

Starting with Safety - American Chemical Society

Chemistry lab is different from most other courses. Here you gain new knowledge by doing things, not just reading about them. You'll spend much of your time in Chemistry lab working with equipment and techniques that are new to you. They can be dangerous if you don't adhere to strict safety procedures. But if you start with safety by following the rules, paying attention, and using common sense, you can work with confidence that you'll be safe in the Chemistry laboratory and you can have fun at the same time.

Handling Chemicals Safely

Handling chemicals safely means following rules designed to keep them from contacting your skin and eyes, or someone else's. One important safety rule is always use small containers that you can control easily. Ignoring this rule can cause accidents. If you have an accident, always inform your teacher. Pouring from small containers is far safer.

Accidents can also happen when mixing chemicals. To be safe, only mix chemicals when your teacher says to. Read the instructions for the experiment all the way through first before doing anything. Read and reread labels before use to make sure you have got the right chemicals. Note the concentration and the hazard warning. Accidents can happen when the wrong chemicals are mixed together or when the right chemicals are mixed together in the wrong way.

Make sure to follow your instructions exactly. For example, suppose you have to dilute concentrated sulfuric acid with water. You might think you can mix them together anyway you wish, but there is an important rule for diluting concentrated sulfuric or phosphoric acid that should always be followed. Add the acid to the water - never the reverse. Remember it by the initials "AA" - add acid. Watch what happens when you don't follow this rule.

This is water added to acid. The acid boils and it can splash out of the beaker. When acid and water are mixed correctly, there is less danger. Acid is poured from a graduated cylinder or beaker down a stirring rod into the water.

Whenever you work with chemicals, there is a chance of spills. A work tray under your set up will help contain them. Always move carefully when handling with chemicals. Keep coin-top stoppers between your fingers, not on the bench where they can pick up contaminants. Hold bottles with your hand over the label and replace stopper immediately. Covering the label keeps drips from blurring it or getting on your hands. Set bottles out of the way when you're finished so they won't get knocked to the floor.

When handling chemicals, always keep them away from your face, never taste anything to see what it is, and don't touch it or smell it directly from the bottle either. Small amounts of some chemicals, even vapors, can harm your eyes, mouth and nasal membranes.

There's a safe way to smell a chemical indirectly, if your teacher gives you permission. Hold it away from your face and waft the vapors to your nose, that way you won't get a strong whiff of them directly. Certain chemicals give off vapors, they're called volatile chemicals. You should work with harmful volatiles under a fume hood. Your teacher will tell you what these chemicals are.

Chemicals should be kept pure and uncontaminated. One way to prevent contamination is to use only clean glassware. Another way is to only pour out of a reagent bottle. Never pour anything back in, even excess chemicals you haven't used. It's better to waste the excess than risk contaminating the entire bottle with particles from around the lab. After measuring out a reagent, you'll often have something left over. Instead of pouring it back in the reagent bottle, dispose of it in the proper waste container.

When drawing out chemicals with a pipette, don't use your mouth, use a bulb or pipette filler. You can collect the exact amount you need and never have to come in contact with it.

At some point in your laboratory work, you'll probably spill something. You should report spills immediately. Stay away from the spilled chemical and let your teacher clean it up. To keep a large spill from spreading it's barricaded with an absorbent material, such as kitty litter. It's then either mopped up, or covered over completely with the absorbent. The absorbent and chemical can be swept up with a broom.

What's done with the residue depends on the type of chemical it contains. Your lab should have a container for each type of waste. Don't throw waste chemicals down the sink unless your teacher says it's all right. Waste paper that's not contaminated by chemicals goes in a conventional trash can, and broken glassware goes into a separate container.

The last chemical handling safety rule to keep in mind is to clean up when finished. Glassware should be thoroughly scrubbed and rinsed so it's as clean as possible for the next experiment. Liquid puddles or powders left behind on the lab bench can get on the next person's clothing or skin. Wipe them up thoroughly and throw the paper towels away in the proper container. And clean chemicals off your hands before leaving. There may be invisible chemical residues that could damage your skin or contaminate your food the next time you eat.

Review Handling Chemicals Safely

- *Work with small containers*
- *Mix chemicals only when your teacher says to*
- *Read and reread chemical labels*
- *Read instructions all the way through first*
- *Use a work tray if your lab has them*
- *More carefully and deliberately when handling chemicals*
- *Add concentrated sulfuric or phosphoric acid to water*
- *Hold coin-top stoppers between your fingers while pouring*
- *Hold bottles with your hand over the label*
- *Replace stoppers immediately*
- *Keep chemicals away from your face*
- *Work with harmful volatiles under a hood*
- *Keep chemicals as pure and uncontaminated as possible*
- *Draw out chemicals with a pipette filler - never by mouth*
- *Notify your teacher to cleanup spills*
- *Put waste in the proper container*
- *Cleanup when finished.*

Bunsen Burner and Glassware Safety

The main heat source in most Chemistry labs is the Bunsen burner. It produces an open gas flame burning at a high temperature. There is always the danger of an accident if it's not used properly. For example, it should never be used to heat volatile organic liquids that give off flammable vapors. These substances should be heated in a heating mantle or a steam bath in a hood. But for most other substances, a Bunsen burner is an ideal heat source when used properly.

There are several types of Bunsen burners, but they all have the same basic parts. The gas comes from an outlet on the lab bench. A rubber hose fits over the tip and over a similar fitting on the Bunsen burner. Most burners have a valve at the bottom to control the flow of gas. Air inlets control the amount of oxygen in the flame. A wing top can be placed on the burner to spread the flame out.

There are several important rules to follow to use a Bunsen burner safely. First check the gas hose for cracks. If you see any, get a new hose. Make sure the hose fits securely on the gas valve and on the Bunsen burner. The gas valve at the bottom of the burner should be open. You can light a Bunsen burner with a striker or a match. Open the gas line valve and light the burner. If the flame's properly adjusted, you can place the burner under your setup.

When using a match, strike it away from you. Turn the gas on after the match is burning, that way gas won't escape while you're striking the match. Light the gas from the side, so the match isn't blown out. A yellow flame is too cool, opening the air holes lets in more oxygen for combustion. Adjust the bottom valve if the flame is too large or small. The flame should be blue with a lighter inner cone. The tip of the inner cone is the hottest part of the flame.

If the flame begins to sputter or flare, turn the gas off immediately. Also turn the gas off immediately if the flame goes out. Unburned gas escaping into the room could ignite and cause an explosion. Even when the burner seems to be working properly, if you smell gas turn it off.

Cracks or stars in glassware are dangerous. They can break open when it's heated. So before you heat any glassware, check it carefully for cracks or stars.

Flat bottom containers are normally heated on a wire screen on a ring stand. Erlenmeyer flasks and other narrow necked containers should be secured to the stand with a clamp. Test tubes can be heated in a water bath. The water bath transfers the heat slowly and evenly to the test tube and helps keep it from boiling over.

You can also heat a test tube directly in the flame. Hold it at an angle while moving it back and forth to distribute the heat evenly. Aim it away from yourself and your neighbors in case it boils over.

Only heat containers with openings. A boiling liquid changes to gas which must be able to escape. Gas can't escape from a closed container and the pressure that builds up can burst it.

Be extra careful when working with heated equipment. Hold hot glassware in beaker tongs, never your hands. Remember that the wire screen and ring stand are also hot. If you don't have tongs, protect your hands with gloves designed for hot glassware. Keep them away from the flame. Handle everything as if it's hot if you've been using a Bunsen burner. Glass and metal look the same when hot as they do when they're cold.

Review Bunsen Burner and Glassware Safety

- *Heat volatile organics in a heating mantle or steam bath in a hood - not over a Bunsen burner*
- *Check the gas hose for cracks*
- *Make sure the hose fits securely on the gas valve and Bunsen burner fittings*
- *Stand back from the burner while lighting it*
- *Strike matches away from you*
- *Turn on the gas after lighting the match*
- *Turn the gas off immediately if the flame sputters, flares, or goes out or if you smell gas*
- *Check glassware for stars or cracks*
- *Clamp narrow-necked containers to the ring stand*
- *Move test tubes back and forth through the flame at an angle while heating*
- *Don't heat closed containers*
- *Hold hot glassware in beaker tongs or hot mitts.*

Thermometer Safety

Thermometers are one of the most important tools in the chemistry laboratory. They're easy to use, but since they're usually made of glass, they have to be handled properly.

One common misconception is that lab thermometers have to be shaken down like medical thermometers. Shaking is totally unnecessary and it can be dangerous. The liquid inside can move freely up and down on its own without shaking.

Some lab reactions take place at higher than an alcohol or mercury thermometer can stand. The temperature of oxidation in a Bunsen burner flame is around 600°C. That high a temperature will vaporize the liquid inside. The resulting pressure will break the glass. But most lab experiments are conducted at temperatures from 120°C down to -20°C, and for that range either a mercury thermometer or an alcohol thermometer is suitable.

No matter which type you use, always treat it carefully. When you are finished with it, set it down where it will be safe. Lay it away from the edge of the bench on a wire screen or towel so it can't roll off.

When a thermometer breaks, the glass and any liquid that spills out must be cleaned up and disposed of properly. This is a job for your teacher. Glass fragments can be swept up. If any alcohol escapes from the glass, it can be wiped up with a paper towel.

Cleaning up a broken mercury thermometer is more difficult and is also a job for your teacher. Mercury is poisonous and it won't soak into a paper towel. Mercury vapors can also escape into the air. If you work with mercury thermometers, your lab may be equipped with a mercury cleanup kit or sponge. The kit and broken glass should be disposed of in the proper container.

Review Thermometer Safety

- *Don't shake thermometers*
- *Use thermometers only in the temperature range they're suited for*
- *Lay thermometers down on a towel or wire screen to cool, away from the edge of the bench*
- *Let your teacher clean up broken thermometers.*

Glass Tubing Safety

The most common lab injuries are cuts from broken glass, especially glass tubing. A typical accident comes from using too much force to push a tube through the hole in the stopper. One way to avoid this kind of accident is to use an inserter. First, dip the Teflon tip in a glass lubricant, such as glycerin. Then push it through the stopper. Remove the tip and slide the tubing through the hollow inside of the inserter shaft. Removing the shaft leaves the tubing behind. Make sure to wash the lubricant off of the tubing and stopper before using them. And replace the Teflon tip so it doesn't get lost.

To remove the tubing, take out the tip and lubricate the end of the hollow shaft. Push it through the stopper hole around the tubing. Then slide the tubing out through the shaft and remove the inserter. Remember to wash the lubricant off before returning the stopper and tubing to storage. And don't forget to replace the tip.

If you don't have an inserter, lubricate the tubing instead and protect your hands with leather gloves. Push the tubing gently through, rotating if there's any resistance. Use the same care when removing it. And don't forget to wash off the lubricant.

Review Glass Tubing Safety

- *Use an inserter to place glass tubing in a stopper or remove it, or*
- *Lubricate the tubing and protect your hands with leather gloves.*

Centrifuge Safety

A centrifuge spins mixtures around in test tubes to separate solid from liquids. The solids move out toward the bottom of the tubes and the liquid stays on top.

When the test tubes inside aren't evenly distributed, the centrifuge is unbalanced. It vibrates like a washing machine with an unbalanced load. If the vibration is bad enough, it can fall off the benchtop.

To prevent vibration, the centrifuge must be balanced. If you're only centrifuging only one test tube, place another one opposite it with an equal amount of water. Once the centrifuge is balanced, you can turn it on. When it's finished, turn it off then wait till it stops spinning on its own. Never try to stop a centrifuge with your hand.

Review Centrifuge Safety

- *Place equally filled test tubes in a centrifuge to balance it*
- *Don't try to stop the spinning with your hand.*

Dressing for Safety

A safe lab session starts with proper clothes. You must wear clothing and equipment that will protect you from chemicals and flames and at the same time stay out of your way.

For example, sleeves that are too loose can drag through a chemical puddle or knock things over. The wrong material is also dangerous as this mannequin demonstrates. Fuzzy sweaters or filmy fabrics can easily catch on fire. Synthetics such as polyester melt when they burn and stick to the skin.

The right kind of clothing includes sleeved shirts that fit fairly close, but aren't too tight to restrict movement. And fabrics made of sturdy cotton or wool that won't melt and stick to your skin. A lab apron keeps most splashes off your clothes, but you should still wear older clothes underneath in case any chemicals get past the apron. Legs are vulnerable to chemical splashes and broken glass if you drop something, so long pants or a long skirt should be worn to protect them.

Open shoes can't protect your feet from spills, closed leather shoes are much better. And shoes made of cloth or woven material can absorb spills and hold harmful chemicals against your skin.

Besides wearing the right clothes, there are other precautions you should take to avoid accidents. Tie up loose long hair, it could knock something over or even catch fire. Remove rings and watches, they can trap corrosive chemicals against your skin and the chemicals can damage your jewelry.

Your eyes are the easiest to hurt and the most important to protect. Don't wear contact lenses in lab, they may trap chemical vapors against your eyes. If that happens, your eyelids may go into spasms that make it impossible to remove the lenses and wash out the chemical. Always wear goggles with side shields to completely protect your eyes, even if you're already wearing glasses.

And finally, protect your hands. Never use bare hand with concentrated acids, bases, or other reactive chemicals such as concentrated hydrogen peroxide. Your teacher will tell you what type of gloves to wear to work with these chemicals.

With the right clothes and protective equipment, you can work with laboratory chemicals with confidence and safety.

Review Dressing for Safety

- *Don't wear extremely loose clothing*
- *Fabrics should be sturdy and natural*
- *Wear older clothes and cover them with a lab apron*
- *Wear long pants or a long skirt to cover your legs*
- *Wear closed leather shoes to protect your feet*
- *Tie up long hair*
- *Remove rings and watches*
- *Take out contact lenses*
- *Cover your eyes with goggles with side shields*
- *Protect your hands with the right kind of gloves.*

Behavior in Lab

A chemistry laboratory is full of beakers and bottles holding chemicals. Fooling around can have disastrous consequences. You could scar yourself or others for life, even cause blindness.

So the most important rule of all in the lab is no fooling around. Don't run, push, or wrestle, or even move fast. Even if you're not fooling around, accidents can happen. Personal belongings in the middle of aisles can trip someone. Even a job as simple as reading a buret can lead to an accident. For greatest accuracy, your eyes should be on the same level as the number you're reading. If you can't read a buret accurately, lower it down to eye level. If you can't do that, stand on a step stool.

There are behavioral rules to protect you against less obvious hazards too. Applying makeup may seem harmless enough but chemicals and vapors and spills in the lab can contaminate it. Then when you apply it to your face, you put on a chemical too. So keep makeup outside the lab.

Eating and drinking in the lab can cause similar problems. Chemicals can contaminate your food or splash into a drink. Get rid of them before you come into the chemistry lab.

Review Behavior in Lab

- *Don't fool around in lab*
- *Keep aisles clear of personal belongings*
- *Stand on a step stool when you have to reach*
- *Keep makeup in your purse*
- *Keep food and drinks outside*

Emergency Equipment

In spite of safety precautions, people sometime get careless and accidents happen. That's why a well-equipped chemistry lab has emergency equipment to take care of them.

If you've cut yourself, wash the wound to remove any chemical traces. Make sure there are no pieces of glass in the cut. Dry your skin carefully so a bandage will stick. Let your teacher put the bandage on the cut. Notify your teacher whenever you have an accident. And make sure to get immediate medical attention after any injury in the lab.

Chemical spills and splashes are also common lab accidents. If a chemical hits your eyes, wash them immediately in an eye wash fountain. Hold your eyes open and roll them around so the water can wash them thoroughly. You shouldn't be wearing contacts, but if are get them out as soon as you've given your eyes a good initial rinsing. Continue washing for at least 15 minutes, then see a doctor immediately to check your eyes for damage.

Non corrosive chemical splashes on bare skin should be rinsed off in a lab sink with plenty of water. Spills of corrosive materials require a lot more water. Don't wait until you feel pain from the chemical, head for the safety shower immediately. Rinse your body thoroughly as fast as possible. Take off all your clothes, don't let modesty make your injury worse. Your teacher will clear the other students out of the room. Stay under the shower for at least 15 minutes.

Fires are always a potential hazard in chemistry lab, especially when organic liquids are involved. Small fires and containers can often be put out by covering them. Turn off the burner so the fire won't reignite. Larger fires require a fire extinguisher. It should be operated by a teacher, not by a student.

If a fire is too large to control, clear out of the building. Call the fire department when you're safely outside and tell them what chemicals are involved.

Clothing fires can be put out in a couple of ways, as the mannequin will demonstrate. The best way is in a safety shower. If the shower is not close by, the rule is stop, drop and roll. The victim's weight on the fire puts some of it out, and a fire blanket gets the rest. Flames should be kept away from the victim's face. Anyone who has been burned must get medical attention immediately.

Review Emergency Equipment

- *Clean and dry the skin around a cut before a bandage is applied*
- *Rinse chemicals from your eyes in the eyewash fountain*
- *Rinse chemicals from your hands and arms with water in the sink*
- *Remove your clothes on the way to the safety shower to rinse large spills from your body*
- *Extinguish small fires in containers by covering them*
- *Let your teacher use an extinguisher to put out larger fires*
- *Put out clothing fires in the safety shower*
- *If there's no other way to put out a clothing fire, use a fire blanket carefully to keep flames away from the face and neck*

Conclusion

The accidents in this program may look serious and many of them are. But don't let the potential for danger scare you away from chemistry lab. A safe, well run chemistry lab is an interesting and rewarding learning experience. If you pay attention, use common sense, and follow the safety rules you've seen here the chemistry laboratory can be safer than your own home.