5 Safety in the Chemical Laboratory

A considerable part of the work in an organic chemistry laboratory involves using materials and processes that can be dangerous if not properly handled. With careful preparation beforehand and careful use of chemicals and equipment, accidents can be avoided. Lack of intelligent preparation and careless use of chemicals and equipment can be extremely hazardous, even fatal. Therefore, you must learn to work intelligently and take the proper precautions for each experiment. Specific safety precautions are given for each experiment. Be sure to check both the text and the manual for this information. The following are some general rules for safe laboratory practice.

Preparation

Before coming to the laboratory, study the experiment and try to understand the procedure that you will be performing. Make a special note of any safety precautions. At times there will be parts that you don't understand. Be prepared to ask your instructor about these.
You need to prepare for each experiment in order to start the notebook writeup and to be ready for the quiz that is given before the experiment. A more important reason for adequate preparation is to be able to work efficiently in the laboratory. However, the most important reason for adequate preparation is so that you can work safely in the laboratory. As you prepare for the experiment you should have all of these things in mind, not just the quiz.

Protective Wear

All students in the laboratory must wear ***safety goggles*** at all times. Much of the danger of injury to the eyes from spattering reagents or flying glass fragments from your own or your neighbors' accidents can be eliminated by this simple precaution. Another important protection for your eyes is to avoid rubbing your fingers in or near your eyes. Chemicals can easily be transferred from your hands to your eyes in this way.

All students are required to wear a ***lab coat*** at all times. A lab coat is more than a uniform identifying you as a scientist; it affords you some protection from spills of hot or corrosive materials as well as protecting your regular clothing. Use common sense in choosing the clothes that you wear to the laboratory. Loose clothing may be more susceptible to catching on fire and may also cause accidental spills.

Never wear sandals or open-toed shoes in the laboratory. This is a requirement. Feet are especially vulnerable to anything that falls.

There is some controversy about wearing contact lenses in a chemical

laboratory. In general, it is better to wear eyeglasses if you have them. Be sure to change from contacts to glasses in enough time to allow your eyes to adapt to the glasses by the start of the lab. If you must wear contacts, let your instructor know that you wear them and be especially careful to wear goggles at all times. Chemicals can get behind the lens, between it and your eye. This is very dangerous because the lens holds the chemical in contact with the eye. The lens also obstructs the cleaning of the eye and becomes difficult to remove because the eye muscles tighten in this situation. In extreme cases the contact lens can fuse to your eye.

Hazardous Chemicals

There are many different kinds of hazards associated with various chemicals. Many chemicals are ***flammable***; that is, they can catch on fire. (Note that the term ***inflammable*** does not mean not flammable as you might expect. It means the same thing as flammable.) Some flammable chemicals catch fire rather easily; others are not so susceptible. Some common flammable chemicals include low molecular weight ethers, alcohols, and hydrocarbons.

Some chemicals are ***carcinogens*** or cancer-causing agents. ***Mutagens*** cause mutations, inheritable changes in the genetic material. ***Teratogens*** cause birth defects. ***Lachrymators*** cause crying and eye irritation. There are chemicals that are ***explosive***. Some are ***corrosive*** and can cause visible destruction of skin and clothing. Others irritate the skin in other ways. Some chemicals that are relatively harmless individually become hazardous when mixed together.

Many common chemicals have one or more of these properties, so treat any chemical that you do not know about as potentially dangerous. Nevertheless, do not let the hazards scare you unduly. Chemicals are safe when handled in the right way, and even water is unsafe when handled the wrong way. The key is to look up chemical hazards ahead of time. Use your textbook, this lab manual, or (even better) the Material Safety Data Sheet (MSDS) of each individual compound. A binder with MSDS is available in the laboratory. Handle chemicals in accordance with the information you find, and be especially cautious with unknown materials.

In this laboratory we have reduced the possibility of fire by eliminating the use of open flames for heating. The sand baths, Mel-Temps, and hot plates that we use can become extremely hot, however. So, beware of touching the surfaces of these items and of spilling flammable solvents or solutions on them. Be especially wary of the sand. Hot sand can cause severe burns and it does not look any different from cold sand. Although we do not use open flames in this laboratory, you must be aware of the hazards involved in using them. Never use an open flame in an organic chemistry laboratory in which flammable solvents are in use.

Do not allow any laboratory chemicals to come in contact with your skin. If you do get a chemical on your skin, immediately wash with large

quantities of water. Clean up chemical spills on bench tops and balances as soon as they occur. These are common sources of chemicals that get on the skin. (Besides that, the balances are sensitive electronic instruments that are easily damaged by spilled chemicals getting into their interiors.) Be especially careful of concentrated acids and bases. ***Mercury spills from broken thermometers are especially dangerous. Notify your instructor when these occur.***

If any chemicals get into your eyes, flush them out immediately with large quantities of water from the eye wash fountain or saline solution from an eye wash bottle. Flushing should be continued for fifteen minutes and then prompt medical attention should be obtained.

Some chemical operations produce poisonous or irritating gases. When this is the case, the operation should be carried out in a working fume hood or with an appropriate trap. In this class you will be instructed when this is required. The hoods in our labs are most effective when the sash is closed. Only open them high enough to work in and lower them when you finish.

Never eat or drink in the laboratory. Do not even bring food or beverages into the laboratory. Federal inspectors even consider a food container found in a lab trash can as sufficient evidence of eating in lab and can levy heavy fines.

Electrical Hazards

Open flames have been eliminated from our organic chemistry laboratories, but the amount of electrical equipment has increased. Be especially careful of the equipment on your lab bench. This includes sand baths and their controllers, Mel-Temps, and hot plates. There are burn hazards associated with all of these (as mentioned above). There is also the danger of electrical shock. Make sure that your hands are dry when handling this equipment. Clean up water spills as soon as possible, and if water has spilled on the equipment notify your instructor immediately.

Another potential hazard with the electrical equipment comes from damaged insulation on power cords. If you notice exposed wires on any of this equipment, notify your instructor immediately so it can be repaired. Do not use it until it is repaired. Much of this kind of damage is caused by the cord coming into contact with the hot surfaces of the equipment or with hot sand. Please be aware of this possibility and try to keep the cords away from harm.

Disposal of Excess or Used Materials

One of the reasons that many teaching laboratories have converted to microscale methods is to reduce the amount of chemical waste. However, there are still excess and waste chemicals, and it is important for the safety of individuals and the environment that the disposal of this material be done safely.

The laboratory text gives specific instructions for disposal of chemicals from each experiment. Follow these instructions unless this manual or your instructor gives you other directions. The following are some general guidelines regarding the handling of surplus materials.

One of the simplest ways to reduce the amount of waste is: ***take no more material than you need from the container***. Once you have removed a chemical from its original container, it must be considered contaminated and should not be returned to the container. Therefore, take only what you need. If you should take too much of a reagent, see if anyone else in the class needs some. If not, the reagent must be properly disposed of. ***Do not leave the excess lying around near the balances or elsewhere in the laboratory.*** Also, to minimize contamination as well as unpleasant odors, put the lids back on all reagent containers immediately.

Never put any solids in the sink. This includes filter paper, litmus paper, boiling chips, and sand as well as surplus solid chemicals. Dispose of paper, sand, and other harmless materials in the waste basket. Some nonhazardous chemicals can also be placed there. However, never put any chemical in the waste basket unless specifically instructed to do so by the text, manual, or instructor.

Place most waste solid and liquid chemicals and reaction products in a container placed in a fume hood for that purpose. Find the appropriate container and place the chemical in that container. If you don't find such a container or if it is already full, consult your instructor. Do not place the material in another container unless your instructor tells you to do so. It is dangerous to mix certain reagents, so don't place the material in the wrong container.

Glass is in a class by itself. Never put any broken glass item in a sink or waste basket. Special boxes are provided in the laboratory for glass that is broken or must be disposed of for other reasons. Put glass in these boxes only, and only put glass in these boxes.

A few liquids can be disposed of in the sink. Small samples of dilute acids and bases are in this category. Concentrated acids and bases must be diluted and neutralized, if necessary, before disposing of them in the sink. When diluting acids or bases remember to add them to water, not vice versa. In all cases in which materials can be disposed of in the sink, they must be flushed down the drain with a large quantity of water.

Safety and First Aid Equipment

The laboratory is equipped with several pieces of safety equipment. During the first laboratory session, your instructor will point out all of their locations and demonstrate the use of some of them. This equipment includes ***fire extinguishers,*** a ***safety shower,*** one or more ***eye wash fountains,*** and ***first aid supplies.*** Know where all of these items are located and how to use them. It is too late to learn at the time that they are needed. You must know ahead of time.

Immediately report all accidents, no matter how minor, to your instructor. In the event that your instructor is unable to assist you in an emergency, contact the stockroom supervisor, the department chairperson, or another chemistry faculty member.

Assignment

Before the first experiment, in addition to preparing for that experiment, read the inside cover, first page, and the first two chapters in Williamson. These contain important instructions on laboratory safety practices and first aid. Two thirds of the quiz before the first experiment, in each semester, is on safety. You will also be tested on laboratory safety on the final exam. There may be safety questions on ***any*** quiz.

A student who is familiar with the material on Introductory Laboratory Safety should be able to:

1. Define, recognize, and give examples of each of the following: carcinogen, teratogen, mutagen, lachrymator, corrosive; flammable, inflammable, nonflammable.
2. Describe when and how each of the following should be used: safety goggles, lab coat, fume hood, eyewash fountain, safety shower, fire extinguisher; always work in your assigned laboratory section with your instructor's supervision.
3. Identify the procedures for disposal of waste in the laboratory. Classifications can include: Halogenated and nonhalogenated organic liquids, halogenated and nonhalogenated organic solids, broken glass, acids and bases, and ordinary (nontoxic) trash. (Additional classifications may be added for subsequent experiments).
4. Give and recognize the procedures for dealing with the following laboratory emergencies: fire, whether on a person or not; chemical spills on the floor or desktop, on a person's skin or lab coat, and in a person's eyes; cuts; burns.
5. Carry out all of the assigned experiments in this laboratory safely, with knowledge of the material in this section in mind.

A Final Caution

The most important test of your knowledge of laboratory safety is not your responses on a quiz, but your actions in the lab. If you continuously disregard safety rules and practices, your instructor cannot allow you to remain in the laboratory since you will be a danger to yourself and others.