Student Name: _____ Date: _____

30S Chemistry Laboratory Safety

PREPARATION AND SAFETY

To get the most out of your laboratory experience, you must be well-prepared for each experiment. This means that you must read the experiment thoroughly before coming to the laboratory. Make sure you have a clear idea of what the experiment is about. Be sure that you understand each step of the procedure. Before you begin, talk over the experiment with your partner or classmates. Involve your teacher in the discussion if you are unsure about any part of the experiment.

Preparation is important not only to understanding, but also to safety. If you are well-prepared for the laboratory, it is much less likely that an accident will occur. In the laboratory, you are responsible not only for your safety, but also for the safety of your classmates. If an accident happens because you are not prepared, it can also affect your friends. This is all the more reason for you to take the time and make the effort to prepare for the laboratory.

Be sure to note the safety warnings illustrated by the screened areas headed **Caution**. These warnings are emphasized by symbols appearing in the margins. In addition, be sure to observe the general safety precautions described in the safety section that follows. Finally, remember the most important safety advice of all: **Always wear safety goggles in the chemistry laboratory!**

SAFETY IN THE CHEMISTRY LABORATORY

Everyone who works in a chemistry laboratory should follow these safety precautions.

1. Wear safety goggles in the laboratory at all times. Wear a laboratory apron when using corrosive chemicals.
2. Close-toed shoes must be worn in the laboratory. Avoid wearing bulky or loose-fitting clothing. Remove any dangling jewelry.
3. Conduct only assigned experiments, and do them only when your teacher is present.
4. Familiarize yourself with the locations of safety equipment such as eyewash fountains, spill kits, fire extinguishers, fire blankets and the emergency shower. Be sure you know how to use the equipment. Locate the master switch and master taps for power, gas, and water so you can turn them off in an emergency. Locate the fire alarms.
5. Do not chew gum, eat, or drink in the laboratory. Never taste any chemicals. Keep your hands away from your face when working with chemicals.
6. Wash your hands with soap and water after each experiment.
7. Carefully read and reread all the directions and instructions for the procedure before beginning the experiment.
8. Notify your teacher immediately if any chemicals, especially concentrated acid or base, are spilled.
9. Immediately report all accidents, no matter how slight, to the teacher.
10. Pin up or tie back long hair, and roll up loose sleeves when working with flames.
11. Do not leave a lighted burner unattended.
12. Use a hot plate instead of an open flame whenever possible, and always when a flammable liquid is present.
13. Read the label on a reagent bottle carefully *before* using the chemical. After removing the chemical from the bottle, check to make sure that it is the correct chemical for that procedure.
14. To avoid contamination, do not return unused chemicals to a reagent bottle. Similarly, never put a pipet, spatula, or dropper into a reagent bottle. Instead, pour some of the reagent into a small, clean beaker and use that as your supply. From your teacher, find out what to do with surplus materials, and how to dispose of chemicals.
15. Do not use chipped or cracked glassware.
16. Dispose of broken glassware in a separate, well-labeled container used only for that purpose.
17. When diluting an acid, *always* pour the acid slowly into water, constantly stirring to dissipate the heat generated. Caution: *Never pour water into a concentrated acid.*
18. When heating a liquid in a test tube, turn the mouth of the test tube away from yourself and others.
19. Clean up spills and broken glass immediately, as directed by your teacher. Leave your work area clean at the end of the laboratory period.
20. Always stand while conducting an experiment.
21. Always use boiling chips when heating liquids.
22. Never peer into flasks, beakers, or test tubes because they may contain harmful fumes and materials that could be expelled.

LABORATORY HAZARDS

By being aware of possible hazards in the laboratory and taking the appropriate safety precautions, you minimize the risks involved in conducting chemistry experiments. This safety section acquaints you with the hazards that exist in the laboratory and teaches you to avoid these hazards. In addition, there is information on what you should do if an accident occurs.

THERMAL BURNS

A thermal burn can occur if you touch hot equipment or come too close to an open flame. You can prevent thermal burns by being aware that hot and cold equipment look the same. If a gas burner or hot plate has been used, some of the equipment nearby may be hot. Hold your hand near an item to feel for heat before you touch it. Use oven mitts or tongs to handle hot equipment.

Treat a thermal burn *immediately* by applying cold running water to the burned area. Continue applying the cold water until the pain is reduced. This usually takes several minutes. In addition to reducing pain, cooling the burned area also serves to speed the healing process. Greases and oils should not be used to treat burns because they tend to trap heat. Seek medical assistance for serious burns. **Notify your teacher immediately if you are burned.**

CHEMICAL BURNS

A chemical burn occurs when the skin or mucous membrane is damaged through contact with a corrosive substance. The Caution notes of each experiment indicate the substances which can cause chemical burns. Certain chemicals can irritate the skin and the membranes of the eye, nose, throat, and lungs. Treat corrosive and irritant chemicals with special care. Chemical burns can be severe. Permanent damage to mucous membranes can occur despite efforts to rinse thoroughly a chemical from the affected area. See page 13 for the Safety Symbols.

Prevention is the best defense against chemical burns. Without exception, wear safety goggles during all phases of the laboratory period — even during cleanup. If a corrosive chemical contacts your skin, wash the affected area with running water for several minutes. Should any chemical get in your eyes, hold your eyelids open, and flush your eyes under a gentle stream of water for 20 minutes. Call for assistance and inform your teacher. If you wear contact lenses, avoid wearing them on days when you conduct experiments. If you are wearing contact lenses when any chemical gets into your eyes, remove them immediately. This is crucial especially if the chemical is an acid or a base. It can concentrate under the lens and cause extensive damage. Wear a laboratory apron and closed-toed shoes (no sandals) for protection.

An additional burn hazard exists when concentrated acids or bases are mixed with water. The heat released in mixing these chemicals with water can cause the mixture to boil and spatter corrosive chemicals. The heat can also cause nonPyrex containers to break, spilling corrosive chemicals.

To avoid these hazards, follow these instructions: Always add an acid or a base to water, very slowly, constantly stirring. Never do the reverse. One way to remember this piece of critical advice is to think of these words: "Pouring acid into water is doing what you ought-er."

CUTS FROM GLASS

Cuts occur most frequently when thermometers or pieces of glass tubing are forced into rubber stoppers. Prevent cuts by using the correct technique for this procedure, see page 20.

Avoid cuts from other sources by discarding chipped and cracked glassware according to your teacher's instructions. If you should receive a minor cut, allow it to bleed under cold water for a short time. Wash the injured area and notify your teacher. Serious cuts and deep puncture wounds require immediate medical help. Notify your teacher immediately. While waiting for assistance, control the bleeding by applying pressure with the fingertips or with a clean towel or gauze.

FIRE

A fire may occur if chemicals are mixed improperly or if flammable materials come too close to a burner flame or hot plate. When using a burner flame or hot plate, prevent fires by tying back long hair and loose-fitting clothing. Do not use a burner when flammable chemicals are present. The Caution notes of each experiment indicate the substances which are flammable. Use a hot plate as a heat source (instead of a burner) when flammable chemicals are present.

If hair or clothing catches fire, DO NOT run because running fans a fire. Drop to the floor and roll slowly to smother the flames. Notify your teacher immediately. Shout for help. If another person is the victim, get a fire blanket to smother the flames. If a shower is nearby, help the victim to use it.

POISONING

Many of the chemicals used in the experiments are toxic and are identified in the Caution notes of each experiment.

There are some guidelines to follow to prevent poisoning. Never eat, chew gum, or drink in the laboratory. Do not touch chemicals. Clean up spills. Keep your hands away from your face to prevent chemicals from reaching your mouth, nose, or eyes.

In some cases, the detection of an odor is used to indicate that a chemical reaction has taken place. It is important to note that many gases are toxic when inhaled. If you must detect an odor, use your hand to waft some of the gas toward your nose. Sniff the gas instead of taking a deep breath. This will minimize the amount of gas sampled.

SAFETY SYMBOLS

Take appropriate precautions whenever any of these safety symbols appears next to the instructions in a procedure.

Eye Hazard
- Wear safety goggles.

Corrosive Substance Hazard
- Wear safety goggles and laboratory apron.
- Do not touch chemicals.

Fire Hazard
- Tie back hair and loose clothing.
- Do not use a burner near flammable materials.

Toxic Hazard
- Do not chew gum, drink, or eat in the laboratory.
- Keep your hands away from your face.

Inhalation Hazard
- Avoid inhaling this substance.

Thermal Burn Hazard
- Do not touch hot equipment.

Disposal Hazard
- Dispose of this chemical only as directed.

Electric Shock Hazard
- Do not touch the discharge tube or power supply.

EMERGENCY PROCEDURES

Report any injury, accident, or spill to your teacher immediately. Know the location of the closest eyewash fountain, fire blanket, fire extinguisher, and shower.

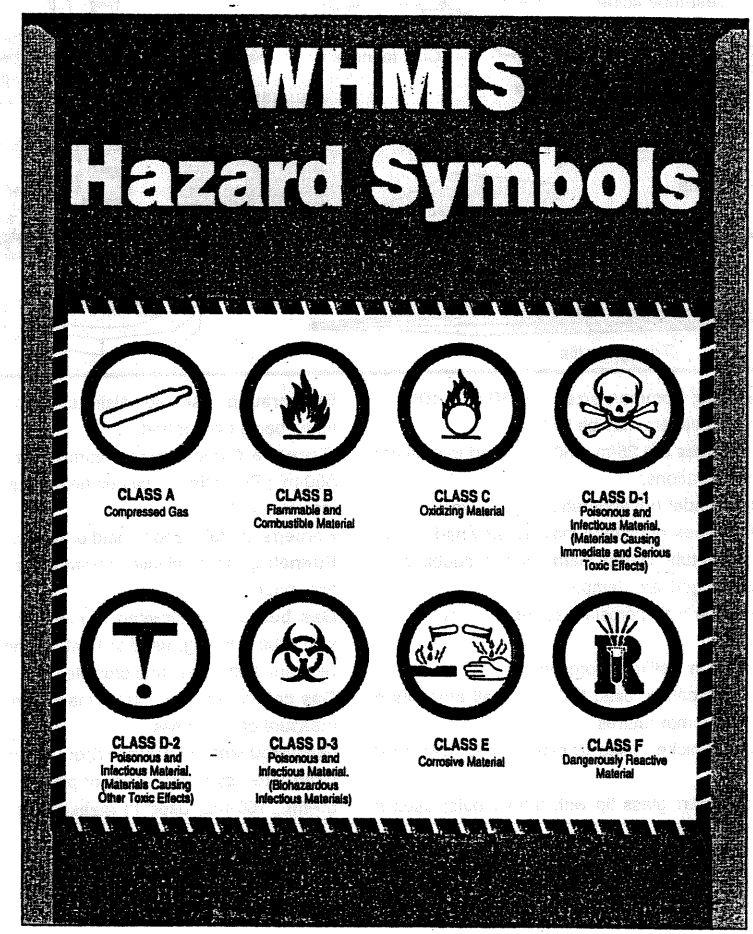
Situation	Safe Response
Burns	Immediately flush with cold water until the burning sensation subsides.
Eye injury	Immediately flush the eye with running water for 20 minutes. Remove contact lenses. Do not allow the eye to be rubbed if a foreign object is present in the eye.
Fainting	Provide fresh air (for instance, open a window). Move the person so that the head is lower than the rest of the body. If breathing stops, use artificial resuscitation.
Fire	Turn off all gas outlets. Unplug all appliances. Use a fire blanket or fire extinguisher to smother the fire. Caution: Do not cut off the person's air supply.
Minor cuts	Allow to bleed briefly. Wash with soap and water.
Poisoning	Note what substance was responsible. Alert your teacher immediately.
Spills on skin	Flush with water.

WHAT IS WHMIS?

The Workplace Hazardous Materials Information System, or WHMIS, is a national system. It is designed to ensure that all employers obtain the information they need to inform and train their employees about the safe handling and usage of hazardous materials. Through legislation, the hazards of materials produced or sold in, imported into, or used within workplaces in Canada are identified by standard classification criteria. The goal of WHMIS is to reduce the incidence of illnesses and injuries resulting from the use of hazardous materials in the workplace.

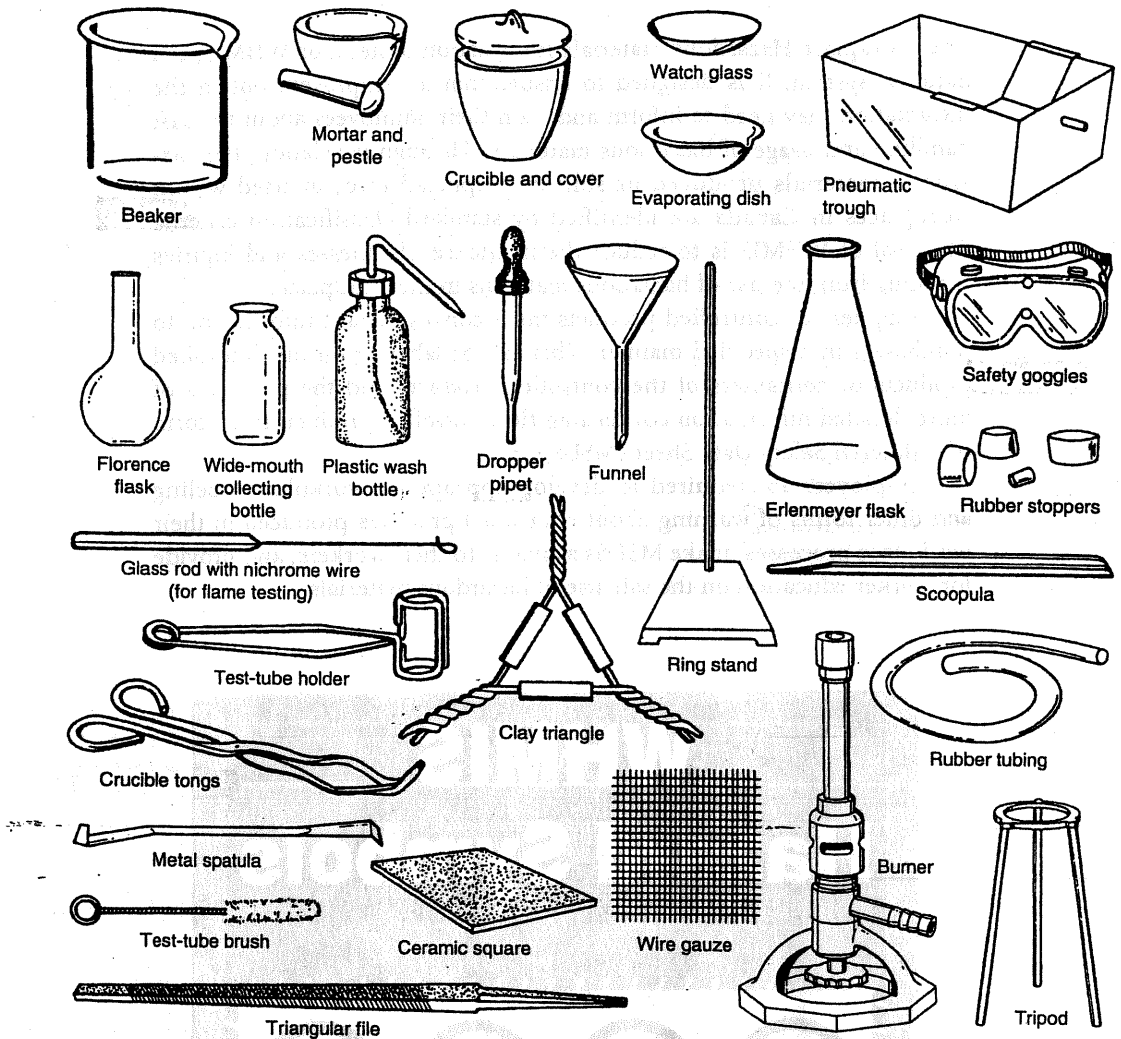
Suppliers of controlled products must convey hazard information to purchasers in a specified manner. This can be labeling on the controlled products or containers of the controlled products and the provision of more detailed information concerning the controlled product in the form of a Material Safety Data Sheet (MSDS).

Employers are required to develop appropriate workplace labeling and other forms of warning about controlled products produced in their workplace processes, make MSDSs available to their workers, and provide for worker education on the safe use of hazardous materials.



Provided courtesy of Alberta Occupational Health and Safety

LABORATORY EQUIPMENT



Beaker: glass or plastic; common sizes are 50-mL, 100-mL, 250-mL, 400-mL; Pyrex beakers may be heated.

Buret: glass; common sizes are 25-mL, 50-mL; used to measure volumes of solutions in titrations.

Ceramic square: used under hot apparatus or glassware.

Clamps: the following types of clamps may be fastened to support apparatus: buret/test-tube clamp, clamp holder, double buret clamp, ring clamp, 3-pronged jaw clamp.

Clay triangle: wire frame with porcelain supports; used to support a crucible.

Condenser: glass; used in distillation procedures.

Crucible and cover: porcelain; used to heat small amounts of solid substances at high temperatures.

Crucible tongs: iron or nickel; used to pick up and hold small items.

Dropper pipet or dropper: glass tip with rubber bulb; used to transfer small volumes of liquid.

Erlenmeyer flask: glass; common sizes are 100-mL, 250-mL; Pyrex flasks may be heated; used in titrations.

Evaporating dish: porcelain; used to contain small volumes of liquid being evaporated.

Florence flask: glass; common sizes are 125-mL, 250-mL, 500-mL; Pyrex flasks may be heated; used in making and for storing solutions.

Forceps: metal; used to hold or pick up small objects.

Funnel: glass or plastic; common size holds 12.5-cm diameter filter paper.

Gas burner: constructed of metal; connected to a gas supply with rubber tubing; used to heat chemicals (dry or in solution) in beakers, test tubes, and crucibles.

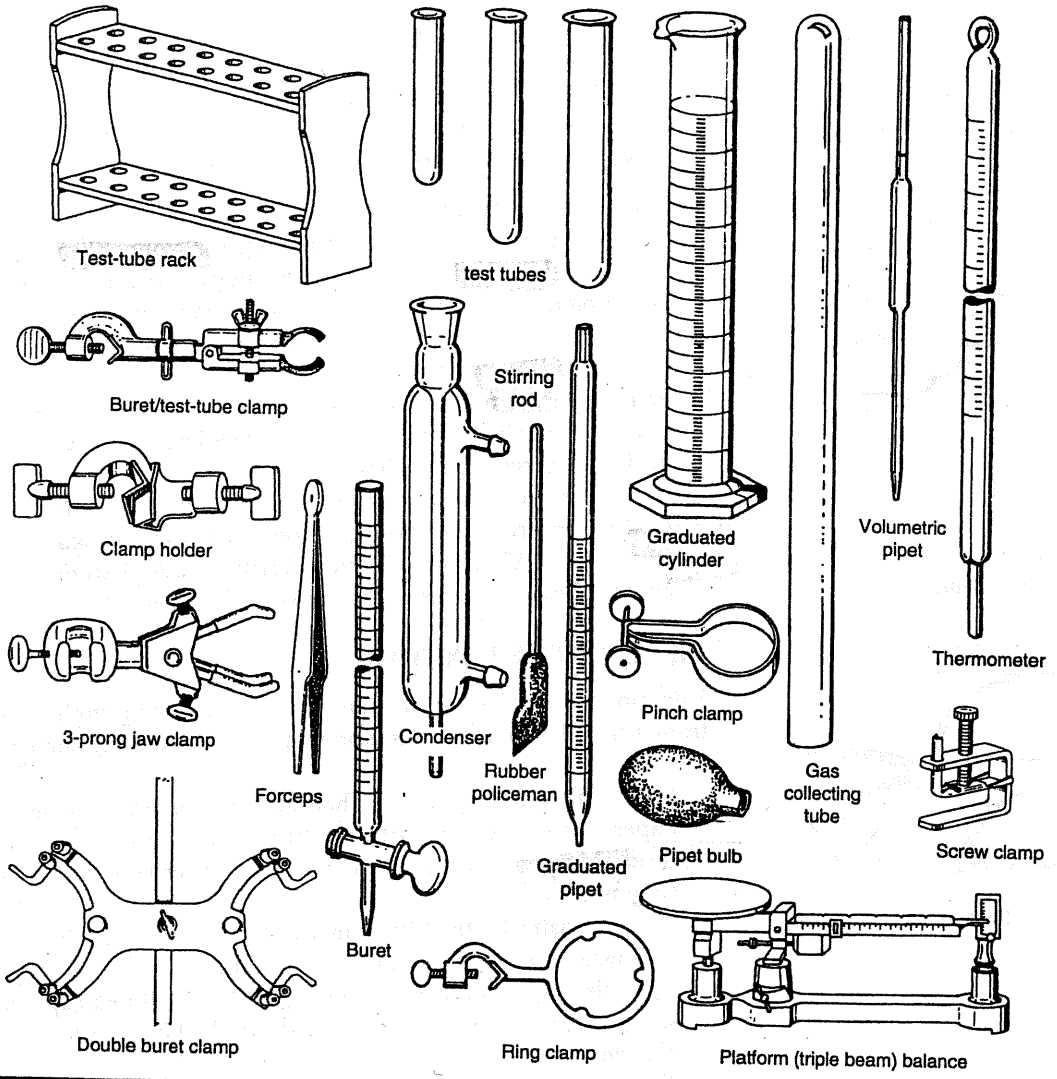
Gas collecting tube: glass; marked in millilitre intervals; used to measure gas volumes.

Glass rod with nichrome wire: used in flame tests.

Graduated cylinder: glass or plastic; common sizes are 10-mL, 50-mL, 100-mL; used to measure approximate volumes; must not be heated.

Graduated pipet or delivery pipet: glass; common sizes are 10-mL, 25-mL; used to measure solution volumes; less accurate than a volumetric pipet.

ELECTRONIC BALANCE



Mortar and pestle: porcelain; may be used to grind crystals and lumpy chemicals to a powder.
Pipet bulb: rubber; used in filling a pipet with a solution; a pipet must never be filled by mouth.
Platform balance: also known as a triple beam balance.
Pneumatic trough: galvanized container with shelf; used in experiments where a gas is collected.
Ring stand: metal rod fixed upright in a heavy metal base; has many uses as a support.
Rubber stoppers: several sizes.
Rubber tubing: used to connect apparatus so as to transfer liquids or gases.
Safety goggles: plastic; must be worn at all times while working in the laboratory.
Screw clamp, pinch clamp: metal; used to block off rubber tubing.
Spatula, scoopula: metal or porcelain; used to transfer solid chemicals; the scoopula has a larger capacity.
Stirring rod and rubber policeman: glass with rubber sleeve; used to stir, assist in pouring liquids, and for removing precipitates from a container.
Test-tube brush: bristles with wire handle; used to scrub small diameter glassware.
Test-tube holder: spring metal; used to hold test tubes or glass tubing.
Test-tube rack: wood or plastic; holds test tubes vertically.
Test tubes: Pyrex; common sizes are small (13 mm by 100 mm), medium (20 mm by 150 mm), large (25 mm by 200 mm); may be heated.
Thermometer: spirit in glass; common range −10°C to 110°C.
Triangular file: metal; used to scratch glass tubing prior to breaking to desired length.
Tripod: iron; used to support containers of chemicals above the flame of the burner.
Volumetric pipet: glass; common sizes are 10-mL, 25-mL; used to measure solution volumes accurately; must not be heated.
Wash bottle: flexible plastic; squeeze sides to dispense distilled water.
Watch glass: glass; used to cover an evaporating dish or beaker.
Wide-mouth bottle: glass; used with pneumatic trough.
Wire gauze: used to spread the heat of a burner flame.

SAFE LABORATORY TECHNIQUES

POURING LIQUIDS

- Always read the label on a reagent bottle before using its contents.
- Always wear safety goggles when handling chemicals.
- Never touch chemicals with your hands.
- Never return unused chemicals to their original containers. To avoid waste, do not take excessive amounts of reagents.

Follow this procedure when pouring liquids.

1. Use the back of your fingers to remove the stopper from a reagent bottle. Hold the stopper between your fingers until the transfer of liquid is complete. Do not place the stopper on your workbench.
2. Grasp the container from which you are pouring with the palm of your hand covering the label.
3. When you are transferring a liquid to a test tube or measuring cylinder, the container should be held at eye level. Pour the liquid slowly until the correct volume has been transferred.

   When you are pouring a liquid from a reagent bottle into a beaker, the reagent should be poured slowly down a stirring rod (Figure 1). When you are transferring a liquid from one beaker to another beaker, you can hold the stirring rod and beaker in one hand.

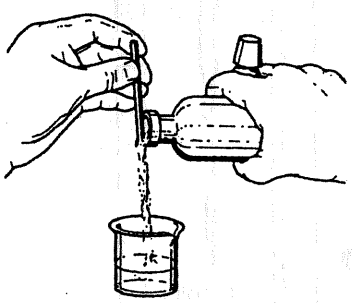


Figure 1. Pouring from a reagent bottle into a beaker

FILTERING A MIXTURE

Sometimes it is necessary to separate a solid (for example, a precipitate) from a liquid. The most common method of separating such a mixture is filtration.

1. Fold a filter paper circle in half and then quarters. Open the folded paper to form a cone with one thickness of paper on one side and three thicknesses on the other. Put the paper cone into a filter funnel (Figure 2).

   Alternatively, the filter paper can be fluted. Fold the paper in half, in quarters, in eighths, and so on, until it cannot be folded further. Open the paper and place it in the funnel. The fluted paper has a larger surface area than the folded paper, hence the filtration is faster and more efficient.

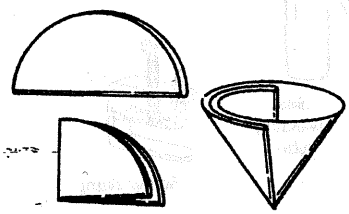


Figure 2. Folding the filter paper

2. Place the funnel in an iron ring clamped to a ring stand. Moisten the filter paper with a small volume of distilled water, and gently press the paper against the sides of the funnel to give a good fit. (If the correct size of filter paper has been used, the top edge of the cone will be just below the rim of the filter funnel.)
3. Place a beaker beneath the funnel to collect the filtrate. The tip of the funnel should touch the inside surface of the beaker and extend about 3 cm below the rim (Figure 3).
4. Decant the liquid from the solid (precipitate) by pouring it down a glass stirring rod into the funnel. Be careful to keep the liquid below the top edge of the cone of filter paper at all times; the liquid must not overflow. Finally, use a jet of distilled water from a wash bottle to wash the solid (precipitate) into the filter.
5. When the filtration is complete, wash the solid residue on the filter paper with distilled water to remove traces of solvent. Dry the solid.
6. If the filtrate contains a dissolved salt it may be recovered by evaporation if desired.

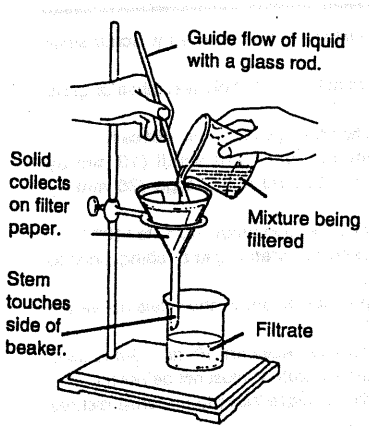


Figure 3. Filtration assembly

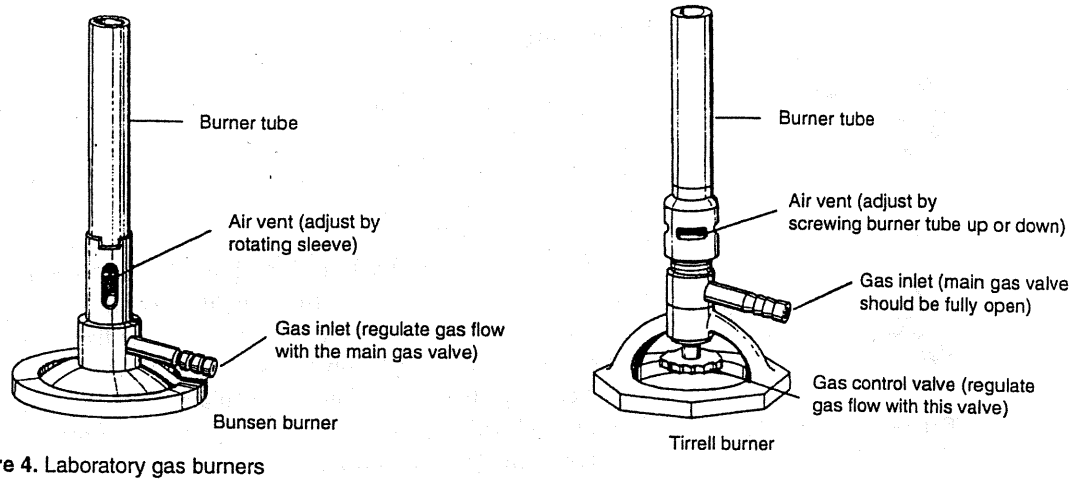
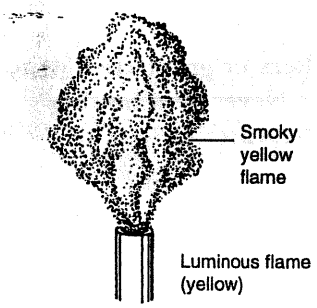


Figure 4. Laboratory gas burners

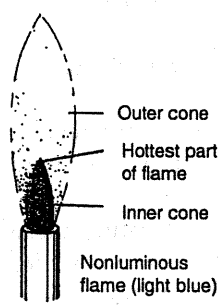
USING A GAS BURNER

Laboratory gas burners produce various kinds of flames when different mixtures of gas and air are burned. The two most common models are the Bunsen burner and the Tirrell burner. Both have adjustable air vents; the Tirrell burner also has a gas control valve at its base (Figure 4).

1. Examine your laboratory burner. Determine which model you have.
2. Connect the burner to the gas supply with rubber tubing.
3. Close the air vents. If your model is a Tirrell burner also close the gas control valve at the base of the burner.
4. Hold a lighted match or a gas lighter at the top of the burner and turn on the gas supply. Do this by opening the main gas supply valve located on top of the nozzle to which you attached the rubber tubing. (If your model is a Tirrell burner, open the gas control valve at the base approximately $\frac{1}{2}$– turn after opening the main gas supply valve.) You should get a yellow or luminous flame, sometimes called a "safety" flame because of its visibility (Figure 5a). When a Tirrell burner is used, the main gas supply valve should be opened fully and the gas flow regulated by the gas control valve. Gas supply to a Bunsen burner is controlled by the main gas valve.
5. Open the air vents slowly, to admit more air into the flame, to produce a light blue (nonluminous) cone-shaped flame (Figure 5b). If the flame "blows out" after lighting, the gas supply should be reduced.
6. Adjust the air vents and gas supply to produce the desired size of flame. For most laboratory work the blue inner cone of the flame should be about 2 cm high and free of yellow color. If you want a smaller flame, close the air vent slightly and reduce the gas supply. You will learn how to control the burner flame by trial and error.
7. Turn the burner off at the main gas supply valve when you finish.



a. air vents closed



b. air vents open

Figure 5. Burner flame characteristics

Caution: Confine long hair and loose clothing when using a gas burner. Do not reach over a burner. Ensure that flammable liquids are not being used when a burner is lighted. Never leave a lighted burner unattended. Know the location of fire extinguishers, the fire blanket, and safety shower.

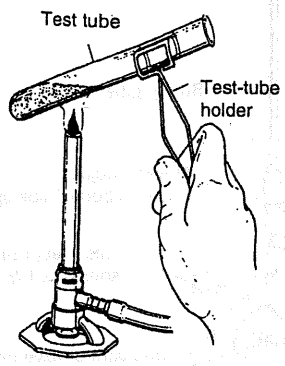


Figure 6. Heating a liquid in a test tube

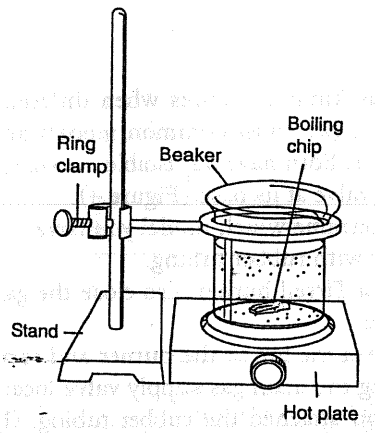


Figure 7. Heating a liquid in a beaker

HEATING LIQUIDS

Heating a liquid in a test tube. The correct procedure for heating a liquid in the laboratory is important to laboratory safety. A spurt cap can be used to prevent a hot liquid from accidentally spraying out of the test tube as the liquid boils.

1. Adjust your gas burner to give a gentle blue flame.
2. Fill a test tube one-third full with the liquid to be heated.
3. Grab the test tube with a test-tube holder near the upper end of the tube.
4. Hold the test tube in a slanting position in the flame, and gently heat the tube a short distance below the surface of the liquid. Move the test tube back and forth over the flame to regulate the heat input (Figure 6).
5. Shake the tube gently as it is being heated, until the liquid boils or reaches the desired temperature.

Caution: Never point the open end of a test tube you are heating either toward yourself or anyone working nearby. Never heat the bottom of the test tube.

Heating a liquid in a beaker. Many laboratory experiments require the use of a hot-water or boiling-water bath. This procedure describes how to assemble a water bath.

1. Place a 250-mL beaker half-filled with water on a hot plate (Figure 7).
2. Add a boiling chip to the beaker.
3. Secure the beaker by placing a ring clamp around it.
4. Heat the beaker as needed.

Caution: Never heat plastic beakers or graduated glassware in a burner flame. Never let a boiling-water bath boil dry; add water to it as necessary.

INSERTING GLASS TUBING

In many experimental procedures you are required to insert a thermometer or a length of glass tubing into a hole in a rubber stopper. It is essential that you know the correct way to do this. Otherwise serious injury may result.

1. Lubricate the end of the glass tubing with a few drops of water, dish detergent, glycerol, or vegetable oil.
2. Hold the glass tubing close to where it enters the hole in the rubber stopper. Protect your hands with a glass tubing manipulator, work gloves, a piece of cloth, or paper towels.
3. Ease the tubing into the hole with a gentle twisting motion. Push the tubing through the hole as far as is required. Do not use force!
4. Wipe excess lubricating material from the tubing before continuing with the experiment.
5. If the glass tubing is to be removed from the stopper it should be done immediately after the experiment is completed.