

Appendix A: Laboratory Safety and Practices

I: BACKGROUND

There are a variety of hazards associated with working in a laboratory, just as there are hazards associated with cooking in a kitchen. Before you are allowed to begin any experiment involving chemicals, you must undergo training in chemical hazards, laboratory safety rules, and hazardous waste training. Then you must pass a safety quiz. You will also sign the *Chemistry Lab Rules for Students and Safety Agreement*. The purpose of this workshop is to make you aware of the hazards, so that you can minimize hazards to yourself and others in the laboratory.

II: SAFETY INFORMATION FOR CHEM 115 STUDENTS

Minimization of hazards requires everyone to follow safety and lab practice rules.

Each CHEM 115 student will be required to pass a safety quiz with a 100% score before working with chemicals in the lab.

Part A: Chemical Hazards

At the start of each exercise is a table of all of the chemicals used in the exercise and their associated hazards. (The following table is an example.)

There are three types of information given in these tables—chemical classification, chemical hazard (possibility of), and the National Fire Protection Agency (NFPA) code. The chemical classification scheme is designed to help identify the dominant properties of a given chemical, and to help segregate incompatible chemicals. The chemical hazard defines the dominant type of hazard associated with the chemical. The NFPA code helps to identify some major hazard(s) that may be associated with the chemical. The definitions of the chemical classifications, chemical hazards, and the NFPA system are included in the introduction to the Laboratory Manual.

Chemical Classification and Potential Hazards of Chemicals Used in Experiment

| CHEM 115 Expt. 1 How Do We Get Light from Matter? | Chemical Classification | | | | | | | | | | | Possibility Of: | | | | | NFPA Codes | | | | | |
|--|-------------------------|---------------|------------------|--------------------|-------------------|----------|------------------|----------|----------------|----------------|-----------------------|-----------------|-----------|------|----------------------------|----------|---------------------------------|---------------------------------|------|--------|------------|---------------------|
| | Poison A | Flammable Gas | Flammable Liquid | Combustible Liquid | Reacts with Water | Oxidizer | Organic Peroxide | Poison B | Corrosive Acid | Corrosive Base | Irritating or Harmful | Misc. Hazard | No Hazard | Fire | Sudden Release of Pressure | Reactive | Immediate (Acute) Health Hazard | Delayed (Chronic) Health Hazard | Fire | Health | Reactivity | Special Precautions |
| Barium Nitrate, 0.1 M | | | | | | X | | | | | | | | | | | X | | 0 | 1 | 1 | |
| Strontium Nitrate, 0.1 M | | | | | | X | | | | | | | | X | | X | X | | 1 | 1 | 1 | |
| Sodium Nitrate, 0.1 M | | | | | | X | | | | | | | | | | | X | | 0 | 2 | 0 | |
| Magnesium Metal, Powder | | | | | | | | X | | X | | | | | | | X | | 1 | 3 | 0 | |
| Magnesium Metal, 20 Mesh | | | | | | | | | | X | | | | | | | | | 0 | 3 | 0 | |
| Iron Metal, 20 Mesh | | | | | | | | X | | X | | | | | | | | | 1 | 2 | 0 | |

Before beginning an experiment, review this material carefully to plan how you will handle these chemicals. If you have any questions, discuss the matter with your lab instructor prior to starting the lab.

Part B: Equipment Hazards

There are hazards associated with working with equipment in labs.

Although we have designed this course to minimize the hazards associated with chemicals and equipment, the chemicals and procedures described in these experiments do present hazards. You must understand what you are doing and take adequate precautions at all times. We enforce safety measures, such as the use of personal protective equipment, because we know that accidents can happen even in the best of circumstances.

CAUTION:

Unauthorized experimentation is strictly forbidden.

Part C: Laboratory Safety

Specific safety instructions for a particular experiment will be given during each pre-laboratory lecture.

CAUTION:

It is your responsibility to read through the experiment, think about the possible hazards, and take precautions to minimize those hazards. You must take an active role in this process.

The most important way in which you can minimize hazards to yourself is by wearing the appropriate personal protective equipment (PPE). Minimization of hazards also requires that participants respect each other and keep in mind that there are multiple sections of lab using the same space each day. Keeping a neat and organized work area is one way to respect each other in the laboratory.

Sharing the Laboratory

Your lab notebook, lab manual, and required apparatus are the only items allowed on the laboratory bench. Personal items, such as clothing and books, are not allowed on the laboratory bench, top shelf, or on the floor. These items must be stored in the designated storage area in the lab. We recommend that you bring only lab items to the lab. You can rent a hall locker in Science, Thornton Hall, Hensill Hall, or the gym to store other belongings.

Locker equipment is shared across multiple sections of the laboratory. At the end of lab, please clean all glassware and return it to the locker. It does not have to be dry. Any community equipment used should also be cleaned and returned to its original location. Bottles of chemicals should have caps replaced on them immediately after use, and bottles should be placed where they were originally located. All workspaces should be wiped down before leaving for the day, and all trash thrown away.

Personal Protective Equipment

Appropriate clothing and protective equipment can help to protect you if an accident occurs in the lab. The following are *required*.

1. full shoes that cover the top of your feet—no open-toe or heeled shoes, no sandals or bare feet
2. long sleeves and long pants or skirts
3. laboratory coats
4. chemical splash goggles (*not* glasses with side-shields)
5. hair below the neckline tied back
6. no loose clothing, jewelry, or other dangling apparel

Chemical splash goggles must be worn in the lab whenever anyone is doing experimental work. Do not take off your goggles until after you leave the lab. We strongly recommend chemical splash goggles with polycarbonate lenses and an anti-fog coating. The Uvex Stealth™ model is an excellent choice.

Many students complain of poor vision and/or headaches from wearing splash goggles. This is NOT a valid excuse to not wear goggles. Think of the poor vision you will have if you do not wear goggles and get chemicals in your eyes.

CAUTION:

Whenever ANYONE in the laboratory is doing experimental work in the lab, EVERYONE must wear chemical splash goggles.

Laboratory coats are required by the University in any room in which hazardous chemicals are used or stored. Students must purchase and wear lab coats. Lab coats should be transported in plastic bags, preferably sealed bags such as Ziploc™ bags. At the end of the semester, the University will launder lab coats. If you wish to have your lab coat laundered, you must turn it in for a voucher in the last week of the semester, and exchange the voucher for a clean lab coat of the same size (but not the exact same lab coat that you turned in) in the first two weeks of the following term. Instructions about this process will be provided at check-out at the end of the semester.

Recommended

Powder-free latex gloves are recommended to minimize chemical exposure. If you have an allergy to latex, nitrile or vinyl gloves may be substituted. Gloves must be purchased by the student, and it is recommended that several students with the same size hands split the cost of a box of gloves for the semester. It is important to wear gloves that are the correct size—loose gloves are themselves a hazard. Gloves are available at the bookstore, as well as at Costco™. It is also recommended that you wash your hands after lab before eating anything.

Use of Fume Hoods

A typical work area for each student includes a bench-top fume hood. Any procedure that has the potential to release hazardous vapors must be performed directly in this fume hood. The apparatus must be positioned against the back wall of the fume hood. In this way, exposure to fumes is minimized for all participants in a laboratory.

Part D: Safety and Chemical Handling Rules

The following table contains some of the laboratory rules that have been adopted by the Department of Chemistry and Biochemistry to make this laboratory course as safe as possible. These rules will be strictly enforced by all staff and faculty members of the department. Continued infractions will be reported to the laboratory coordinator and could result in your removal from the class.

Anyone found acting contrary to the rules will be excluded from the remainder of the lab period and assigned a zero for that day's work.

| | Rule | Reason |
|-----|--|---|
| 1. | Wear chemical splash goggles, whenever anyone in the laboratory is doing experimental work. Laboratory coats are required in all laboratories. | Goggles are required because your eyes are the most delicate and irreplaceable exterior part of your body. Even if you are not working with chemicals at the moment, you must protect yourself if anyone else is working with chemicals. Laboratory coats are now required to protect the rest of your body from harm in case of a splash or spill. |
| 2. | Unauthorized experimentation is forbidden. | The potential hazards of a chemical experiment preclude unauthorized experimentation in a first-year course. |
| 3. | No eating, drinking, or smoking in the laboratory. This includes chewing gum. | Anything in the laboratory is apt to become contaminated, possibly with intensely toxic compounds. The way to avoid poisoning is to put nothing in the mouth. |
| 4. | Know the location of the fire extinguisher, sand bucket, eyewash fixture, and safety shower. | The reason is obvious. Your instructor will discuss the use of these devices. |
| 5. | Follow up any laboratory injury, even if it does not appear serious, with a visit to the Student Health Service. | There may be unexpected after effects. You may require follow up treatment. Medical personnel are qualified to provide you with instructions and medication as needed. |
| 6. | Clean up (wipe, wash, neutralize) any chemical spills <i>promptly and thoroughly</i> , including liquid that dribbles down the outside of a bottle. | This avoids the possibility of incompatible chemicals mixing on the bench-top. Assess the hazards of the substance before taking action. |
| 7. | (a) When obtaining chemicals from reagent bottles, know <i>exactly</i> what it is you are looking for and read the label twice to be sure you are dispensing the right reagent. (b) Label all beakers, test tubes and glassware with the name of the chemical in the container. | (a) A procedure that is perfectly safe when correctly carried out can become dangerous when an incorrect reagent is used. (b) Many chemicals look identical. Identify the contents. |
| 8. | Never pipet by mouth. | Don't poison yourself! Never suck chemicals into a pipet using your mouth. |
| 9. | Chemicals should never be returned to the stock bottles. Instead, they should be disposed of as hazardous waste. | Avoid the possibility of contaminating the stock solutions used by all students. |
| 10. | Never pour chemicals down the drain. All chemicals are to be poured into the appropriately labeled hazardous waste bottle. | Don't pollute the environment. Pay attention to the label on the waste bottle to avoid mixing incompatible chemicals. |

Part E: Safety Response

In general, the laboratory instructor should always be informed immediately if anything unexpected happens in the lab. Below are general guidelines on action to take for various incidents.

Chemical Spill

Anytime a chemical is not in the beaker or container it is supposed to be in, it is considered a chemical spill. The appropriate response depends on the magnitude of the spill and the nature of the chemical spilled. According to the *SFSU Hazardous Waste Guidelines*, “the initial observer of the incident shall attempt to contain the release, only if this action can be taken without risk to the individual.”

- *Routine Spills:* A routine spill would be liquid spilled due to an overturned beaker or overfilling of a graduated cylinder, or solids scattered off of a spatula in the weigh room. Students can generally manage these types of spills themselves—however, the lab instructor should be informed if there are any questions, or if the spill seems too large to manage.
 - *Immediate Action to Take:* If the spill is liquid, use paper towels to contain the spill. Inform neighbors and others in the area, so that they do not walk through, or place things in, the spill.
 - *Acid or Base Spill:* Bottles of acid neutralizer and base neutralizer are located in the hood. Get the appropriate neutralizer and dump it liberally on the spill. Sweep up the material with the whisk and dust pan in the lab. Get a container from the stockroom for the disposal of the material.
 - *Other Liquids:* Mop these up with paper towels. Get a box or container from the stockroom for the paper towels.
 - *Solids:* Sweep these up with the whisk and dust pan. Use the hazardous waste container in the hood for disposal.
- *Large Spills:* If the spill is large, extends over an extensive area, or is of a particularly hazardous material, a spill cart may be needed to manage this spill. Inform the lab instructor immediately in this circumstance, and follow his or her instructions.

Fire

A fire of any size should be immediately reported to the lab instructor and neighbors should be warned. A fire extinguisher is located in the lab, as is a bucket of sand to extinguish fires. Do not put water on a chemical or electrical fire. Use the sand or the fire extinguisher. Paper towels that have caught on fire can be put out with water—however, make sure you are putting water and not a clear, flammable chemical on the fire!

Evacuation

Follow instructions from the lab instructor should an evacuation be ordered due to fire, fire drill, spill, earthquake, or other emergency. There are multiple exits from the lab, including doors to other labs and the windows.

For any serious injury or sudden illness, call campus police at 911 from any campus phone. Campus police have first responder and CPR training to assess the situation and decide if an ambulance needs to be called.

Injury and Chemical Exposure

The lab instructor should be notified of any injury (cut or burn) or chemical exposure (inhalation, splash on skin, clothes or eyes) immediately, and their instructions should be followed.

CAUTION:

The top priority is to take care of any injury or personal exposure due to chemical splash—spill clean-up is a secondary priority.

- *Wounds and Burns:* Wear gloves to treat all wounds. Gloves are available in the stockroom, as are bandages. Burns should be placed under cold running tap water for 10–15 minutes.
- *Chemical Splash:* Chemical splashes should be rinsed with running water for a minimum of 15 minutes. Obtain help to use the eye wash station or the emergency shower. If a large spill occurs on clothing, the clothing should be removed prior to using the safety shower.

Students will be escorted to Student Health Services under any of these circumstances for treatment, assessment, and follow-up. If a student is too ill or injured to be moved, call 911.

Broken Equipment

Any broken or unsafe equipment should be reported to the laboratory instructor.

Broken Glassware

Any broken glassware should be carefully disposed of in the broken glass container (not in the regular garbage can). All fragments should be swept up with the whisk and dust pan and disposed of in the broken glass container.

Full or Missing Waste Bottle

Inform the instructor that a waste bottle is needed and follow any instructions. Keep waste in a beaker on your bench until a waste bottle is supplied.

Part F: Hazardous Waste Disposal

Every student, faculty, or staff member who handles and generates hazardous wastes on campus must follow all procedures specified in the *SFSU Hazardous Waste Guidelines*, which are posted in every laboratory. Some aspects of these guidelines are taken care of on your behalf—your responsibilities include the following.

1. Put waste in the correct container.

Containers for waste generated in each lab will be located in a hood in your lab with a hazardous waste label attached. If more than one type of waste is generated, you may find more than one waste container. Read the label on the container and place your waste in the correct container. For example, an experiment may generate a solid product that is separated from a solution. There may be one bottle for the solution and one container for the solid and filter paper. Make sure you put the waste into the correct containers.

2. Close hazardous waste containers.

After placing your waste in the container, put the cap back on, even if someone is waiting right behind you. Do not leave the container open or with a funnel in the neck of the bottle.

3. If a container is full, do not put more waste into it.

Notify the instructor. Keep the waste in a beaker on your bench until an empty waste bottle is provided.

4. Excess, unused chemicals should be disposed of as waste.

Do not put excess, unused chemicals back into stock bottles. Dispose of them as waste.

5. Never pour chemicals down the drain.

All chemicals should be disposed of in a hazardous waste container in the hood.

6. Never put chemicals in the garbage can.

Solid chemical waste should be put into the yellow solid hazardous waste container near the hoods. This includes paper towels used to clean up a chemical spill.

Part G: Proper Laboratory Practices

Guidelines for Good Laboratory Practices

The following set of guidelines are designed to ensure that the lab runs smoothly and safely for all participants.

1. Follow all safety rules found in the lab manual and posted in the laboratory.
2. Follow all instructions given by the instructor about laboratory procedures, chemical handling, and waste disposal.
3. Read and follow any notes from the stockroom about the disposition of equipment and supplies.
4. Dispose of all waste properly. Read the label before adding your waste to be sure you are using the correct bottle.
5. Pour liquid solutions out of the bottle by tilting away from the label. In this way, the contents of the bottle will not spill on the label and deteriorate it. Never place a stopper for a stock bottle down on a surface—it could become contaminated. Hold the stopper between the fingers of one hand while pouring with the other hand.

6. Never take a stock bottle of chemicals to your bench or perform your experiment where the stock bottles are located. Take as much of each chemical as you think you will need for the experiment to your bench in a *labeled* beaker. Read the label twice to be sure you are taking the correct chemical.
7. Never return unused chemical to the stock bottle. Dispose of unused chemicals as hazardous waste.
8. Use a clean pipet for each new chemical to avoid contaminating solutions.
9. Never pipet by mouth. Use a bulb to draw liquid into the pipet.
10. Weigh solids directly into a beaker or a weigh boat, never directly onto the pan. Use a clean, dry spatula to move the solid from the bottle to the balance. Do not pour the solid out of the bottle. Clean the spatula before using it for a different chemical to avoid cross contamination. Any extra solid taken out of the bottle must be disposed of as hazardous waste. Any scattered solid on or around the balance should be swept up and disposed of as hazardous waste.
11. When heating a test tube, never point the test tube at yourself or another classmate.
12. If a reagent bottle is empty or soap or paper towels are needed, inform your lab instructor and follow their directions.
13. If a hazardous waste bottle is full or missing, inform your lab instructor and follow their directions. Keep your waste in a beaker at your bench until a replacement bottle is supplied.
14. If while you are adding waste to a bottle it becomes full, STOP pouring the waste into the bottle. Put the cap on the bottle, inform your instructor, and keep the rest of the waste in a beaker on your bench until an empty bottle is supplied.
15. Clean and return all community equipment to the location where it was obtained.
16. Maintain a clean and orderly bench while working. All backpacks, jackets, and other items not needed for the lab must be stored on the hooks on the walls of the lab—not on the bench-top and not at your feet.
17. At the end of the day, all equipment should be washed and returned to your locker, community equipment should be cleaned and returned, waste should be disposed of, the bench washed down with a wet paper towel, and all trash put in the trash can (not in the sink).

Guidelines for Keeping a Proper Laboratory Notebook

1. A laboratory notebook that is permanently bound and uses carbon paper or carbonless paper to make duplicate pages is required. A 100-page book is highly recommended.
2. The laboratory notebook is a working notebook. It should be legible and organized to you, but not necessarily neat. However, all information should be adequately described so that someone else can tell what you were doing. All numbers should have units.
3. All writing in the notebook must be done with a ball-point pen that contains permanent ink. Erasures or use of white-out are strictly forbidden. Any erroneous entries should be lined out in such a way that the reader will see what it is that is being corrected.

4. Begin the entry of each experiment on a new page. All entries must be dated and clearly identified.
5. All data and observations must be entered directly into the notebook, never recopied. Paper towels, filter paper, filler paper, scraps of paper, or other loose pieces of paper containing recorded data will be confiscated and destroyed by your lab instructor.
6. You are required to include all data, observations, analysis, and answers to questions that are part of the exercise in your laboratory notebook. You may take notes from the pre-lab lecture either in your notebook or in some other notebook—whichever you prefer.