LABORATORY SAFETY POLICIES

Introduction

The science classroom laboratory with its equipment, glassware, and chemicals has the potential for accidents. In order to avoid dangerous accidents, or to minimize their damage, precautions must be taken by every student and staff to ensure the safety of everyone working in the laboratory. Following are the safety rules for handling chemicals and carrying out procedures which will help to create a safe environment in the laboratory.

GENERAL SAFETY AND OPERATIONAL RULES

1. A laboratory coat should always be worn while working.
2. Clothing worn in the laboratory should offer protection from splashes and spills, should be Laboratory clothing should be kept clean and replaced when necessary.
3. Eating or drinking within laboratories is not permitted
4. Work areas should be kept free from obstruction.
5. No running or jumping in a laboratory is permitted. Stored items or equipment shall not block access to the fire extinguisher(s), safety equipment, or other emergency items and access to emergency equipment and/or exits must be kept dry and unobstructed; i.e., no storage, no equipment, phone or other wiring. No combustible material such as paper, wooden boxes, pallets, etc., shall be stored under stairwells or in hallways.
6. No food or beverage may be stored in the cold Laboratory refrigerators and freezers.
7. Mouth pipetting is never allowed.
8. Never use chipped or cracked glassware. Broken glassware should be discarded in a special "glass only" container.
9. Always wash your hands before you leave the lab.

Protective Clothing

It is important to be properly dressed when working in a laboratory. Appropriate clothing is probably the first caution a person needs to take who works in the laboratory. A laboratory coat or apron should always be worn while working. Other protective clothing such as gloves and shoes should be used. Expensive clothing should not be worn as they may get damaged by splashing of harmful liquids.

A laboratory coat provides enough protection in case of splashes and minimizes the contact of chemicals with the skin. Shorts and skirts should never be worn as they expose large areas of the skin. Special shoes are not necessary, however, using sandals, open-toed shoes and cloth shoes are not safe.

Equipment and Apparatus

Working safely with hazardous chemicals requires proper use of laboratory equipment. Maintenance and regular inspection of laboratory equipment are essential parts of this activity. Equipment should not be handled unless one is sure it is functioning properly. All broken and cracked glassware's should be rejected. Before assembling the apparatus, one should be acquainted with the different pieces. Laboratory Instructor should always be asked when in doubt.

Handling Chemicals

All chemicals are either dangerous, toxic, hazardous, inflammable or corrosive. If they are not handled rightly, they can cause varying degrees of injuries.

Following are some rules that help to prevent contamination of the chemicals, but can also be used to prevent users from having problems caused by undesirable events during the use.

a. Never use a wrong or an unmarked reagent. If you are unsure about the compound, do not use it. Instead, have it disposed of (see Disposal of Hazardous Waste).
b. Do not return chemicals to their original packaging. An incompatible mixture may accidentally be formed. Keep chemical containers closed. Dust and vapour may

escape from an open container, while gases and suspended material may penetrate this, causing the nature of the chemical to change. This will also avoid unnecessary exposure.

c. Never put spatulas, stirrers or other objects into a storage container for chemicals.

d. Remove the contents by pouring and rolling the contents of the glass into a beaker, glass container or other suitable equipment. Spatulas may be used with caution in laboratory reagent containers. Remember the labelling (see the Safety Rules for work-ing in lab).

e. Never put any chemicals in the bottle other than the one indicated on the label. Special precautions should be taken when handling concentrated acids. Dilution of acids should be performed by pouring the acid into water and stirring continuously

f. Acids, alkalies and bromine cause severe burns if brought in contact with the skin. Acetic anhydride and acetyl chloride bring tears to the eyes. Alcohols, benzene, carbon disulfide and ethers are highly inflammable. Diazo compounds, peroxides and azides are explosive. Silver nitrate, mercuric chloride, copper sulfate, etc., are considerably poisonous if taken internally by oversight. An exceptional precaution should be exercised in working with such chemicals. Always read the instructions on the label of the bottle before opening.

Corrosive and Toxic Reagents

A corrosive substance is one that will damage or destroy other substances with which it comes into contact by means of a chemical reaction. Such reagents require special attention during their use. A corrosive reagent causes visible destruction of or irreversible chemical action at the site of contact. While working with such reagent's gloves should be worn. In case of accidental spill or contact with the skin, the affected area should be washed immediately with liberal quantities of water. Phenol, bromine and various mineral acids cause severe burns. Mineral acids are also very corrosive. Toxic chemicals are very harmful on ingestion, inhalation or absorption by skin. These chemicals are also very hazardous to health.

Flammable Materials

Always follow the general guidelines when using flammable materials or fire hazard chemicals and reagents. Solvents form a major part of the inflammable material commonly used in an organic chemistry laboratory. One should not heat a reaction flask containing a solvent using a burner. Such solvents should be distilled or evaporated on a steam bath, hot plate or sand bath. Alcohols, carbon disulfide, benzene, toluene, ether, etc., catch fire easily. Diethyl ether has a very low flash point and has a considerable narcotic effect.

Some gases like hydrogen and certain solids such as Lithium aluminum hydride liberate hydrogen on reaction with water which is an extensively inflammable gas. Sodium and potassium undergo explosive reaction with water. Any excess sodium metal in sodium fusion should be destroyed in methanol and not in water.

Irritant and Lachrymatory Chemicals

A lachrymator is an irritant that causes tearing (watering of the eyes).Eg, acid chlorides, thionyl chlorides and acid anhydrides. These affect the eyes and the respiratory system. In general, many low boiling compounds can also be listed under this category. These reagents should be handled in the fume hood.

Eye Protection

The human eye is the most valued sense organ and at the same time the most vulnerable because of its fragility. Protection of the eye is most important. Whenever possible eye hazards should be controlled at the source, for example, splashing of liquids, flying objects, enclosures to confine dust, vapours or fumes. Besides safety glasses must always be worn while performing an experiment. Ordinary glasses do not provide adequate protection since they do not have side shields, and also many may not have shatter-proof lenses. Do not look directly into the open mouth of a test tube in which a reaction is being conducted.

Electrical Hazards

Person working in the laboratory may be exposed to electrical hazards including electric shock, arc blasts, electro-cautions, fires and explosions. Potential exposures to electrical hazards can result from faulty electrical equipment/instrumentation or wiring, damaged receptacles and connectors, or unsafe work practices. To avoid such hazards, follow these best practices while using electrical equipment:

Do not use electrical equipment to perform a task for which it is not designed.

- Most equipment includes either a 3-pronged plug or double insulation. Equipment with neither of these features is less safe but may meet electrical codes. You will not be protected from electric shock if a 3-pronged plug is not inserted into a 3-prong outlet. If you plug more than two pieces of low demand equipment into a standard outlet, use a fused power strip that will shut off if too much power is used.
- Make sure that any outlet near a sink or other water source is Ground-Fault Circuit Interrupter (GFCI) protected. If you have a GFCI, periodically test it by plugging something into it and pushing the "test" button. Once the equipment shuts off just turn it back on. Above all, do not disable any electrical safety feature.
- Before turning equipment on, check that all power cords are in good condition. Do not use extension cords as a substitute for permanent wiring.
- If you see a person being electrocuted, DO NOT TOUCH THEM! The electricity can go through you, too. If possible, turn off the power (pull the plug or trip the circuit breaker), or use an item made of non-conductive material (e.g. Wooden broom handle) to pry him or her away from the contact.

Disposal of Chemicals and Solid Wastes

Proper chemical waste management protects the health and safety of everyone and prevents or minimizes pollution. In general, a waste is considered hazardous if it is ignitable, corrosive, toxic or reactive.

It can be considered that all chemical wastes generated in a chemical laboratory are hazardous. It is observed that waste chemicals if water soluble are simply poured down the drain accompanied with a large amount of tap water. Material not soluble in water is simply thrown out in the trash. All these create serious environmental problems nowadays. It is, therefore, the duty of everyone working in the laboratory not to dispose off the waste in a haphazard manner and thus risk the health of others. Organic solvents are used in plenty and many of them are miscible with water and are inflammable. These should not be thrown in the sink. Different labelled containers should be used for storing the solvents.

If possible, solvents like acetone, ethanol and benzene may be redistilled for reuse for cleaning purposes. Acids and alkalies should be neutralized before pouring them down the sink. A large amount of solid waste such as filter papers, drying agents, broken glasswares, chromatographic supports, cotton, aluminum foil, etc., is generated in the laboratory. These are non-toxic and should be packaged in suitable containers and disposed off. Toxic material, on the other hand requires special treatment before disposal. The instructor should be consulted on the procedure.

Guidelines in case of Accident or Injury

The above guidelines are intended to prevent accidents in the chemical laboratory. However, in the event of an accident or injury one should know what to do. The first important point is one should not panic, the instructor is to be informed immediately and medical assistance called if necessary. Minor Cuts from broken glassware's are common in the laboratory. The cut should be thoroughly flushed under the tap and then covered with an appropriate bandage. If the cut is serious medical assistance should be sought. Similarly minor burns from hot equipment or chemicals are a constant hazard. Try not to touch hot glass. Wash the affected area with water and ask for medical assistance.

Burning Chemicals and Clothing from low boiling inflammable organic solvents is the most common fire hazard in the laboratory. If the fire is limited to a small container like a beaker then cover it with a wire gauze. Since all inflammable solvents are less

dense than water, water should never be used to extinguish fire. Sand is often useful. For larger fires, a fire extinguisher is required which should be available in the laboratory. Learn the location and operation of a fire extinguisher. For fires beyond control, the fire alarm should be sounded and fire services summoned. In the event of one's clothes catching fire, the victim should roll over on the ground to extinguish the fire or should be covered with a fire blanket. A fire extinguisher should not be used on a person.

Toxicity and Hazards of Chemicals

In our daily life we handle chemicals in one form or the other whether it is in the laboratory or the house or contamination of the atmosphere. Most of these chemicals are inherently toxic and hazardous. Toxicity is the inherent property of a molecule to produce injury on reaching a susceptible site or in an organism. They harm by inhalation, ingestion or absorption by skin. They should, thus be handled with the utmost care to avoid threat to the health and life. For your own health and safety, exercise caution while handling chemicals and minimize your exposure to them. A brief description of the hazardous properties and effects on the human body of some basic chemicals is given below:

(**TLV** (Threshold limit value) is the concentration of an airborne constituent to which a person may be repeatedly exposed without adverse effect for a normal 8 hr work day).

Acetaldehyde: It is a gas at room temperature, b.p. 21°C, flammable and pungent smelling. The TLV* is 200 ppm. Inhalation of its vapors causes irritation of eyes, skin and respiratory organs. Acetaldehyde should be stored in a cool place.

Acetic anhydride: It is a liquid b.p. 139.9°C, possess a pungent odour. It decomposes slowly with water to form acetic acid. The TLV is 5 ppm. Acetic anhydride irritates eyes, skin and mucous membrane and causes nausea.

Acetonitrile: It is a colourless liquid, b.p. 81.6°C, possess aromatic odour and is toxic. It is flammable, TLV is 40 ppm, it causes acute headache, dizziness and nausea when inhaled.

Acetyl chloride: It is a colourless fuming liquid, b.p. 52°C. With water, it decomposes violently to form acetic acid and hydrochloric acid. It is highly irritant and causes inflammation of skin. Store in well ventilated cool room.

Acrolein: It is a colourless, flammable and pungent liquid, b.p. 59.7°C. TLV is 0.1 ppm. Its vapors cause inflammation of eyes, nose, skin and throat. Acrolein should be handled in a fume hood.

Ammonia: Ammonia is colourless gas, b.p. -33.5°C. It has a sharp irritating odour and is soluble in most solvents. TLV is 50 ppm. Its inhalation may cause suffocation and damage to lungs. Ammonia is immensely irritant to skin and also causes nausea, cough, bronchitis.

Aniline: It is colourless oily liquid, b.p. 184°C. It darkness on exposure to air. TLV is 5 ppm. It causes dizziness, nausea, abdominal pain and malaise.

Benzene: It is a colourless to yellow liquid, b.p. 80°C and highly flammable. TLV is 10 ppm. Breathing benzene causes euphoria, headache, narcosis, dizziness and rapid heart rate. Long term exposure to benzene can affect the bone marrow and decrease red blood cells leading to anaemia.

Bromine: It is a dark reddish-brown liquid, b.p. 58.8°C only slightly soluble in water. Bromine rapidly vaporizes at room temperature; the fumes are very irritating and is an extremely unpleasant chemical. TLV is 0.1 ppm. It causes skin burns, dizziness, headache, bronchitis and nausea. Store in a cool dry place and out of direct sunlight.

n-Butanol: It is a colourless liquid, b.p. 177°C. It has a moderate fire risk. TLV is 100 ppm. On inhalation it causes respiratory inflammation, paralysis and dizziness. n-Butyl acetate: It is a volatile liquid with fruity odour, b.p. 126.5°C. TLV is 150 ppm. It causes conjunctivitis, cough, headache and anorexia (loss of appetite).

n-Butyllithium: Commercially a stable solution of n-butyllithium is obtained in pentane or heptane. It is strongly irritant and toxic and ignites on contact with moist air. The solution should be preserved below 15°C.

Carbon disulfide: It is a colourless or faintly yellow liquid, b.p. 46°C and very flammable. Carbon disulfide is a potentially fire hazard and toxic. TLV is 20 ppm. It causes headache, vomiting and abdominal pain.

Carbon tetrachloride: It is colourless non-flammable heavy liquid, b.p. 77°C. TLV is 10 ppm. It has sweet odour and is toxic. Carbon tetrachloride causes irritation of eyes, headache, abdominal cramps and nervousness.

Chlorine: It is a greenish-yellow gas having a suffocating odour. Chlorine is toxic and irritating. TLV is 1 ppm. Its inhalation causes irritation of eyes, difficult breathing, cough, pain, nausea and cyanosis.

Chloroacetyl chloride: It is a colourless or slightly yellow liquid, b.p. 106°C. Decomposes with water, and is non-combustible. It causes irritation of eyes, nose and throat.

Chloroform: It is a colourless, heavy liquid, b.p. 61°C and possesses a sweet taste. It is volatile. TLV is 50 ppm. Chloroform causes unconsciousness, shortness of breath and vomiting.

Diazomethane: It is a yellow gas at room temperature and soluble in ether. It decomposes explosively by water or alcohol. It possesses a severe explosion hazard. TLV is 0.2 ppm. Diazomethane is severely toxic and irritant.

Diethyl ether: It is a colourless, very volatile and flammable liquid, b.p. 34.5°C. It has a very low flash point. It travels considerable distance to the source of ignition. TLV is 400 ppm. Ether has a penetrating smell. On inhalation it causes headache, vomiting, paralysis and irritation of respiratory tract. Store in a cool area.


EMERGENCY
BUTTON
EXIT
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DANGER
HIGH VOLTAGE
DANGEROUS
WHEN WET
4
FLAMMABLE LIQUID
3
CORROSIVE
8
RADIOACTIVE
7
TOXIC
6
9
FLAMMABLE
SOLID
4
CAUTION
DANGER