LABORATORY SAFETY

Safe Personal Laboratory Habits

1. Eye protection must be worn at all times.

2. Food/drink is not allowed in laboratories where chemicals are used/ stored.

3. No smoking in the laboratory.

4. Lab coats must be worn while handling corrosive, toxic, or flammable materials. Gloves must be worn when necessary, especially when handling corrosives, toxic and dangerously reactive materials.

5. Do not work alone.

6. Do not mouth pipet.

7. If you see a colleague doing something dangerous, point it out to him or her.

8. Know where safety equipment (eyewash, shower and extinguisher) is located.

9. Always read MSDS before handling new chemicals.

10. Know how to clean up spills of common chemicals and specific chemicals you see. Be familiar with the locations and contents of spill carts and how to use it.

11. Always wash your hands after handling chemicals and before eating.

12. Short skirts, shorts, and open shoes must not be worn.

13. Lab coats must not be worn outside laboratories and in public areas.

14. Avoid wearing a walkman or other portable music devices while working in the lab.

PERSONAL PROTECTIVE EQUIPMENT

1. Eye Protection

Adequate eye protection is required for all individuals in the laboratory. Do not remove your eye protection until you have physically left the lab room. The following types of eye protection are acceptable.

- Protective glasses and face shields that cover corrective prescription lenses are commercially available and/or from Chemistry Stores.
- Normal prescription eyeglasses, either with or without safety side shields as long as the glasses are shatterproof and cover a large enough area surrounding your eye (this usually means that the frames must be a minimum of 2 inches (5 cm) from top to bottom as well as from side to side). NOTE: check size restrictions with your supervisor/instructor.

- Where exposure to toxic or irritating fumes could be a problem, the best form of eye protection is safety goggles. Safety goggles that will form a tight seal to your face.
- Contact lenses can be a hazard and sometimes should not be worn in the lab. Therefore contact lenses wearers have three options in the labs:
    a) remove the contact lens before entering the lab and wear safety glasses or safety goggles.
    b) replace the contact lens with prescription glasses
    c) wear the contact lens into the lab under a pair of safety goggles but you must inform your supervisor/ instructor about it.
- A full-face shield is highly recommended when there is a risk of explosion or splashing, or with combustion and high temperature reactions.

2. Gloves

Depending on the procedure to be carried out, different types of gloves must be available in the laboratory. The gloves should “fit” the chemical. Asbestos gloves should not be used. If any are found, they should be replaced.

- Gloves are made from a variety of materials which vary in their impermeability and wear-resistance.
- Disposable gloves are made of PVC, latex, nitrile, and combinations of the aforementioned. These gloves are for general use and have low abrasion resistance.
- More resistant, impermeable, reusable gloves are made from butyl rubber, nitrile, or neoprene.
- Rubber: good chemical resistance, low abrasion resistance;
- Neoprene: almost impermeable to regular solvents, fairly abrasion resistant;
- Nitrile: highly resistant, maximum protection from liquids.

- Multicomposite gloves are available for special work involving high or low temperatures or special procedures.

3. Lab aprons or lab coats

The strength and impermeability of aprons depends on the materials used. These materials are also used for gloves, and their characteristics are described in 2.

- Aprons should be fire-resistant, chemical-resistant, and easily washed.
- Flammable fabrics should be avoided.

Lab coats should be made of strong fabric and must be able to be removed quickly in case of accident. They must be long enough to protect the legs. Lab coats exposed to harmful chemicals should not be worn in public areas.

4. Footwear

- Substantial shoes must be worn and should cover the entire foot.
- Open-toed shoes and sandals must not be worn in the laboratory.
- Safety shoes or foot guards may be required under certain circumstances (e.g., when moving compressed gas cylinders – foot guards are available in cylinder storage area).
- When cleaning up floor spills wear plastic foot covers available on all spill carts.

5. Respirators

Respirators used by the person at the Laboratory must provide effective protection against airborne contaminants which may be present. Use of respirators should be considered to control exposure only after engineering and administrative controls have been considered. These types of controls include ventilation (e.g. fume hoods), enclosing the process, substitution of less hazardous products, rescheduling of work procedures, etc. Users are responsible for:

1. Obtaining proper certification for respirator use by H.S.&E.
2. Using the respirator in accordance with training instructions
3. Being properly fit-tested for a respirator
4. Cleaning, disinfecting, and storing the respirator
5. Reporting any respirator malfunction to their supervisor

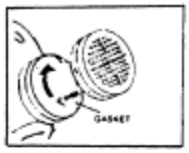
The following cartridges are available for use with half-mask and full-face respirators. Select the appropriate cartridge according to the chart below. Consult with H.S.E. for situations not listed. Always ensure that the cartridges used are appropriate for the types of hazardous vapour present.

Cartridge Type	Colour	Examples of Uses
Organic vapour and acid gas	Yellow	Rooftop entry/lab procedures/spills
Organic vapour only	Black	Solvents/Paints
Dusts, particulate, and aerosols	Purple	Toxic dusts/infectious aerosols/asbestos welding fumes
Ammonia/amines	Green	Ammonia Spill
Acid Gas	Grey	Acid gases/chlorine/sulfur dioxide

INSTRUCTIONS FOR THE USE OF RESPIRATORS

PERSONNEL MUST BE CERTIFIED BY HS&E PRIOR TO RESPIRATOR USE.

When fitting a new respirator, try on several brands and sizes. Different brands will fit slightly differently on your face. Respirator manufacturers usually have small, medium, and large face-pieces available. Adjust the straps so that the respirator fits tightly, but does not dig into your face or leave red marks on your skin. The respirator should feel snug, yet comfortable.

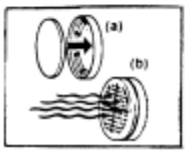


1. Remove respirator, cartridges, and filters from plastic bags. Check to see that gasket is in cartridge holder before screwing in cartridges. Insert filter into retainer caps and snap onto cartridge holder or cartridges.

2. The cartridge holders are keyed to assure their correct positioning and maintain the proper balance of the device. Make sure they are properly positioned and seated.

3. Place respirator on face with narrow end over nose and bottom under chin. First attach top headband around crown of head and then bottom around neck. Adjust headbands until a tight but comfortable fit is obtained.

4. TEST FOR TIGHTNESS: Place the palm of the hand or thumb over the valve guard and press lightly. Exhale to cause a slight pressure inside face piece. If no air escapes, respirator is properly fitted. If air escapes, readjust respirator and test again. There are two simple checks to test the seal. These are called the positive and negative pressure fit-checks. These tests must be done EVERY TIME the respirator is put on (see overleaf).

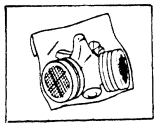


5. FILTERS: (a) REPLACE when breathing becomes difficult, INSERT new filters INTO retainer cap and replace cap. Generally the filter discs should be changed after eight hours of dusty exposure. (b) CHEMICAL CARTRIDGES should be replaced when the senses detect ANY abnormal condition, assuming that levels of detection by the senses do not constitute a health hazard.

6. MAINTENANCE: The respirator face piece should be cleaned daily to prevent skin irritation and for general sanitary purposes. First remove filters and cartridges. Then the face piece may be washed with a hand brush using a good detergent in warm water, rinsing, and air drying in a clean place. Some compounds considered to be suitable for disinfecting are: (1) a hypochlorite solution (50 parts per million of chlorine; immersion time: 2 minutes) (2) an aqueous solution of iodine (50 ppm iodine; immersion time: 2 minutes) (3) a quaternary ammonium solution (200 ppm quaternary ammonium compounds

in water with less than 500 ppm total hardness). RINSE IN CLEAN WARM WATER AND AIR DRY. Inspect respirator daily for worn or faulty parts and replace these at once. Proper parts supplied by the manufacturer must be used.

7. For your protection, the DUST FILTERS and CHEMICAL CARTRIDGES must be assembled tightly, and changed frequently, according to exposure.
8. KEEP RESPIRATOR CLEAN when not in use. Store in container provided.



NEGATIVE PRESSURE FIT-CHECK

a) Put the respirator on and tighten the straps until it feels tight but comfortable.
b) Close off the cartridges by covering them gently with the palm of hands, plastic bags, or gloves.
c) Breathe in slightly to create a vacuum.
d) Hold for 10 seconds.
e) If you have a good seal, the face piece should collapse slightly against your face and stay collapsed. No air should leak into the face piece past the sides, top, or bottom.
f) If the face piece doesn't collapse and stay collapsed, there is an air leak. Check the exhalation valves and try repositioning the respirator on your face and adjusting the head straps. Try the negative pressure check again. If you cannot get a seal after a few attempts, try on another size, make, or model of respirator, and repeat the check until you find a respirator that will pass.

POSITIVE PRESSURE FIT-CHECK

a) With the respirator on comfortably, close off the exhaust valve opening by covering it with the palm of the hand.
b) Breathe out slightly to force air into the face piece
c) Hold for 10 seconds.
d) If you have a good seal, the face piece should bulge out and stay out.
e) If the air does leak out, check the inhalation valves, readjust the respirator and try the check again. Try on another size, make or model if you fail to pass the positive pressure fit-check.

HAZARDOUS SUBSTANCES
(TOXIC, DANGEROUS, CARCINOGENIC, AND MUTAGENIC/TERATOGENIC)

1. TOXIC SUBSTANCES

Any volatile substances which are dangerous when inhaled must be handled only in an adequately ventilated area or in a fume hood.

a) Benzene

Benzene is particularly dangerous since it causes blood diseases.

- Avoid using it as a solvent. Chronic poisoning is possible following prolonged inhalation of minute quantities of benzene.
- Avoid skin contact.
- It is a known carcinogen.

b) Carbon tetrachloride and chloroform

Carbon tetrachloride and chloroform have specific dangers:

- They can be absorbed through the skin.
- These substances can eventually cause functional disorders of the kidney and the liver even at low concentrations.
- They are suspected carcinogens.

c) Cyanides and Nitriles

Cyanides and Nitriles are some of the most acutely toxic substances known; they react very quickly “in vivo” when they are present in the ambient environment.

- Symptoms of poisoning (weakness, difficulty in breathing, nausea) appear as soon as these substances have been absorbed, inhaled, or ingested.
- Contact with acid liberates a highly toxic gas. The inhalation of a very minute amount of hydrogen cyanide (HCN) can be fatal.

d) Phenols

Solutions of phenols are very dangerous.

- Phenols are absorbed rapidly through the skin during contact.
- If rapid and complete decontamination is not effected immediately, serious poisoning and even death could occur, depending on the concentration of the solvent and the amount of body surface that is contaminated.

e) Hydrogen fluoride

Hydrogen fluoride is extremely corrosive. Due to the absence of immediate pain, penetration can be extensive and lead to serious injury. It can cause severe eye irritation and skin burns.

f) Hydrogen sulfide

Hydrogen sulfide is very toxic. Inhalation causes respiratory paralysis. It can also damage the eyes and mucous membranes.

- Small cylinders of it are commercially available for laboratory use.
- CAUTION: The gas can be easily synthesized by action of dilute acids on sulfides
- Waste gas should be passed through scrubbers before venting.

2. DANGEROUS SUBSTANCES

a) Perchloric acid

Perchloric acid is a strong oxidizing agent capable of reacting violently with reducing agents or organic substances.

- Handle it in a specially-constructed fume hood used only for this purpose. This hood should be of the water wash-down type and of non-combustible construction.
- Always destroy any organic material with nitric acid before adding perchloric acid
- Never mix perchloric acid with sulfuric acid because through dehydration, anhydrous perchloric acid is obtained, which is even more unstable.
- Perchlorate esters, when exposed to impact, behave in the same manner as nitroglycerine.

b) Organic Peroxides

Some organic peroxides are very unstable and very dangerous. Due to their high sensitivity to heat, friction, impact, sparks, light, and oxidizing and reducing agents, they can cause violent explosions.

To minimize the risks of such peroxides, the following precautions must be taken:

- Buy only the necessary quantities of peroxides needed.
- Use only the minimum amount necessary. Never replace unused peroxide in the original container.
- Immediately clean up spilled peroxide.
- Reduce the sensitivity of most peroxides to impact and to heat by using them in inert solvents such as aliphatic hydrocarbons.
- If a volatile solvent must be used, avoid losses due to evaporation which could increase the peroxide concentration, eventually causing the formation of dangerously explosive crystals upon complete evaporation of the solvent.
- Never use a metal spatula to handle peroxides because contamination by metals can lead to the formation of explosive compounds. Use wood, ceramic, or plastic spatulas.
- Avoid flames, sources of heat, and direct sunlight.
- Avoid friction or impact with solid peroxides. Never use glass containers with ground glass or metal tops. Use only polyethylene bottles with screw tops.
- Store peroxides at as low a temperature as possible above the freezing point, so as to minimize the rate of decomposition.
- Do not cool liquid peroxides, or those in solution, to temperatures where they could solidify or precipitate because in this form they are extremely sensitive to impact and to heat.

3. CARCINOGENS

Carcinogens and substances capable of inducing cancer. These substances must be subject to strict guidelines such as those published by the International Agency for Research on Cancer when they are stored, used, and disposed of.

- Avoid exposure.
- Where exposure is unavoidable, keep it as low as reasonably achievable.
- The list of known carcinogens is continually updated. (See next page for some examples of carcinogens).

4. MUTAGENS AND TERATOGENS

Mutagens are substances causing permanent transmissible alterations in genetic information. Teratogens are agents interfering with normal prenatal development causing abnormalities in the fetus. Exposure to mutagens and teratogens should be kept as low as possible. (See following pages for some examples of mutagens and teratogens).

KNOWN/PROBABLE HUMAN CARCINOGENS

CAUTION: This is NOT a complete list of all chemicals having substantial evidence of carcinogenicity. Further, each substance listed here may have additional health hazards.

CARCINOGENS MUST BE DISTINCTLY LABELLED

a) KNOWN HUMAN CARCINOGENS

- 4-Aminobiphenyl (xenylamine, p-phenylaniline)
- Arsenic
- Arsenic Pentoxide
- Arsenic Trichloride
- Asbestos
- Arsenic Trioxide
- Benzene
- Benzidine (4,4'-diaminobiphenyl, 4,4'-biphenyldiamine)
- Benzo(a)pyrene (3,4-benzpyrene)
- Bis(chrloromethyl)ether
- 1,4-Butanediol dimethylsulfonate
- Calcium arsenate (tricalcium arsenate)
- Chloromethyl methyl ether (chloromethyloxymethane)
- Chromates (certain insoluble forms such as lead and zinc chromates)
- Coal tar pitch volatiles
- Cyclophosphamide (N,N-bis (2-chloroethyl) tetrahydro – 2H-1,3,2 – oxazaphosphorin-2-amine-2-oxide)
- Lead Arsenate
- 2-Napthylamine (2-aminonapthylamine)
- N, N-bis (2-chloroethyl)-2- napthylamine
- 4-Nitrobiphenyl (p-nitrobiphenyl)
- Sodium Arsenate
- Sodium Arsenite
- Thorium dioxide
- Treosulfan (pure product)
- Vinyl chloride (chloroethane, chloroethylene)

Please Note: These are ALARA substances which means that the contamination concentration of these chemicals must be as low as reasonably achievable.

SUSPECTED HUMAN CARCINOGENS

CAUTION: This is NOT a complete list of all chemicals having substantial evidence of carcinogenicity. Further, each substance listed here may have additional health hazards.

CARCINOGENS MUST BE DISTINCTLY LABELLED

- Acrylamide (propenamide, acrylic amide)
- Acrylonitrile (propene nitrile, cyanoethylene, vinyl cyanide)
- 1,3-Butadiene (vinylethylene)
- Cadmium powder
- Cadmium Chloride
- Cadmium Sulfate
- Beryllium
- Carbon tetrachloride (tetrachloromethane)
- Chloroform (trichloromethane)
- Dimethyl sulfate (sulfuric acid dimethyl ester)
- Ethylene dibromide (1,2-dibromoethane), ethylene oxide (1,2 epoxyethane oxirane)
- Formaldehyde (methanal, oxomethane)
- Hexachlorobutadiene
- * Hexamethylphosphoramide (HMPA) (hexamethylphosphoric triamide)
- Hydrazine (diamine)
- Lead acetate
- Lead phosphate
- Lead subacetate
- Methylhydrazine
- Methyl iodide (iodomethane)
- Nickel
- Nickel carbonate
- Nickel carbonyl
- Nickel oxide
- Nickel hydroxide
- Nickel subsulfide
- 2-Nitropropane
- Phenyl hydrazine
- beta-Propiolactone (2-oxetanone, 3-hydroxy-beta-lactone propanoic acid)
- Propyleneimine (2 -methylazacyclopropane, or 2-methylaziridine)
- o-Toluidine (2-methylaniline, or o-aminotoluene)
- p-Toluidine (4-aminotoluene)
- Vinyl bromide (bromoethylene)
- Production of SbO_3, AsO_3, CdO

* HMPA is apparently a particularly nasty carcinogen which is used in several labs throughout the Department of Chemistry. Users should be aware of its extreme toxicity, its ability to be absorbed though the skin, and the dangers of inhalation during distillation procedures. Precautions should include: use restricted to fume hoods, all contaminated vessels labelled “carcinogen”, use of two pairs of gloves, and the transfer of waste directly into the waste solvent containers or a separate correctly labelled vessel. There are at least two alternative solvents, 1,3-Dimethyl-2-imidazolidinone (DMEU) and 1,3-Dimethyl-3,4,5,6-tetrahydro-2(1H) pyrimidinone (DMPU) which are considered safe.

MUTAGENS OR TERATOGENS

CAUTION: This is NOT a complete list of all chemicals having substantial evidence of mutagenicity or teratogenicity. The extent of the hazard to humans associated with exposure to these substances is less clear than it is with carcinogens. However, it is recommended that similar caution should be exercised in handling substances which are mutagenic or teratogenic.

- Acetamide
- Acridine Orange
- Ammonium Chromate
- Ammonium Bichromate
- Ammonium Dichromate
- Anthracene
- Antimony Oxide
- Beryllium Carbonate
- Cobalt Powder
- Colchicine
- 1,2-Dichloroethane (Ethylene Dichloride)
- Formaldehyde
- Formamide
- Hydroquinone
- Indigo Carmine
- Lead Diacetate
- Mercury
- Osmium Tetraoxide
- Potassium Chromate
- Potassium Permanganate
- Pyrogallic Acid
- Silver(I) Nitrate
- Sodium Azide
- Sodium Dichromate
- Sodium Nitrate
- Sodium Nitrite
- Thioacetamide
- Toluene
- Urethane (Ethyl Carbamate)