

Laboratory Safety and Practice

Objectives: The information in this laboratory is intended to acquaint you with basic safety procedures, more general regulatory safety responsibilities, and laboratory practice in our labs. By the time you successfully complete this laboratory, you will be able to:

- Identify and use the mandatory and optional safety equipment used in the CHEM 1361 lab
- Identify your safety responsibilities toward your partner and others in the laboratory
- Extract relevant safety information regarding chemicals to be used from Safety Data Sheets (SDS), formerly called Material Safety Data Sheets (MSDS) and know their location in the laboratory
- Apply the “Right-to-Know” law to different situations
- Identify the significance of the National Fire Protection Association (NFPA) diamond and its markings
- Recognize and understand the new Globally Harmonized System pictograms

Personal Safety Obligations

Though laboratory safety is not all about you, it certainly begins with you. Three particular personal aspects will be considered – personal protective equipment, lab community-wide safety, and sources of safety information.

1. Personal Protective Equipment (PPE)

There are four basic routes through which materials can enter your body:

- Eye Contact
- Skin contact/absorption
- Ingestion
- Inhalation

Personal protective equipment is comprised of those items that an individual uses to minimize exposure to chemicals through any of the routes above.

- a. *Eye contact* is easily prevented by using protective goggles, a requirement in this laboratory at **ALL** times. Acceptable forms of eye protection in this laboratory are splash goggles or a face shield. A large poster is mounted in the lab that illustrates the difference between different types of eye protection in the case of a splash. After viewing the poster, you will see why only these two forms of eye protection are acceptable in the lab. The term “splash” comes from the vents located around the goggles – a material splashed in the face cannot penetrate into the eyes. Goggles with simple perforations are not acceptable since a splash in the face could penetrate that type of goggle and reach the eyes. Acceptable face shields for lab must rest against the forehead, extend past the eyes on the right and left sides, and extend down past the jawline. Note that contact lenses and prescription glasses are acceptable in the lab but must be worn under chemical splash goggles



Figure 1. Acceptable Safety Goggles

Even with best practice, it is important to realize that once you leave the laboratory an important first step is to wash your hands thoroughly. During the course of an experiment you may come into contact with chemicals that could be irritants to the eyes. Once you leave the lab and take off your eye protection, please be aware that you may still carry some of those chemicals on your hands. If you were to rub your eyes without washing your hands

first, you could quickly undo all of your goggle diligence.

If you do splash something into your eyes or feel as though your eyes have been contaminated, know the location of the eye wash station (northwest corner of the lab – near the exit door on the right). Using the eyewash station is simply a matter of pushing the handle and immersing your open eyes in the stream of water. In the case of a large splash across the face, it is best to put your face in first with goggles on until the bulk of the spill is removed. Then remove the goggles and begin the open eye wash. Practice indicates that, regardless of the cause of the irritation, once started the open eye wash should be continued for at least 15 minutes.

- b. *Skin contact/absorption* can occur through many avenues in the lab. The best prevention comes in the form of adequate coverage of the skin, thus the need to set forth some guidelines for acceptable clothing:
- Closed toe shoes must be worn in the laboratory. This includes tennis shoes, gym shoes, dress shoes, etc. Flip flops, sandals, and any shoe exposing a part of the foot are not acceptable and will result in you being required to leave the lab.
 - Pants or dresses past the calf must be worn in the laboratory. Absolutely no shorts. It is acceptable to bring (or store in your locker) sweat pants to slip into for the lab.
 - As much of the upper body as reasonable must be covered. The implication here is that mid-riff tops or any sort of clothing that exposes the torso is not acceptable. Tank tops are also not acceptable lab attire.
 - One way to help protect your clothes in the laboratory is to bring a lab coat. These are optional. If you do choose to wear a lab coat, it is good practice to either store it in your locker from week-to-week or be sure to wash it regularly. Remember it will carry on it anything that you spilled on it during the lab period.

Another important avenue of preventing the absorption of chemicals into your body is to use protective gloves. The department supplies two types of protective gloves for your use – latex and nitrile. Some individuals are allergic to latex and/or nitrile. Due to the severity of some latex allergies, latex gloves will not be stored in the lab. If you require latex gloves please inform your instructor. If you are allergic to BOTH latex AND nitrile, please notify your instructor as soon in the semester as possible so other gloves can be made available.

There are a few things that are helpful to know about the use of gloves. The chemicals you will work this semester are not particularly hazardous, but it is helpful to develop good habits early.

- Not all gloves are created equal. Different glove materials have different compatibilities with a range of chemicals. The gloves are categorized by degradation, breakthrough rate, and permeation. An example of this sort of information may be found at
- If you are working in the laboratory wearing gloves, do not leave the laboratory with the gloves on. Since you are trying to protect yourself from contamination by wearing them, it is not wise to spread any potential contamination outside of the confines of the laboratory. Remove them and dispose of them before leaving the room. Do not reuse protective gloves.

- Use the thumb and index finger on one of your gloved hands to grasp the palm of the glove on your other hand.
 - Peel the grasped glove off of its hand.
 - Once the glove is off, wad it up with your gloved hand and place it in the palm of your gloved hand.
 - Slide a bare finger from your newly ungloved hand under the bottom of the glove on the still-gloved hand and peel the glove off with the finger – don't touch the outside of the glove.
 - Pull the glove off in this fashion until you have turned this glove completely inside out. The other glove will be in the inside of the just-removed glove. Dispose of the gloves in the trash.
- c. *Ingestion* is a third avenue through which chemicals can enter your body during the lab. This area is covered rather directly by the rules that include no smoking, eating, or drinking in the lab. Again, though, be aware that washing your hands immediately after leaving the lab is an important habit to acquire since your hands could still contain something that could be ingested.
- d. *Inhalation* is not a common avenue of entry in the CHEM 1361 lab. During some experiments in which noxious fumes could be given off, we will work almost exclusively in the fume hoods to prevent the vapors from entering the room.

2. Lab Community-wide Safety Considerations

You will be working in a laboratory setting that could have as many as 27 other students working at the same time in rather close quarters. Though Section 1 dealt with your personal safety equipment, it is also important to recognize your role in the safety of others in the laboratory.

Starting with your obligations to your partner, it is essential to recognize that your ability as a pair to work safely and efficiently in the laboratory is entirely dependent on having both of you come to the laboratory prepared. Though getting an experiment “done” in the time allotted is important, it is not the ultimate goal. This is an instructional laboratory – the goal is for both members of a pair to be active participants in the laboratory. It is absolutely essential that both members of a pair come in prepared to conduct the experiment with a full awareness of safety concerns as well as an understanding of the objectives of the laboratory. You may have heard the expression – “There is no such thing as a bad question”. In the lab, there is one bad question, particularly to ask an instructor. When you enter the lab to do an experiment, do not ask “Which experiment are we doing today?”. You need to be prepared.

In the larger lab community, there are a few things you can do to help ensure a smooth safe lab experience for everyone. In particular:

- Arrive at the lab on time so you can hear the prelab comments. These often involve group information such as the location of chemicals and equipment, a listing of safety concerns, modifications to the procedure, ideas for efficiently completing the lab, disposal guidelines, etc. Late arrivals cause a huge disruption to the lab as the tardy arriver has to constantly ask questions that were covered in the prelab comments.

- Be cautious as you move around the lab – look where you are going. There are often stools in the rows and they can be difficult to see in a full lab.
- Pay particular attention to disposal directions. There is typically one fume hood designated as the disposal hood. Follow the directions in the hood to properly dispose of chemicals. This does fall under a safety concern since anything that is put down the sink – which will be virtually nothing in this laboratory – ends up in the environment eventually.
- During the safety orientation lecture at the start of the semester pay close attention to the location and directions for the eyewash station, safety shower, fire blanket, fire extinguisher, and broom/dust pan for sweeping up broken glass. In the event of an emergency, your role may be to help someone get to one of these safety devices.
- The emergency phone number is posted near the exit door: 581-2911. This is the first number to call as it brings campus security officers who are trained in first response. They can then direct in other help as necessary.

3. Sources of Safety Information

a. Safety Data Sheets (SDS or MSDS)

One must be aware of the hazards of particular chemicals in order to use the proper personal protective equipment, methods, protocol in case of exposure, and disposal methods. This information is contained in documents called Safety Data Sheets (SDS). These were previously called Material Safety Data Sheets (MSDS) but the name is changing effective June 1, 2015 due to the implementation of the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The GHS is a United Nations devised and endorsed means of standardizing hazard communication internationally. It will replace several individual national systems and is intended to improve communications.

There are sixteen sections to the SDS sheets as shown in the table below.

Section #	Title	Short Description
1	Identification	includes product identifier; manufacturer or distributor name, address, phone number, emergency phone number; recommended use; restrictions on use
2	Hazard(s) identification	includes all hazards regarding the chemical; required label elements including classifications according to different agencies
3	Composition/information on ingredients	includes information on chemical ingredients; trade secret claims
4	First-aid measures	includes important symptoms/effects, acute, delayed; required treatment
5	Fire-fighting measures	lists suitable extinguishing techniques, equipment; chemical hazards from fire
6	Accidental release measures	lists emergency procedures; protective equipment; proper methods of containment and cleanup
7	Handling and storage	lists precautions for safe handling and storage, including incompatibilities
8	Exposure controls/personal protection	lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; PPE
9	Physical and chemical properties	lists the chemicals characteristics
10	Stability and reactivity	lists chemical stability and possibility of hazardous reactions
11	Toxicological information	includes routes of exposure; related symptoms, acute and chronic effects, numerical measures of toxicity
12	Ecological information*	
13	Disposal consideration*	
14	Transport information*	
15	Regulatory information*	
16	Other information	includes the date of preparation or last revision of the SDS sheet

Information regarding the GHS was drawn largely from the Occupational Safety and Health Administration (OSHA) website found at:
<https://www.osha.gov/dsg/hazcom/ghs.html#4.8>. The United Nations documents detailing all aspects of the GHS is available as the "Purple Book" at:
http://www.unece.org/trans/danger/publi/ghs/ghs_rev00/00files_e.html
 * Information in Sections 12-15 comes from agencies other than OSHA.

The shaded regions in Table 1.1 suggest areas of the SDS that may be of the most interest to you for materials used in this CHEM 1361 laboratory. Looking at the shaded areas item-by-item:

- Section 2 – It could be helpful to understand the hazards regarding any chemicals you will be using in the laboratory
- Section 4 – First-aid measures could come into play in the laboratory and it is important to know what the SDS says in this area
- Section 8 - Notice that recommended PPE are given in Section 8, though at no point will you escape at least wearing chemical splash goggles while in the laboratory regardless of whether or not they are recommended by the SDS. The limit values are measures of how much exposure an individual may experience under different circumstances before experiencing ill effects.
- Section 10 – Knowledge of the stability of a chemical and products of its hazardous reactions may be found here and could be of value.
- Section 11 – The Toxicological information informs you of the route of exposure (remember there are four routes), symptoms of exposure, and also provides numerical data regarding the level of toxicity.

Though this may look a little intimidating, realize that you are working in a controlled environment in the presence of instructors who are familiar with the chemicals being used. Materials are also selected with consideration for their safety in the general chemistry laboratory.

Finding the SDS sheets is not difficult. Each of our laboratories contains a binder in a drawer in the front with SDS sheets for the chemicals commonly stored in that laboratory. In addition, the stockroom (SC 222) contains binders with SDS sheets for ALL of the chemicals in our storeroom. In addition, there are multiple internet sites which make available SDS sheets. As examples:

<http://www.ilpi.com/msds/> provides a variety of sites at which you can find SDS sheets
<http://ehs.okstate.edu/links/msds.htm> Oklahoma State's site provides a number of locations
<http://www.sigmaaldrich.com> a commercial site for a company that sells a wide range of chemicals

and there are many more. Please be aware that we are not talking about just chemicals used in the laboratory. As you look, for example at Oklahoma State's site, you will see sites focusing on inks and toners. Some sites list janitorial and office supplies. Any time a manufacturer provides a hazardous chemical they are also required to supply the SDS with it.

The United States (and several other nations) have enacted "Right-to-Know" laws regarding the relaying of information to affected parties about the materials they are routinely exposed to. A summary from the OSHA site is given as:

Protection under OSHA's Hazard Communication Standard (HCS) includes all workers exposed to hazardous chemicals in all industrial sectors. This standard is based on a simple concept - that employees have both a need and a right to know the hazards and the identities of the chemicals they are exposed to when working. They also need to know what protective measures are available to prevent adverse effects from occurring.

Note this does not apply specifically to students in an educational setting, but it is important for you to realize that if you want further information about anything you will be working with in the laboratory we will make every effort to accommodate that request. It is also important to realize that, wherever your career path takes you, the Right-to-Work concept is in place and you are entitled to information about substances you will be working with and those working for you have the same right.

b. Symbols and Pictograms

There is quite a bit of important information on the SDS sheets and you might imagine there are circumstances in which someone – a firefighter, first responder, lab manager, etc. – may appreciate a very quick summary of the pertinent information. You have likely seen information of this nature presented in the form of pictures and diagrams – consider a tanker truck with a large diamond affixed to it as well a symbol at each entrance to the Sciences Complex. In this section we will briefly look at two methods, both a current one and a future one, of presenting this information pictorially.

The National Fire Protection Agency (NFPA) diamond currently in use is probably one of the more prevalent public displays of safety information. The diamond and the significance of its sections are given in Figure 1.2. (I have written the colors in the boxes – normally there would be appropriate numbers there.) The numbers to be filled in may be found in Section 2 of the SDS sheet for the specific material.

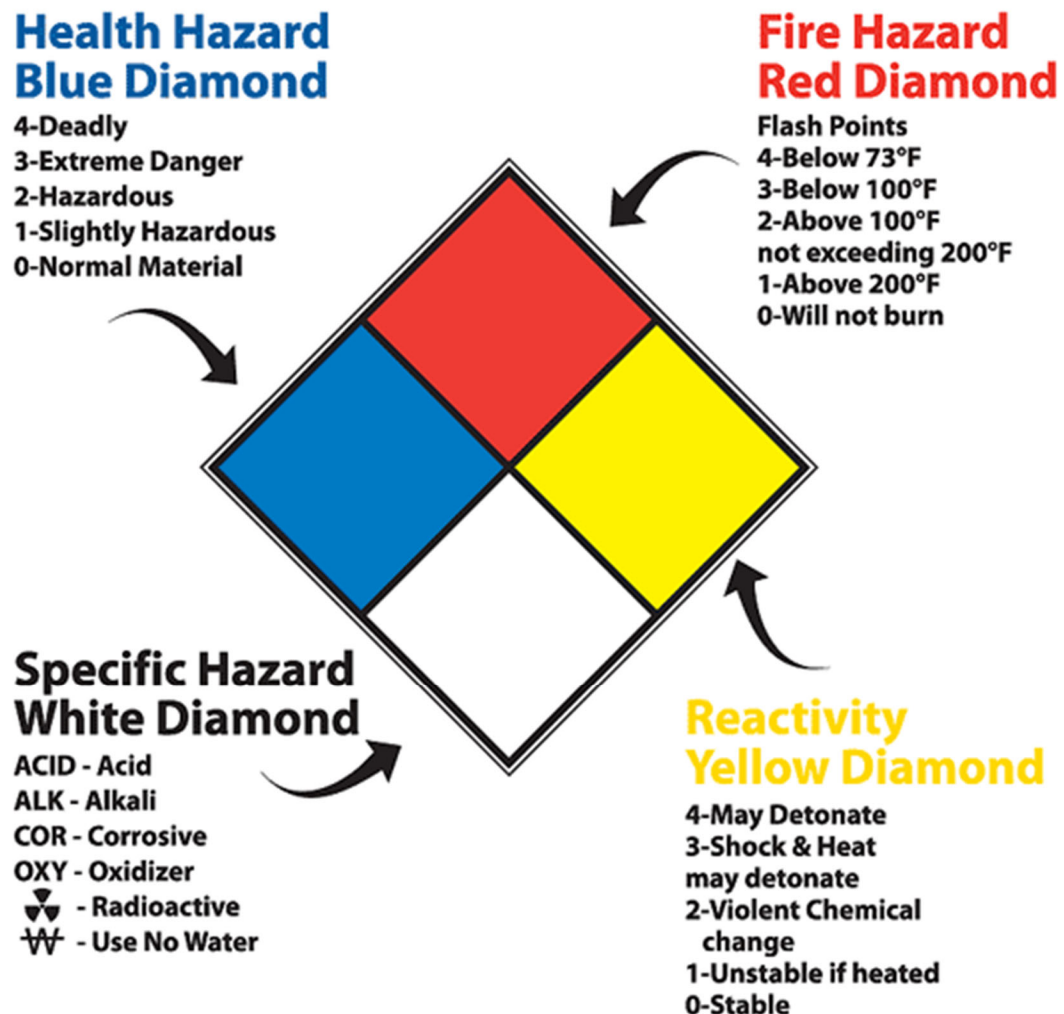


Figure 2 NFPA Diamond (from <http://www.zeably.com>)

A set of visual symbols (pictograms) associated with the GHS will be starting to show up fairly soon. Figure 1.3 gives a summary of those symbols – you do not need to memorize these. Just look them over to become familiar with the appearance of these emerging pictograms. Throughout the lab book these symbols will be used to relay information about any hazards associated with chemicals you will be using.

Other components that go with the pictograms are Signal words, Hazard Statements, and Precautionary Statements.

There are only two Signal Words that might apply – Danger and Warning. These are assigned through criteria in the GHS system, with Danger being the more severe category. Pictograms without a Signal Word indicate that the pictogram hazard exists, but not at a high enough level to warrant a Danger or Warning Signal Word. Throughout the book the Signal Word will be included if it is present.

There are a variety of Hazard Statements that could be used for a chemical. These will be included in the book if it is a reasonably small set.

There are also a variety of Precautionary Statements suggesting what you have to do to work safely with the chemical. These will be provided in each lab write-up as well depending on space available.

Regardless of whether all of this information is provided in each lab, it is always available by looking at the SDS sheet.










GHS Pictograms and Hazard Classes		
		
<ul style="list-style-type: none"> ■ Oxidizers 	<ul style="list-style-type: none"> ■ Flammables ■ Self Reactives ■ Pyrophorics ■ Self-Heating ■ Emits Flammable Gas ■ Organic Peroxides 	<ul style="list-style-type: none"> ■ Explosives ■ Self Reactives ■ Organic Peroxides
		
<ul style="list-style-type: none"> ■ Acute toxicity (severe) 	<ul style="list-style-type: none"> ■ Corrosives 	<ul style="list-style-type: none"> ■ Gases Under Pressure
		
<ul style="list-style-type: none"> ■ Carcinogen ■ Respiratory Sensitizer ■ Reproductive Toxicity ■ Target Organ Toxicity ■ Mutagenicity ■ Aspiration Toxicity 	<ul style="list-style-type: none"> ■ Environmental Toxicity 	<ul style="list-style-type: none"> ■ Irritant ■ Dermal Sensitizer ■ Acute toxicity (harmful) ■ Narcotic Effects ■ Respiratory Tract ■ Irritation

Figure 3 GHS Pictograms