INTRODUCTION TO SAFETY

These guidelines for student safety in the laboratory are excerpted from "Safety in Academic Chemistry Laboratories", published by the American Chemical Society, 1990. To the best of our knowledge, these guidelines are believed to be reliable and represent the best current opinions on the subject. However, these guidelines do not specify legal standards and do not represent policy of the American Chemical Society. The Chemistry Department of Los Angeles City College does not guarantee the completeness of this material.

△ Safety Guidelines

While in the chemistry laboratory, you are responsible not only for your own safety but for the safety of everyone else. S*afety precautions are included in every experiment where needed.* Your instructor may modify these instructions and give you more specific directions on safety in your laboratory. If the proper precautions and techniques are used, none of the experiments in this laboratory program are hazardous. But without your reading and following the instructions, without knowledge about handling and disposal of chemicals, and without the use of common sense at all times, accidents can happen. Even when everyone is doing his or her best to comply with the safety guidelines in each experiment, accidents can happen. It is your responsibility to minimize these accidents and know what to do if they happen.

In case of emergency or accident:

1. Call the instructor immediately. Describe the nature of the accident or injury.

2. Respond quickly but calmly to minimize the effects of the accident.
   (a) Flush away chemical spills on the skin for at least 15 minutes with gently running cool water. Remove contaminated clothing. If the spill covers a large area or cannot be rinsed off in the sink, use the safety shower.

   (b) If anything splashes into your eyes, immediately go to the eyewash and flush the eyes with cool water for 15 minutes. Then seek medical treatment.

   (c) If a fire occurs in a vessel and is small and contained, smother it by covering the vessel with a watch glass or inverted beaker. If the fire is small but threatening, position yourself near an exit and use a fire extinguisher. If a fire is large or spreading, evacuate the lab and call the fire department or campus police. After the fire, turn in all used fire extinguishers for recharging.

   (d) If a person's clothing or hair is on fire, use the safety shower. Alternatively, smother the fire with a blanket or heavy clothing. Get medical attention promptly.

   (e) For severe cuts, burns, chemical ingestion, injury or exposure to smoke or fumes, administer basic First Aid and get immediate medical attention.

There are many dangers of ingesting chemicals in the laboratory. To minimize the possibility of exposure:

(a) Do not bring food or drink into the laboratory (even temporarily).
(b) Do not smoke in any chemical laboratory or storage area.
(c) Wash your hands and arms thoroughly before leaving the laboratory.
(d) Reserve your lab coat or apron for lab use only. Wash it separately from other laundry.
(e) Never pipette liquids by mouth. Always use a safety pipette bulb.
(f) Do not put your fingers into your eyes, nose or mouth without washing first.

Laboratory Rules and Safety Procedures

1. Wear protective goggles or glasses at all times in the laboratory work area. These glasses should wrap around the face so liquids cannot splash into the eye from the side. These goggles are mandated by eye-protection laws and are not optional, even though they may be uncomfortable. Contact lenses increase the risk of problems with eye safety, even when protective goggles are worn. If you wear contact lenses, inform the instructor. Any failure by a student to observe this state health regulation will result in a minimum loss of 10% of the available points for that laboratory, and may also result in removal of that student from the laboratory. Eyes are too valuable to risk. Students will not be allowed to work in the laboratory without approved standard laboratory goggles.

2. Dress appropriately for the laboratory. Shoes that do not completely cover the feet are not allowed (*no sandals)*. Long hair should be tied back. Wear a laboratory coat or apron if available, to protect your clothing.

3. Keep your bench top organized as you work. Put jackets, book bags, and personal belongings away from the work areas. Before you leave, clean your work area and make sure the gas and water are turned off. Clean and return all glassware and equipment to your drawer or the lab bench where you borrowed it.

4. Keep all stock bottles of solid and liquid reagents in the dispensing area. Do not bring reagent bottles to your laboratory work area. Use tests tubes, beakers, or weight boats to obtain chemicals from the dispensing areas: (1) the reagent shelf, (2) the balance tables, (3) in the fume hood, and (4) as instructed.

5. Keep the balance and the area around it clean. Do not place chemicals directly on the balance pans; place a piece of weighing paper, a weigh boat, or another small container on the pan first, and then weigh your material. **Never weigh an object while it is hot.**

6. Carefully check the name on the reagent bottles before you use them. Many names and formulas appear similar at first glance. Label every beaker, test tube, etc., into which you transfer chemicals. Many labels will contain the National Fire Protection Association (NFPA) diamond label, which provides information about the flammability, reactivity, health effects and miscellaneous effects for the substance. Each hazard is rated 0 (least hazardous) to 4 (most hazardous).

More specific information (the reason for potassium chromate being rated an extreme health hazard, for example) about all known substances is available in the form of Material Safety Data Sheets (MSDS), which many institutions keep on file for chemicals by the supplier when they are purchased and are easily obtained from many website sources.

7. Never return unused chemicals to the reagent bottles. This is a source of possible contamination of the entire contents of the stock bottle. Dispose of unused chemicals exactly as instructed in the waste disposal instructions for that substance, identified by throughout each experiment.

8. Disposal of wastes must follow state and federal guidelines. Do not put anything into the trash or sink without thinking first. We have tried to anticipate every disposal decision in the procedure and marked the procedure with the waste icon. The following guidelines are the foundation of waste disposal decisions:

a. Broken glass is put into a clearly marked special container.
b. Organic solvents are never poured into the sink. They are usually flammable and often immiscible with water. Instead, they are poured into a specially marked container (“waste organic solvents”) provided when needed.
c. Solutions containing cations and anions considered toxic by the EPA are never poured into the sink. They are poured into specially marked containers (“waste heavy metal,” etc.) provided when needed. The name of all ions disposed of into a specific bottle must be listed on the label.
d. Solutions poured in the sink should be washed down with plenty of water

e. Some solid chemicals must also be disposed of in specially labeled containers. If you are not sure what to do, ask the instructor.

9. Avoid contaminating stock solutions. Do not insert medicine droppers or pipets into reagent bottles containing liquids. Instead, pour a little of the liquid into a small beaker or test tube. If the bottle is fitted with a special pipet that is stored with the bottle, this may not be necessary.

10. Do not force pipet bulbs onto pipets. Apply just enough pressure to maintain a seal between the pipet and the pipet bulb. Forcing the bulbs may cause the pipet to slip and break, leading to severe cuts or puncture wounds.

11. Working with glass requires special precautions:

a. Do not heat graduated cylinders, burets, pipets, or bottles with a burner flame.
b. Do not hold a test tube or beaker in your hand during a chemical reaction.
c. Do not touch glass that has been near a flame or hot plate. Hot glass looks the same as cool glass and may cause serious burns.
d. Learn and practice proper procedures when inserting glass tubing into rubber stoppers.
e. **Dispose of all broken glassware and other sharp objects into the cardboard glass disposal boxes.** Custodial personnel will stop collecting trash after they find broken glass in the trashcans. If this happens, your class may be placed in charge of emptying the trash cans for the remainder of the semester!
f. **Chipped glassware and glass apparatus from your drawer may be traded for undamaged items at the stockroom.** We can fire-polish chipped glassware so it is usable, but we can't fix cut hands.

12. Do not adjust glass tubing connected to rubber stoppers. Severe cuts or puncture wounds may result. **Lubricate rubber tubing.** When slipping rubber tubing over connectors, such as filter flasks or aspirators, lubricate with a drop of glycerin (hood) or liquid soap (in lab).

13. Avoid all direct contact with chemicals.

a. Wash your hands anytime you get chemicals on them and at the end of the laboratory session.
b. If you spill something, clean it up immediately before it dries or gets on your papers or skin.
c. Never pipet by mouth.
d. Never eat, drink, or smoke in the laboratory.
e. Do not look down into the open end of a test tube in which a reaction is being conducted, and do not point the open end of a test tube at someone else.
f. Inhale odors and chemicals with great caution. Waft vapors toward your nose. The fume hood will be used for all irritating and toxic vapors.
g. Perform in the fume exhaust hood any reactions involving skin-irritating or dangerous chemicals, or unpleasant odors. This is a typical fume exhaust hood. Exhaust hoods have fans to exhaust fumes out of the hood and away from the user. The hood should be used when you are studying noxious, hazardous, and flammable materials. It also has a shatterproof glass window, which may be used as a shield to protect you from minor explosions. Reagents that evolve toxic fumes are stored in the hood. Return these reagents to the hood after their use.

14. Learn the location and proper use of safety equipment: fire extinguisher, eye wash, first aid kit, fire blanket, safety shower, spill kits, and other equipment available. A repeating siren and flashing of the FIRE indicator is the building evacuation signal. If this alarm goes off while you are in the lab, turn off any open flames, grab your valuables, and leave the building as quickly as possible.

Fire Extinguisher: In the unlikely event that a large chemical fire occurs, carbon dioxide fire occurs, carbon dioxide fire extinguishers are available in the lab (usually mounted near one of the exits in the room.) Use of a typical carbon dioxide fire extinguisher is given below.

In order to activate the extinguisher, you must pull the metal safety ring from the handle and then depress the handle. Direct the output from the extinguisher at the base of the flames. The carbon dioxide smothers the flames and cools the flammable material quickly. If you use the fire extinguisher, be sure to turn the extinguisher in at the stockroom so that it can be refilled immediately. If the carbon dioxide extinguisher does not extinguish the fire, evacuate the laboratory immediately and call the fire department.

Safety Shower: One of the most frightening and potentially most serious accidents is the ignition of one's clothing. Certain types of clothing are hazardous in the laboratory and must *not* be worn. Since *sleeves* are most likely to come closest to flames, ANY CLOTHING THAT HAS BULKY OR LOOSE SLEEVES SHOULD NOT BE WORN IN THE LABORATORY. Long hair also presents a hazard and must be tied back. If a student's clothing or hair catches fire, his or her neighbors should take prompt action to prevent severe burns. Most laboratories have a water shower for such emergencies. In case someone's clothing or hair is on fire, immediately lead the person to the shower and pull the metal ring. Safety showers generally dump 40 to 50 gallons of water, which should extinguish the flames. These showers generally cannot be shut off once the metal ring has been pulled. Therefore the shower cannot be demonstrated. (Showers are checked for proper operation on a regular basis, however.)

15. Be conservative in the quantity of materials: Most chemical quantities identified in each experiment are approximate quantities that are practical for the sizes of beakers, test tubes, and other containers you will use. If the quantity you take falls within 10 percent of the amount called for, it will be satisfactory. It is therefore unnecessary for you to try to measure out "exactly" the amount specified. In fact, trying to get that exact amount is a waste of time, both your time and the time of other students who may be delayed because you tie up a balance for so long. YOU MUST RECORD THE EXACT MEASUREMENT YOU COLLECTED AND NOT THE DIRECTIONS VALUE! While using an exact quantity of chemical is not important, knowing as accurately as possible the quantity actually used is essential if that quantity becomes part of your calculations. You will recognize this requirement if your instructions call for so many milliliters of a liquid "estimated to the nearest 0.1 mL," or to "measure 1.5 grams of a solid on a milligram balance." The first tells you to pour into a graduated cylinder a quantity of liquid that is within about 10 percent of the amount specified, and then to measure and record that quantity to the nearest 0.1 mL. The second instruction may be interpreted as, "Take between 1.35 and 1.65 grams of a chemical and then measure and record the quantity taken to the nearest milligram."

Several experiments require "about 1 to 2 mL" of a liquid, usually to be placed in a test tube. Again the exact quantity is not important, and it is a waste of time to measure it with a graduated cylinder. Most eye droppers deliver drops of such size that there are about 20 drops to the milliliter; and the total volume drawn into a dropper by one squeeze of the bulb is about ½ milliliter. One milliliter therefore can be estimated simply as two droppers full.

16. Never work alone in the laboratory area.

17. Never attempt any unauthorized or unassigned experiments. Follow the experimental procedures explicitly, checking and double-checking the identity of all reagents before you use them. There are potentially hazardous combinations of chemicals present in the laboratory. If you have an idea for further investigation, discuss it with your instructor.

18. **Common Sense Guidelines:** A chemical laboratory has a reputation for being a dangerous place to work, probably because of occasional news stories describing accidents in which students have been injured. Accidents actually occur rarely, but the potential is always there. Many of the accidents occur because of ignorance or lack of caution when it is warranted. **The best safety device available is a well-informed student using good lab techniques and common sense.** The following rules and suggestions are made for you and your neighbor's protection.

- **a.** Be familiar with the experiment you are working on and follow directions carefully. Do not modify any experiments except with the instructor's approval. You will be cautioned by the instructor of particularly hazardous situations.

b. Be aware of your neighbor and whether she/he is performing an act dangerous to you or you to her/him.

c. Read labels on reagent bottles carefully. Special warnings are given there. Double check for the correct reagent at the right concentration.

d. Clean up all spills immediately. Neutralize spilled acids with sodium hydrogen carbonate and bases with dilute acetic acid. If acids or bases are spilled on the skin, wash immediately with large amounts of water. Do not try to neutralize with other acids or bases. When diluting acids, always add the acid to water, never water to the acid.

e. All chemicals are poisonous to some degree. Do not taste anything and be cautious in smelling vapors.

f. Get in the habit of washing your hands after handling chemicals and particularly at the end of the period. Don't put hour hands to your eyes or face while handling chemicals.

g. When removing solid reagents from bottles, use the spoon provided in the vial attached to the bottle. To avoid contamination, do not lay the bottle cap down on its side and always return the spoon to the same bottle. Do not use the spoon with any other reagent.

h. When removing liquid reagents from bottles, grasp the stopper and hold the reagent bottle in the same hand. Do not lay the stopper down. Never put a pipette or medicine dropper into the bottle. Instead pour some of the liquid into a beaker then pipette it. Liquids may be poured down a stirring rod to avoid spilling.

i. Never point the open end of a test tube at yourself or another person.

j. Most organic solvents are flammable. Keep these liquids away from open flames.

Safety Guidelines for various equipment commonly used in the laboratory

1. Use of the Sartorius Analytical Balances

Before using the analytical balance, make sure that the object you wish to weigh is less than 200 g, is at room temperature and is clean and dry on the outside. Carry it to the balance room without touching the object. (Fingerprints add mass!)

At the balance, set the object down only on a clean area of the bench or on a clean piece of paper. Prepare the balance for use by leveling the pan, if needed, resetting the display to zero then placing the object in the center of the pan. Close the doors to prevent drafts and movement from disturbing the balance. Record the mass in your notebook, not on scraps of paper. Do not knock or move the balance or lean on the counter top near the balance.

Before adding any chemicals to a weighed empty container, record the tare weight or reset the display to zero, then remove it from the balance. Add chemicals on the counter, NOT in the balance. Return the container to the balance and record the final mass.

Often chemicals are dispensed in a sample vial and the mass of a sample used in an experiment is determined by difference. Weigh the vial and original sample. Tap out approximately the mass required for the experiment into the reaction container; reweigh the vial. Calculate the difference in the two masses and determine if the mass of sample transferred to the container is within the suggested range. Add more if needed. If the sample delivered into the container is much larger than the suggested mass, discard the sample and start again.

When finished with a weighing, remove the object, clean the pan and surrounding counter top if needed, reset the display and close the doors to the balance.

2. Reading a Vernier Scale

A Vernier scale is used on many scientific instruments to increase the accuracy of the last significant figure in a measurement when the marks are close together and difficult to subdivide by eye. A Vernier scale is a pattern of lines, marked with a value from 0 to 10 units, with a different spacing than the line spacing on the main scale. After all certain digits are read from the main scale, one counts up the Vernier scale to the digit on the Vernier scale that is apparently continuous with a line on the main scale. It doesn't matter which main scale line is used; one records the value of the appropriate line from the Vernier scale as the last significant figure.

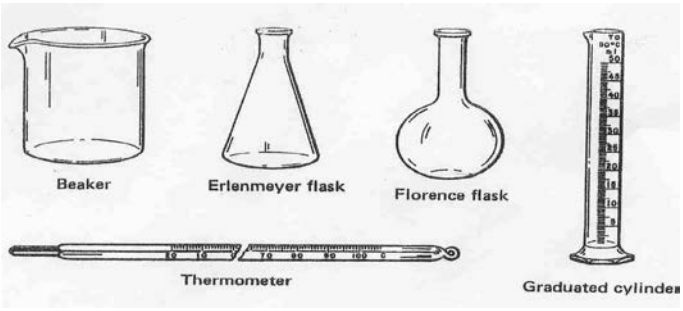
3. Use of Fire and the Bunsen Burner

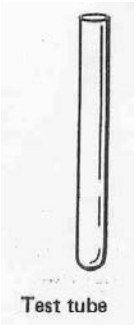
Do not light a match or use fire in the laboratory whenever any flammable chemical is in use by anyone. Flammable chemicals include hydrogen, ether or any volatile organic solvent, among others. Do not use fire when specifically instructed not to by your instructor.

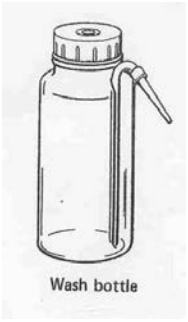
When fire is permitted as a source of heat, use a properly adjusted Bunsen burner. Open the gas jet at the bench fully and reduce the gas flow by turning the valve under the burner to the left. When you can just barely hear the gas flow, light the burner with a match. Adjust the temperature of the flame by adding more gas gradually or by adding more air by raising the chimney on its threaded joint.

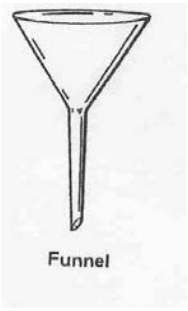
Use a slow gas flow with the chimney almost completely closed for gentle heating, especially when beginning to dry glassware or a solid. Increase the gas flow slightly or increase the air flow to get a hotter flame. A very hot flame will crackle and hiss and will burn with a distinct inner blue cone. The hottest part of the flame is at the tip of the inner blue cone.

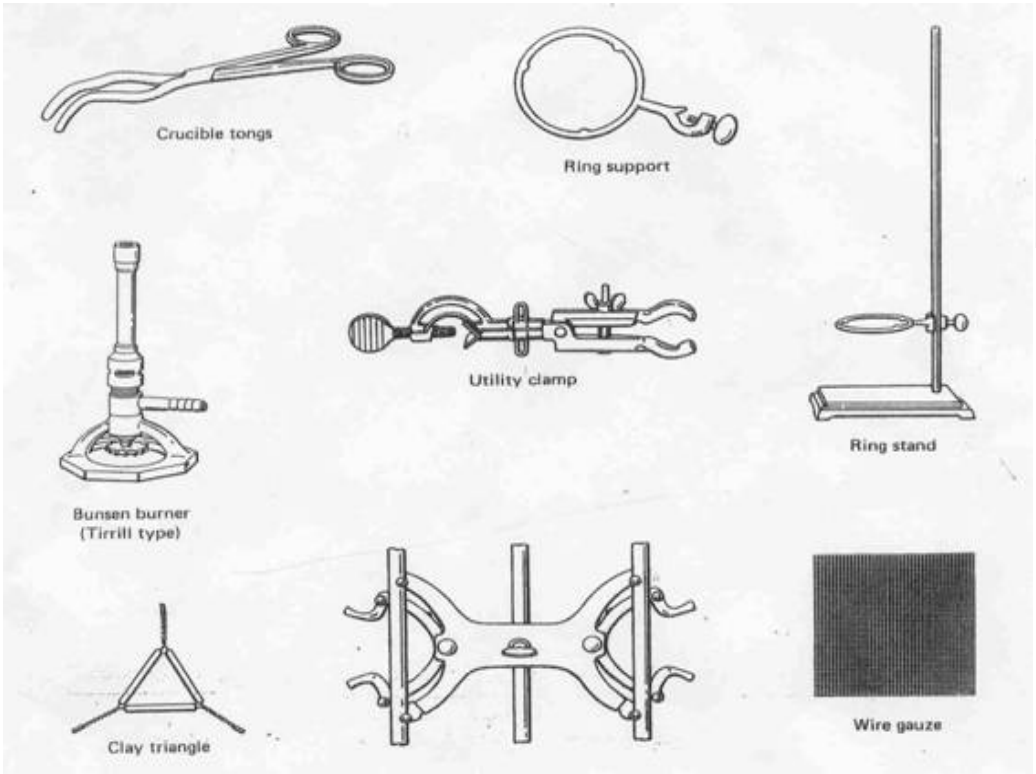
4. KNOW YOUR EQUIPEMENT! Below there are sketches of laboratory equipment you will be using for the course. Some will be kept permanently in your lab locker, some you will check out on a temporary basis, and some you will use in special locations without checking out. The sketches will help identify the various pieces. The instructor will give specific details about the check-out procedures. Directions for the use of unfamiliar equipment are provided at appropriate places in this manual. The instructor will supplement the directions when necessary.

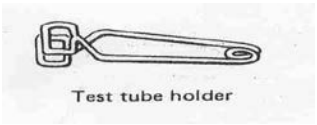


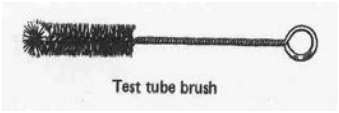












Breakage Policy

Check equipment carefully. You may replace missing or damaged equipment only on check-in. List anything needed for a complete inventory on the Shortage Card and obtain the instructor's signature. Present the card to the stockroom and you will be given the missing equipment to place in your drawer.

You are responsible for anything missing or broken after signing the check-in form. Keep your drawer locked at all times and carry the key with you.

If you break or lose something, go to the stockroom for a replacement. You are responsible for the cost of the replacement item.

You must check out of your locker and return the key before dropping the class or at the end of the semester. You are still responsible for any missing equipment if you drop the class.