X. Preparing and Handling Chemicals for Use

Personal Protective Equipment

The Occupational Safety and Health Administration (OSHA) and Health Canada require that in setting up safety and health applications in the laboratory and classroom, whenever feasible engineering controls such as erecting splashguards and installing mechanical ventilation should be used. In addition, sound application practices should be employed to protect the laboratory personnel from exposure to hazardous chemicals. Often, however, these practices do not provide the full protection required to protect individuals from the potential hazards in a laboratory and classroom. Therefore, additional protection must be provided in the form of personal protection. This Personal Protective Equipment or PPE must be defined and used to protect against possible contact with hazardous chemicals. Depending upon the associated hazards, PPE will need to be selected to protect the body parts that could be harmed by the exposure from spills, splashes, chemical reactions, etc.

In selecting PPE, all wearers of PPE must be properly trained in the purpose, limitations, correct use and care of the PPE before being worn, as regulated by OSHA and Health Canada.

Per these regulations:

- Protective equipment must be provided by the school, used and maintained in sanitary and reliable condition, as necessary to protect the wearer from hazards, and;
- All personal protective equipment shall be of safe design and construction for the work to be performed.

In this section, Ward's Science will help define when, where and what personal protective equipment should be used. To protect an individual in the laboratory from direct exposure to hazardous chemicals and to minimize any potential harm done from contact, a variety of PPE is available and should be worn when required.

How to Choose the Correct Personal Protective Equipment

Personal Protective Equipment must be selected based on the protection it provides against specific chemicals or classes of chemicals when used under certain conditions. Keep in mind that no one type of PPE provides protection from all chemicals or all concentrations of chemicals.

Ward's Science provides a Safety Data Sheet (SDS) for every chemical we sell. Based on the information contained within the SDS, work environment and the specific application of the chemical, PPE can be selected. See *Section IV* for detailed information on SDS's.

In addition to the information on the SDS, other factors must be accounted for. These include: concentration of the chemical to which the individual(s) may be exposed, the length of exposure, temperature of the chemical, worker comfort, and proximity to the chemical. Analyze the experiments, demonstrations and exposures presented in the laboratory and classroom and select appropriately.

Eye Protection

Safety Glasses

The most common need for personal protective equipment in the laboratory and classroom is for eye protection. Safety glasses are provided for use in laboratories and must be worn at all times in all laboratories where chemicals are being used. Safety glasses should be required by all persons who enter a chemical work area or storage, even if the individual is not directly handling or using chemicals.

Safety glasses can look very much like normal glasses but have lenses that are impact resistant and frames that are far stronger than standard glasses. In the science room, environment safety glasses must have side shields and should be worn whenever there is the possibility of objects (such as chemicals substances, particles and glass) striking the eye. Safety glasses must have an American National Standards Institute (ANSI) Z87 designation on the eyewear to be compliant and provide the adequate protection. Safety glasses come in a variety of styles to provide the best fit and comfort, including some designed to fit over prescription glasses.

Safety glasses will not provide adequate protection from significant chemical splashes. They do not seal to the face, resulting in gaps at the top, bottom and sides, where chemicals may seep through. Safety glasses are also not appropriate for dusts and powders, which can get by the glasses. Safety goggles are best used for this type of potential exposure.

Chemical Splash Goggles

Goggles that seal to the face provide much more eye protection than safety glasses against contact with solid and liquid chemicals. Chemical splash goggles should be worn when there is potential for splash from a hazardous material. Like safety glasses, goggles are impact resistant. Chemical splash goggles should have indirect ventilation so hazardous substances cannot drain into the eye area. They can also be worn over prescription glasses. As with safety glasses, goggles must have an American National Standards Institute (ANSI) Z87 designation on the eyewear to be compliant and provide the adequate protection.

Face Shields

Face shields should be used when using or handling large volumes of hazardous materials, when handling hot materials or strong corrosives, toxics that can be absorbed through the eyes or skin, and reactives when carrying out reactions under a vacuum. Face shields must always be used in conjunction with safety glasses or goggles.

Hand Protection

Teachers and students who handle chemicals that are hazardous and/or may come in contact with the skin must wear appropriate gloves that will prevent contact of the hands with the chemicals.

Gloves should resist penetration and permeation by the chemicals being used. *Figure 1 – Gloves Chemical Resistance Chart* is provided as a brief reference regarding glove selection. This color-coded chart makes determining which glove material is best suited for the chemicals you are working with easy to recognize.

- Green – excellent. Material in question is the best option. Some chemicals may have more than one material rated as “excellent”.
- Yellow – good. Material in question will withstand chemical, although prolonged exposure may not be recommended. There may or may not be a better material option.
- White – acceptable. Material in question can be used safely with chemical, although prolonged exposure may not be recommended. There may or may not be a better material option.
- Red – not recommended. Material in question is not compatible with chemical and should be avoided when using that chemical. There will be a safer alternative listed.

This chart should be used as a starting point but cannot account for all possible conditions. Contact your Ward's Science representative for final selection.

	Glove Material		
Chemical	**Latex**	**Neoprene**	**Nitrile**
2,3-dichloro-1-propene	not recommended	not recommended	Acceptable
Acetelaldehyde	excellent	excellent	Acceptable
Acetic acid 50%	excellent	excellent	Excellent
Acetic acid, glacial	excellent	excellent	Good
Acetone	excellent	good	not recommended
Alcoholic beverages	excellent	excellent	Excellent
Ammonia conc.	excellent	excellent	Excellent
Ammonium acetate	excellent	excellent	Excellent
Ammonium carbonate	excellent	excellent	Excellent
Ammonium chloride	excellent	excellent	Excellent
Ammonium nitrate	excellent	excellent	Excellent
Amyl acetate	not recommended	acceptable	Acceptable
Amyl alcohol	excellent	excellent	Excellent
Aniline	good	good	Acceptable
Animal greases	acceptable	excellent	Excellent
Asphalt	not recommended	acceptable	Excellent
Bacon fat	not recommended	excellent	Excellent
Beets	excellent	excellent	Excellent
Benzaldehyde	not recommended	not recommended	Acceptable
Benzene	not recommended	not recommended	Acceptable
Benzyl alcohol	acceptable	good	Good
Birds	acceptable	excellent	Excellent
Bleach	excellent	excellent	Excellent
Borax	excellent	excellent	Excellent
Boric acid conc	excellent	excellent	Excellent
Brake oils	good	excellent	Excellent
Bromides	good	good	Good
Butanol	excellent	excellent	Excellent
Butter	not recommended	excellent	Excellent
Butyl acetate	not recommended	acceptable	Acceptable
Calcium acetate	excellent	excellent	excellent
Calcium chloride	excellent	excellent	Excellent
Calcium fluorophosphate	excellent	excellent	Excellent
Calcium hydroxide	excellent	excellent	Excellent

Chemical	Latex	Neoprene	Nitrile
Calcium hypochloride	excellent	excellent	Excellent
Calcium nitrate	excellent	excellent	Excellent
Calcium phosphate	excellent	excellent	Excellent
Carbon tetrachloride	not recommended	acceptable	Good
Castor oil	not recommended	excellent	Excellent
Chlorine	not recommended	excellent	Excellent
Chloroacetone	excellent	excellent	not recommended
Chlorobenzene	not recommended	acceptable	Acceptable
Chloroform	not recommended	acceptable	Good
Chromic acid	not recommended	not recommended	Acceptable
Citric acid	excellent	excellent	Excellent
Creosote	acceptable	excellent	Excellent
Cresol	not recommended	excellent	Excellent
Cutting oil	not recommended	excellent	Excellent
Cyclohexane	not recommended	acceptable	Good
Cyclohexanol	excellent	excellent	Excellent
Cyclohexanone	good	good	not recommended
di-Butyl ether	not recommended	acceptable	Excellent
di-Butyl phlalate	good	acceptable	Excellent
Dichloroethane	not recommended	not recommended	Acceptable
Diesel	not recommended	acceptable	Excellent
Diethanolamine	excellent	excellent	Excellent
Dioctyl phlalate	good	excellent	Excellent
Domestic detergents	excellent	excellent	Good
Ethanol	excellent	excellent	Excellent
Ethanolamine	excellent	excellent	Excellent
Ethyl acetate	not recommended	acceptable	Acceptable
Ethylamine	acceptable	acceptable	Excellent
Ethylaniline	acceptable	excellent	Excellent
Ethylene glycol	excellent	excellent	excellent
Fish and shellfish	acceptable	excellent	Excellent
Fixers	excellent	excellent	Excellent
Fluorides	excellent	excellent	Excellent
Formaldehyde up to 30%	excellent	excellent	Excellent

Chemical	Latex	Neoprene	Nitrile
Formic acid methyl ester	acceptable	excellent	Acceptable
Formic acid up to 90%	not recommended	good	Excellent
Formol (or Formaldehyde)	excellent	excellent	Excellent
Fuel oil	not recommended	acceptable	Excellent
Fuels	not recommended	acceptable	not recommended
Furol (furfural or furaldehyde)	excellent	good	Acceptable
Gas oil	not recommended	acceptable	Excellent
Glyercine	excellent	excellent	Excellent
Glycols	excellent	excellent	Excellent
Groundnut oil	not recommended	excellent	Excellent
Hair bleach products	excellent	excellent	Excellent
Hair dye	excellent	excellent	Excellent
Hexanes	not recommended	acceptable	Excellent
Hydroxy-4-methyl-4-pentanone-2	excellent	excellent	not recommended
Hydraulic fluids (esters)	excellent	excellent	Excellent
Hydraulic oils (petroleum)	not recommended	acceptable	Excellent
Hydrochloric acid up to 30%	excellent	excellent	Excellent
Hydrofluoric acid up to 30%	good	excellent	Excellent
Hydrogen bromide	excellent	acceptable	Acceptable
Hydrogen peroxide solution	acceptable	excellent	Excellent
Isobutanol	excellent	excellent	Excellent
Isobutyl ketone	excellent	excellent	Excellent
Kerosene	not recommended	excellent	Acceptable
Lactic acid up to 85%	acceptable	excellent	Excellent
Linseed oil	not recommended	excellent	Excellent
Lubricating oils	not recommended	acceptable	Excellent
Magnesia (MgO)	excellent	excellent	Excellent
Manure	excellent	excellent	excellent
Methanol	excellent	excellent	Excellent
Methyl acetate	acceptable	excellent	Acceptable
Methyl ethyl ketone	excellent	good	not recommended
Methyl isobutyl ketone	good	acceptable	not recommended
Methylamine	excellent	good	Excellent
Methylaniline	acceptable	good	Excellent

Chemical	Latex	Neoprene	Nitrile
Methcyclopentane	not recommended	acceptable	Excellent
Methylene chloride	not recommended	acceptable	Acceptable
Milk and milk products	acceptable	excellent	Excellent
Mineral greases	not recommended	acceptable	Excellent
Naphtha	not recommended	acceptable	Excellent
Naphthalene	not recommended	acceptable	Good
n-Butylamine	excellent	excellent	Excellent
Nickel chlorine	excellent	excellent	Excellent
Nitric acid up to 20%	good	good	Acceptable
Nitrobenzene	acceptable	acceptable	Acceptable
Nitrohydrochloric acid	acceptable	good	Acceptable
Nitropropane	excellent	good	Acceptable
Non-alcoholic beverages	excellent	excellent	Excellent
Octanol	acceptable	excellent	Excellent
Oil-based paint	not recommended	acceptable	Excellent
Oils for turbines	not recommended	acceptable	Excellent
Oleic acid	acceptable	excellent	Excellent
Olive oil	not recommended	excellent	Excellent
Oxalic acid	excellent	excellent	Excellent
Paraffin oil	not recommended	acceptable	Excellent
Perchloroethylene	not recommended	acceptable	Good
Perfumes and essences	excellent	excellent	Good
Petrol (for cars)	not recommended	good	Excellent
Petroleum products	not recommended	acceptable	Good
Petroleum spirits	not recommended	good	Excellent
Phenol	acceptable	good	Good
Phosphoric acid	excellent	excellent	excellent
Pine oil	not recommended	acceptable	Excellent
Polyester resins	not recommended	acceptable	Good
Potash conc	excellent	excellent	Excellent
Potash pellets	excellent	excellent	Excellent
Potassium acetate	excellent	excellent	Excellent
Potassium carbonate	excellent	excellent	Excellent
Potassium chloride	excellent	excellent	Excellent

Chemical	Latex	Neoprene	Nitrile
Potassium cyanide	excellent	excellent	Excellent
Potassium dichromate	acceptable	excellent	Excellent
Potassium nitrate	excellent	excellent	Excellent
Potassium permanganate	excellent	excellent	Excellent
Potassium phosphate	excellent	excellent	Excellent
Potassium sulfate	excellent	excellent	Excellent
Powder detergent	excellent	excellent	Excellent
Products for setting hair	excellent	excellent	Excellent
Quick lime	excellent	excellent	Excellent
Salicylic acid methyl ester	excellent	excellent	Excellent
Shampoos	excellent	excellent	Excellent
Shuttle oil	not recommended	acceptable	Acceptable
Silicates	excellent	excellent	Excellent
Slaked lime	excellent	excellent	Excellent
Sodium bisulfite	excellent	excellent	Acceptable
Sodium carbonate	excellent	excellent	Acceptable
Sodium chloride	excellent	excellent	Excellent
Sodium hypochloride	excellent	excellent	Excellent
Sodium nitrate	excellent	excellent	Excellent
Sodium phosphate	excellent	excellent	Excellent
Sodium sulfate	excellent	excellent	Excellent
Soya oil	not recommended	excellent	Excellent
Stearic acid	good	excellent	Good
Styrene	not recommended	acceptable	Acceptable
Sulfites, bisulfites, hyposulfites	excellent	excellent	Excellent
Sulfuric acid conc	not recommended	acceptable	not recommended
Sulfuric acid diluted (battery)	excellent	excellent	Excellent
Sulfuric ether (pharmacy)	acceptable	excellent	Excellent
Tartaric acid	excellent	excellent	Excellent
Turpentine	not recommended	acceptable	Excellent
Tetrahydrofuran (THF)	good	acceptable	not recommended
Tin chloride	acceptable	excellent	Excellent
Toluene	acceptable	acceptable	Good
Tributyl phosphate	acceptable	good	Good
Trichloroethylene	not recommended	acceptable	Acceptable
Tricresyl phosphate	excellent	good	Excellent
Triethanolamine up to 85%	excellent	excellent	Excellent
Trinitrobenzene	not recommended	acceptable	Good

Chemical	Latex	Neoprene	Nitrile
Trinitrotoluene	not recommended	acceptable	Good
Triphenyl phosphate	acceptable	excellent	Excellent
Vinegar and condiments	excellent	excellent	Excellent
Water paints	excellent	excellent	Excellent
Weed killer	excellent	good	not recommended
White spirit	not recommended	good	Excellent
Xylene	not recommended	acceptable	Good
Xylophene	not recommended	acceptable	Excellent
Zinc sulfate	excellent	excellent	Excellent

Foot Protection

Covered shoes that fully encase the foot should be worn at all times in the laboratories and where chemicals are stored or used. Perforated shoes, sandals or cloth sneakers should never be worn in laboratories or where mechanical work is conducted. Keep in mind that leather shoes tend to absorb chemicals and may have to be discarded if contaminated with a hazardous material. Chemical resistant overshoes or boots may be used to avoid possible exposure to corrosive chemical or large quantities of solvents or water that might penetrate normal footwear (e.g., during spill cleanup).

Protective Clothing

When the possibility of chemical contamination exists, protective clothing that resists physical and chemical hazards should be worn over street clothes. Lab coats are appropriate for minor chemical splashes and spills, while plastic or rubber aprons are best for protection from corrosive or irritating liquids. When working with chemicals that are highly corrosive, highly toxic or could cause thermal burns, arm guards or gloves with extra long wrists should be worn to protect the forearms from chemical contact. Close and tie the open end of the glove off or tuck it into the individual's sleeves to prevent contact with the chemical.

When highly corrosive chemicals are used, individual should wear chemically resistant aprons and coats to prevent contact with the body. If an accident does occur, these garments are not designed for long-term protection and should be removed immediately and properly disposed of as hazardous waste if contaminated. If a garment is designed to be reusable, it must be decontaminated following the accepted measures as defined by the appropriate SDS or manufacturer. Disposable outer garments, similar to a Tyvek suit, should be used when cleaning or when decontamination of reusable protective clothing is difficult.

Protective clothing and lab coats should be regarded not as means of preventing exposure, but as means of lessening or delaying exposure. The effectiveness of clothing as a protective barrier for the skin depends upon its prompt removal in the event that it becomes contaminated.

Respirators

The implementation of appropriate engineering and procedural controls should always be the preferred method for ensuring that any airborne levels of chemicals within the laboratory are below regulatory limits. However, in rare circumstances where these controls measures are not sufficient, laboratory personnel may need to utilize respirators for a particular operation. If this is the case, personnel must participate fully in a respiratory protection

program, which requires a medical exam, respirator fit-testing, and training prior to respirator use and as defined by OSHA and Health Canada. Respirators in the school science environment should only be available for emergency purposes and only if personnel are trained in how to use them. Typically any chemical usage by the science teacher for student demonstrations that require respirator use should not be completed and will not be addressed in this handbook.

Internal Transportation of Chemicals

Spills and chemical exposure can occur if chemicals are transported incorrectly, even when moving chemicals from one part of the laboratory to another. To avoid this type of incident, consider the following:

- Use a bottle carrier, cart or other secondary container when transporting chemicals in breakable containers.
- When moving in the laboratory, anticipate sudden backing up or changes in direction by others. If you should stumble while carrying glassware or chemicals, try to propel them away from yourself and others.
- When transporting compressed gas cylinders, the cylinder should always be strapped in a cylinder cart and the valve protected with a cover cap. Do not attempt to carry or roll cylinders from one area to another.

Glassware Use

The following procedures must be adopted when using glassware:

- Containers should be labeled before substances are put in them.
- When moving chemicals, care must be taken to prevent breakage and spillage.
- When you are finished using glassware, all glassware must be cleaned, dried and put away, before the end of the day if possible.
- Chipped or cracked items should be properly discarded. Hand protection should be used when picking up broken glass.
- Hand protection should also be used when inserting glass tubing into rubber stoppers or placing plastic rubber tubing on glass hose connections.
- Tubing should be fire polished or rounded and lubricated.
- With any graduated cylinders, avoid parallax errors by taking level readings at the level of the meniscus (curved surface of the liquid). Whether the meniscus curves upward (as in H_2O) or downward (as in Hg), the reading should be taken from the point of the curve on the central axis of the cylinder.

Burettes

Burettes are useful where an accurate volume of liquid must be delivered. Burettes are stamped TD for "to deliver". As with other glassware, rinse the inside at least once with the solutions with which you will be working. Drops of liquid clinging to the inside indicate that the burette is not clean. Liquids should always be dispensed using proper hand positions and never by mouth. This is necessary not only to protect the individual from mouth contamination, but also to deliver the proper amount of liquid and to ensure support of the stopcock.

Erlenmeyer Flasks

The shape of the Erlenmeyer flask is designed to facilitate swirling or mixing of reactants. The Erlenmeyer flask is not a piece of precision glassware, as a 250 mL flask typically holds 270 mL or so. Do not make volume

measurements with an Erlenmeyer flask unless you only need an approximate amount.

Glass Stirring Rods

A glass stirring rod is a useful tool to mix reactants. It is also placed in liquids that are being boiled to stir and helps to spread the heat evenly. The stirring rod also facilitates the transfer of a liquid being poured into a cylinder or other device, as it provides a path for the liquid to follow.

Pipettes

Whether they are equipped with a bulb or a pump, graduated pipettes are used to accurately transfer a small volume of liquid. As with a burette, a pipette is marked TD for "To Deliver". As with all laboratory glassware, the same cautions apply for avoiding parallax. Before making an accurate transfer, the user should pump the desired liquid into the pipette, roll the pipette horizontally to coat the entire interior surface, and then allow the liquid to drain through the tip. When attempting an accurate delivery of liquid, wipe off the tip of the pipette with an appropriate material before releasing the liquid. After transferring the liquid, remove any hanging drops by touching the tip of the pipette against the container.

Volumetric Flasks

Volumetric flasks are used to prepare solutions of exact concentrations. Their volume must be precisely known. Therefore volumetric flasks should never be heated, and solutions with a high heat of solution should not be prepared directly in them. The purpose of a volumetric flask is usually stamped directly on its neck with the letters TC for "to contain". Generally, the procedure for preparing a solution in a volumetric flask is to first rinse the inside of the flask with the solvent, then transfer a small amount of solvent followed by the required amount of solute, and swirl. The flask is then further filled with solvent to just below the mark etched in the glass. The last few drops are added with a medicine dropper or pipette for added accuracy. To mix, the stopper and the base should be supported and the flask should be inverted about ten times to ensure homogeneity.

Summary

There are many different pieces of laboratory equipment. Each has its own procedure to safely complete the assigned task. The aforementioned items were but a few of these. Regardless of whether a specific task or laboratory device was addressed in this section and/or within this handbook, the intent of every laboratory procedures is to handle, maintain control and complete the chemistry procedure in as safe a manner as possible.

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