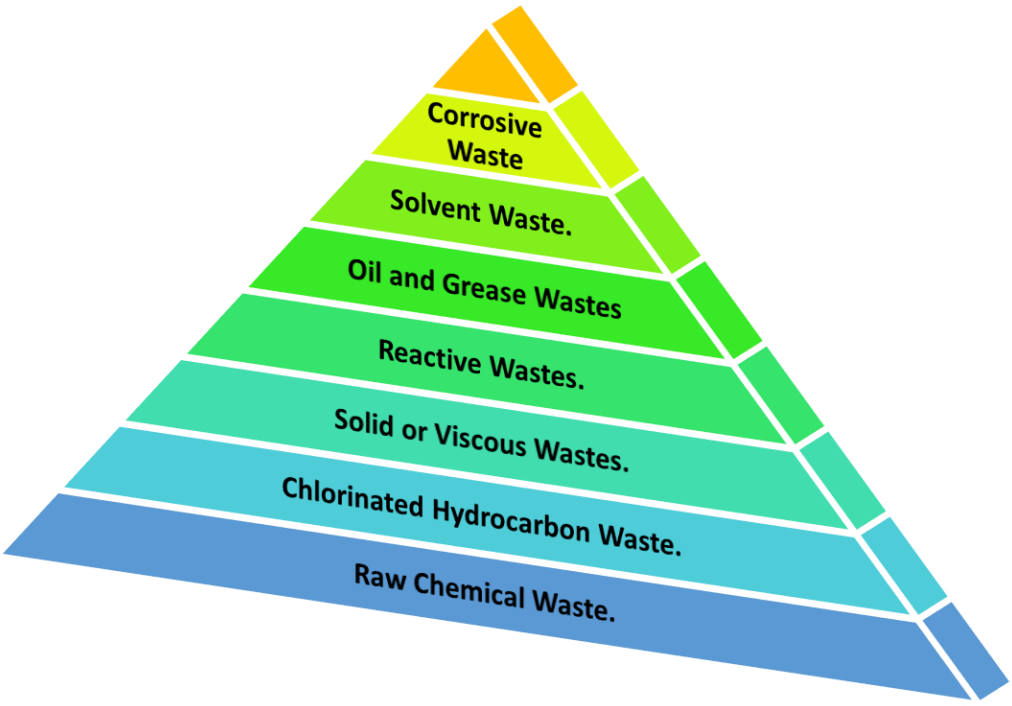
- Bins for the collection of hazardous materials should be placed in the lab. These should be emptied regularly and looked after by lab personnel/technicians.
- All waste from the lab should be collected by a waste collector with a valid waste collection licence, who is specialised in hazardous waste collection and who is licensed to treat and dispose of the waste.

✶ Disposal of Laboratory Waste

- Lab glassware is not suitable for recycling, as its melting point is higher than that of conventional glass. Broken glassware should be collected in puncture proof containers and disposed of in large containers by technical staff. It is not to be placed in a normal waste bin.
- Sharps such as syringes and scalpel blades should be collected in containers labelled “Sharps”.
- Biological waste such as agar plates, waste from dissections etc. should be separated and collected separately. Where appropriate this can be autoclaved.

❖ Standard Operating Procedures Waste Handling & Disposal

- **Order Only What You Need**
- **Substitute Non-Hazardous Or Less Hazardous Materials For Hazardous Ones**
- **Dispose of Nonhazardous Materials Yourself**
- **Use Recycled Chemicals Whenever Possible**
- **Treat Chemicals In Your Laboratory**
- **Date Opening**



Types of waste in laboratory

➢ Hazardous Characteristics

1 IGNITABILITY

→ A liquid which has a flash point of less than 60 ^{0} C is considered ignitable by the Environmental Protection Agency (EPA). This includes almost all organic solvents. Some examples are: Ethyl ether, Methanol, Ethanol, Acetone, Toluene, Benzene, Pentane, Hexane, Skelly B, Xylene, Formaldehyde, Heptane, Ethyl Acetate, Petroleum Ether

2 CORROSIVITY

→ An aqueous solution having a pH of less than or equal to 2, or greater than or equal to 12.5 is considered corrosive by the EPA.Corrosive materials also

include thionyl chloride, solid, sodium hydroxide and other nonaqueous acids or bases.

3. REACTIVITY

→ Chemicals that react violently with air or water are considered reactive by the EPA. An example is sodium metal. Reactive materials also include strong oxidizers, such as perchloric acids, and chemicals capable of detonation when subjected to an initiating source, such as old picric acid and phosphorous. Solutions of cyanide or sulfide that could generate toxic gases are also classified as a reactive by EPA.

Chemical Waste Disposal Guideline

Innocuous aqueous waste

- **Acid** (pH<4)
- **Alkali** (pH>10)
- Harmless soluble inorganic salt
- Alcohol containing salt
- Hypochlorite solution
- Fine (tlc grade) silica and alumina

These chemicals should be washed down with excess water.

Organic Solvent

- **Chlorinated**

Example: DCM, Chloroform, Chlorobenzene etc.

- **Non-Cholronated**

Example: THF, ethyl acetate, hexane, toluene, methanol, etc.

Red List

- Compounds with transitional metals
- Biocides
- Cyanides
- Mineral oils and hydrocarbons
- Poisonous organosilicon compounds
- Metal phosphides
- Phosphorus element
- Fluorides and nitrites.

Solid Waste

- Lightly contaminated

Example: Gloves, empty vials/centrifuge .

Broken Glassware

Broken glassware are usually collected in plastic-lined cardboard boxes for landfilling. Due to contamination, they are usually not suitable for recycling.

❖ Disposal of chemicals For the Sanitary Sewer System

→ You can safely dispose of many chemicals into the sanitary sewer system if they are water soluble, degradable in the sanitary sewer and properly diluted. Examples are given in the following list. Chemicals in solid form should be followed by twenty (20) parts of water.

→ Disposal in the sewer system (down the drain) had been a common method of waste disposal until recent years. However, environmental concerns, the viability of publicly owned treatment works (POTW), and a changing disposal culture have changed that custom markedly. In fact, many industrial and academic laboratory facilities have completely eliminated sewer disposal. Again, like trash disposal, most sewer disposal is controlled locally, and it is therefore advisable to consult with the POTW to determine what is allowed. Yet, it is often reasonable to consider disposal of some chemical waste materials in the sanitary sewer. These include substances that are water-soluble, that do not violate the federal prohibitions on disposal of waste materials that interfere with POTW operations or pose a hazard, and that are allowed by the local sewer facility.

→ Chemicals that may be permissible for sewer disposal include aqueous solutions that readily biodegrade and low-toxicity solutions of inorganic substances. Water-miscible flammable liquids are frequently prohibited from disposal in the sewer system. Water-immiscible chemicals should never go down the drain.

→ Disposal of regulated hazardous waste into the sanitary sewer is allowed only in limited situations. The total wastewater must be a mixture of domestic sewage along with the waste whose amount and concentration meet the regulations and limits of the POTW. If approved of by the local district, it may be allowable to dispose of dilute solutions of metals and other hazardous chemicals into the sanitary sewer.

→ Under the Clean Water Act, some exemption from regulation as a hazardous waste for wastewater containing laboratory-generated listed waste is allowed. In 1993, this exemption was expanded to include corrosive and ignitable wastes. For the exemption to apply, these laboratory wastes must be 1% or less of the annual total wastewater quantity reaching the facility's headworks or have an

annualized average concentration of no more than 1 part per million (ppm) of the wastewater generated by the facility.

→ Waste should be disposed of in drains that flow to a POTW, never into a storm drain and seldom into a septic system. Waste should be flushed with at least a 100-fold excess of water, and the facility's wastewater effluent should be checked periodically to ensure that concentration limits are not being exceeded.