Laboratory Equipment and Skills

In the chemistry laboratory, you will be using equipment, handling materials, and performing certain unfamiliar tasks. The purpose of this section is to introduce you to the equipment and to describe some of the skills you will be required to use in this laboratory course. A few of the "dos" and "don'ts" necessary for safe and effective laboratory work also are included.

Recognizing Lab Equipment

The equipment you will be using most frequently in the laboratory is illustrated in Figure 1. Study this figure carefully and familiarize yourself with each item.

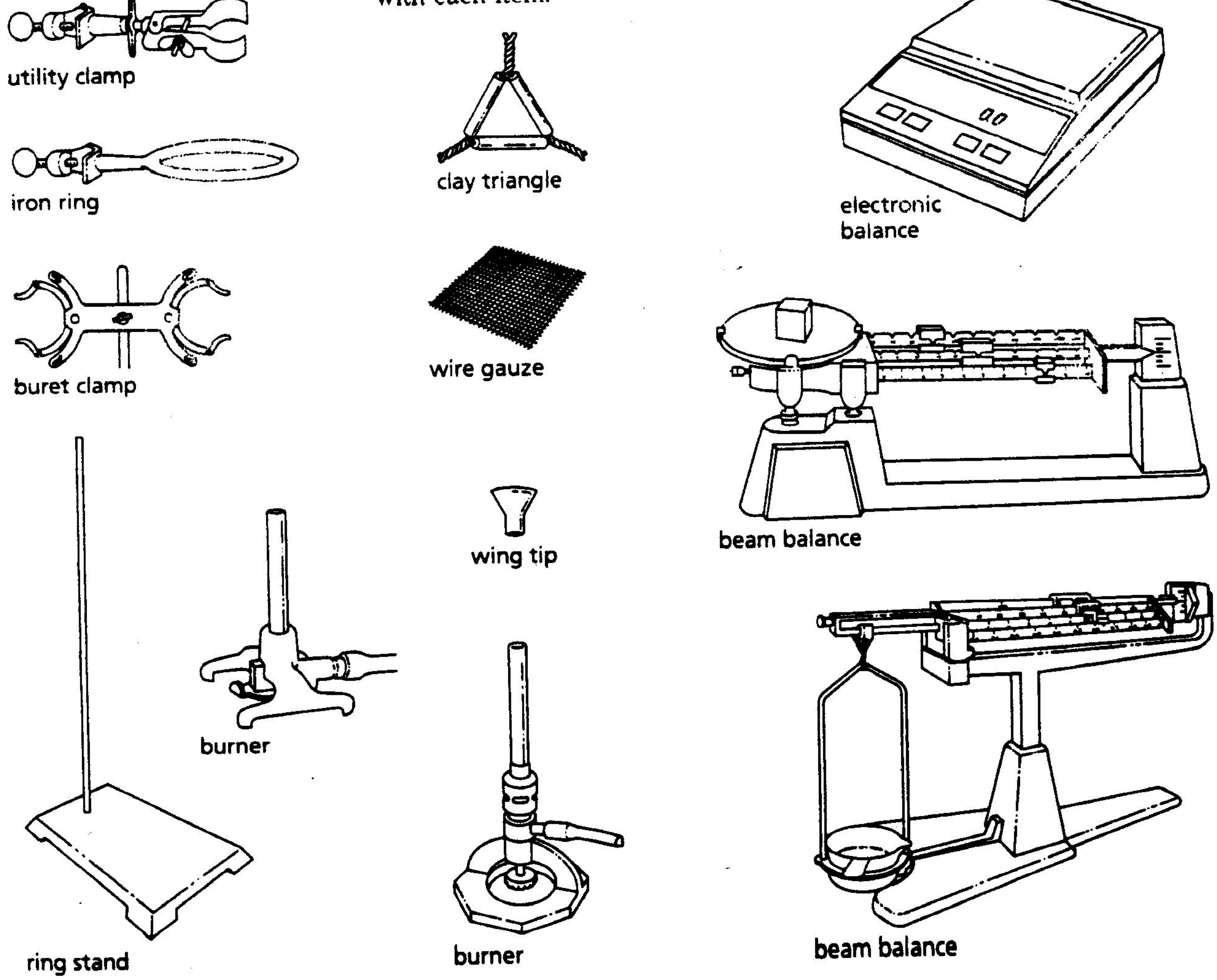


Figure 1 Laboratory equipment.

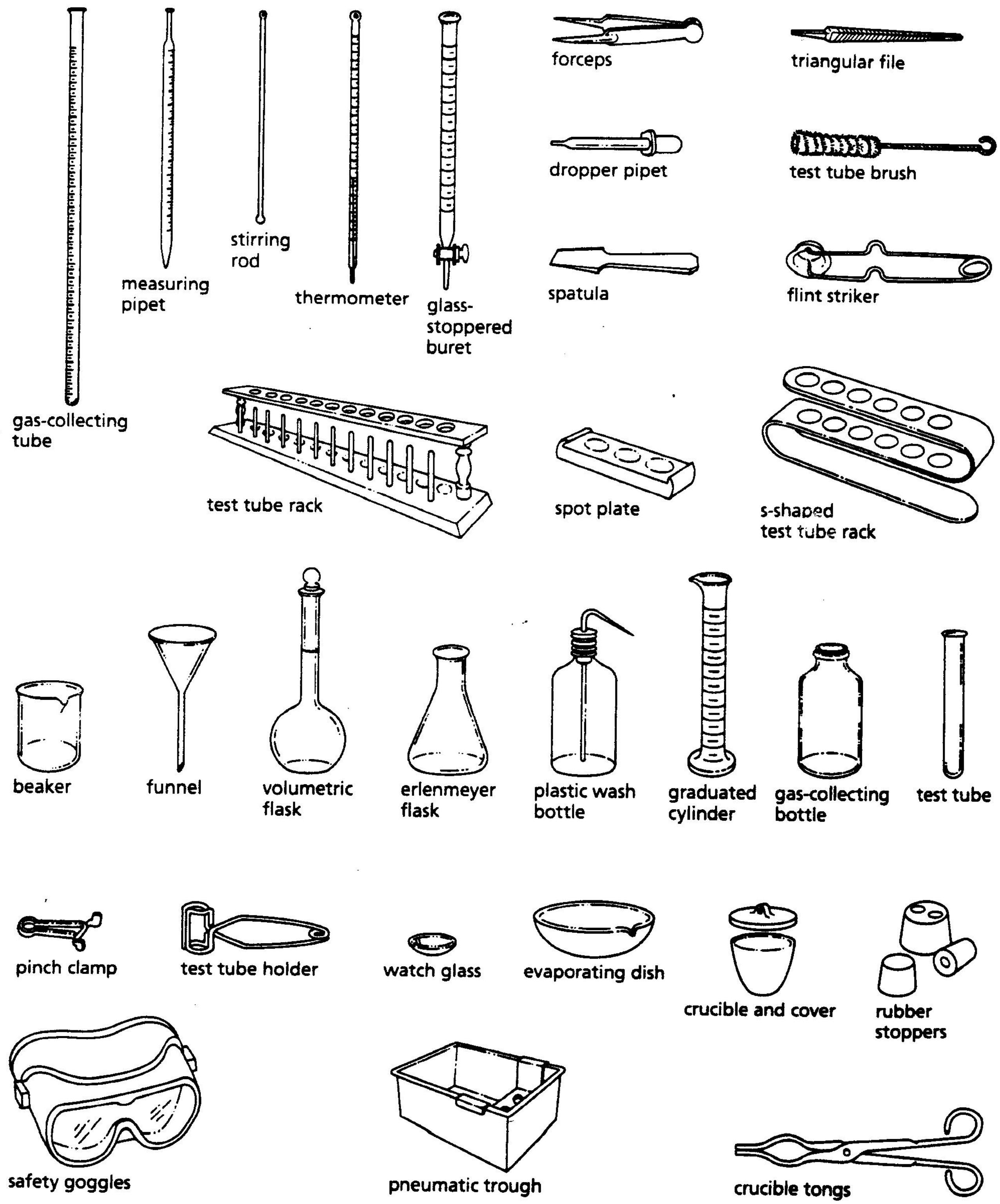
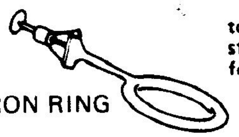
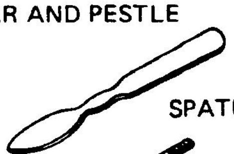
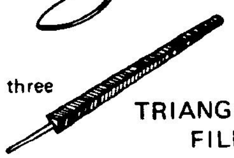
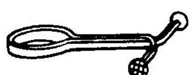
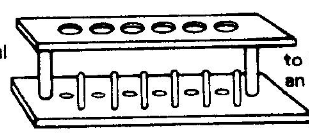
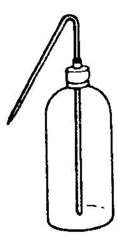
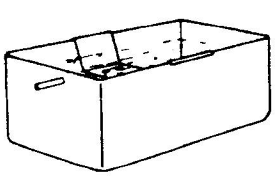
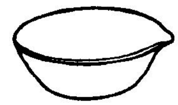
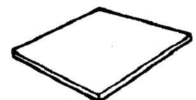
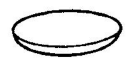
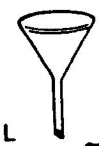
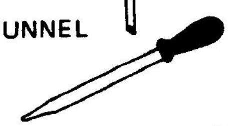
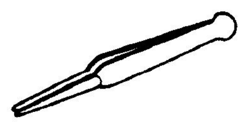
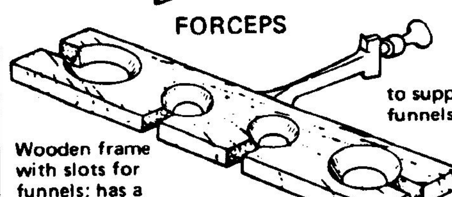
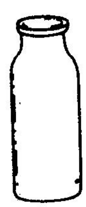
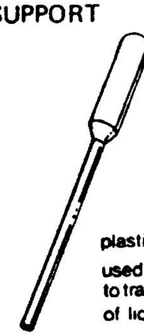
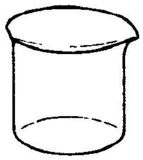
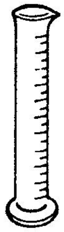
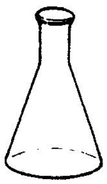
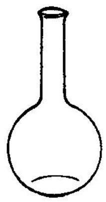
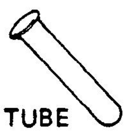
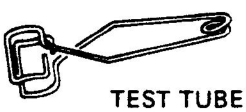
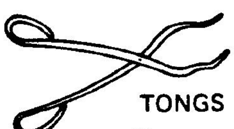
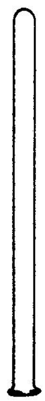
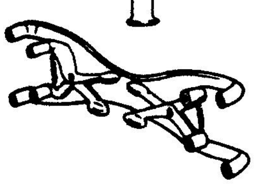
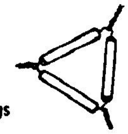
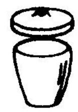
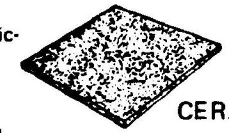
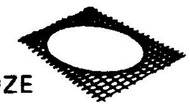
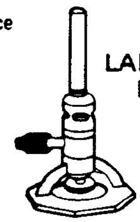
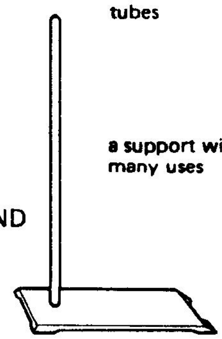
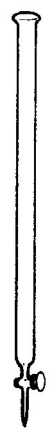
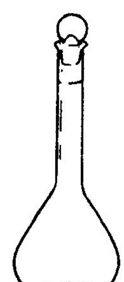
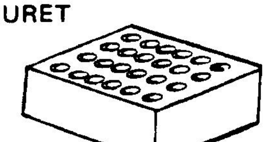


Figure 1, continued

DESCRIPTION	APPARATUS	USE
iron ring with screw fastener several sizes	 IRON RING	to fasten to the ring stand as a support for apparatus
metal clamp with 1. screw fastener 2. swivel and lock nut 3. adjusting screw 4. curved clamp	 BURET CLAMP-TEST TUBE CLAMP	to hold apparatus may be fastened to the ring stand
heavy porcelain dish with grinder	 MORTAR AND PESTLE	to grind chemicals to a powder
may be of metal or porcelain	 SPATULA	to transfer solid chemicals in weighing
metal file with three cutting edges	 TRIANGULAR FILE	to scratch glass to file
short length of rubber tubing	 RUBBER CONNECTOR	to connect parts of apparatus
metal clamp with finger grips	 PINCH CLAMP	to clamp a rubber connector
rack; may be wood, metal or plastic	TEST TUBE RACK 	to hold test tubes in an upright position
squeezable plastic bottle with angular tip	 PLASTIC WASH BOTTLE	to dispense distilled water
galvanized iron container with rolled edge, overflow tube, and bottle shelf	 PNEUMATIC TROUGH	to hold water, gas collecting bottles, and delivery tube from gas generator

DESCRIPTION	APPARATUS	USE
brush with wire handle	 TEST TUBE BRUSH	to scrub glass apparatus
glass rod	STIRRING ROD 	to stir combinations of materials to use in pouring liquids
porcelain dish	 EVAPORATING DISH	as a container for small amounts of liquid being evaporated
thick glass	 GLASS PLATE	many uses (should not be heated)
curved glass	 WATCH GLASS	may be used as a beaker cover may be used in evaporating very small amounts of liquid
glass or plastic	 FUNNEL	to hold a filter paper may be used in pouring
glass tip with rubber bulb	 MEDICINE DROPPER	to transfer small amounts of liquid
metal	 FORCEPS	to pick up or hold small objects
Wooden frame with slots for funnels; has a metal clamp	 FUNNEL SUPPORT	to support funnels
glass many uses as a container	 WIDE-MOUTH BOTTLE	
	 THIN STEM PIPETTE	plastic used in micro experiment to transfer small amounts of liquid

DESCRIPTION	APPARATUS	USE
glass common sizes 100 mL 250 mL 400 mL marked on the beaker	 BEAKER	as a container, like a cup may be heated
glass marked with a milliliter (mL) scale size / divisions 50 mL / 1.0 mL 35 mL / 0.2 or 0.5 mL 10 mL / 0.1 mL	 GRADUATED CYLINDER	to measure volume
glass common sizes 125 mL 250 mL 500 mL marked on the flask	 ERLENMEYER FLASK  FLORENCE FLASK	may be heated
glass several sizes	 TEST TUBE	many uses can be heated
metal clamp with a spring handle	 TEST TUBE HOLDER	to hold a test tube
metal	 TONGS	to pick up and hold apparatus
glass marked with a milliliter (mL) scale	 GAS MEASURING TUBE	used to collect and measure the volumes of gases
metal clamp with flexible clips	 DOUBLE BURET CLAMP	to hold burets when titrating
10 centimeter (cm) ruler, plastic divided into centimeter and millimeter (mm) divisions	 10 CM RULER	to measure length
triangular wire frame with clay material coverings	 PIPESTEM TRIANGLE	to support the crucibl.
small porcelain dish with cover	 CRUCIBLE AND COVER	to heat small amounts of solid material at high temperature
hardened ceramic-fibered material	 CERAMIC-FIBERED SQUARE	to place under hot apparatus
wire screen with ceramic-fibered center	 WIRE GAUZE	to spread the heat of a flame
metal heating device connected to gas outlet with rubber tubing	 LABORATORY BURNER	to heat chemicals in beakers or test tubes
metal rod upright heavy base	 RING STAND	a support with many uses
glass marked with a milliliter (mL) scale and fitted with a stopcock, pinch clamp, or glass bead	 BURET	used to withdraw and measure volumes of solutions in titrations
glass marked off to liter capacity, with a glass stopper	 VOLUMETRIC FLASK	used in the preparation of solutions
plastic	 24 WELL MICROTITRATION PLATE	used to hold liquids in micro experiment

Using the Laboratory Burner

One of the most frequently used pieces of equipment in the chemistry lab is the laboratory burner. Although laboratory burners differ somewhat in appearance and construction, they all have several features in common. Figure 2 shows two typical laboratory burners.

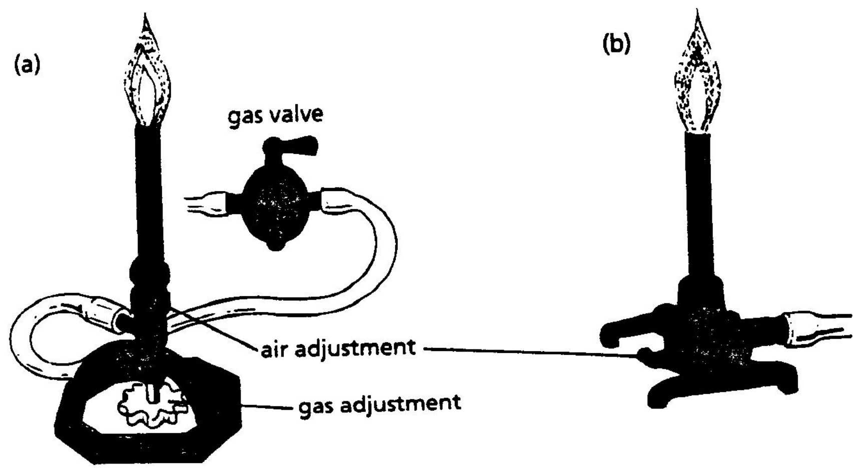


Figure 2 Two types of laboratory gas burners.

Laboratory burners use a mixture of gas and air as fuel. The amount of gas that mixes with the air must be correct in order to obtain the most effective flame. The burner is connected to the gas valve by a piece of tubing. The gas valve is used to turn the gas on and off and to control the supply of gas to the burner. By adjusting the valve, the flow of gas can be increased or reduced. Some burners, such as (**a**) in Figure 2, have a gas adjustment knob that allows you to "fine tune" the flow of gas to the burner. The supply of air is regulated by adjusting a vent or valve on the burner. All burners have some device for this purpose.

To light the burner, hold a lighted match or flint lighter to the side and slightly above the barrel of the burner and turn on the gas. After lighting the burner, make any adjustments necessary to produce a properly adjusted flame.

A properly adjusted burner flame is nonluminous, with two distinct cones, as shown in Figure 3. Improper flames can be corrected by making the following adjustments:

If the flame is too large, decrease the flow of gas to the burner.

If the flame "disappears" down the burner barrel, turn the burner off, decrease the air supply, and light the burner again.

If the flame is too yellow, increase the air supply.

Before lighting a burner, make sure that no flammable materials are nearby. When working around a burner, tie back long hair and secure bulky or loose clothing. Never leave a lighted burner unattended.

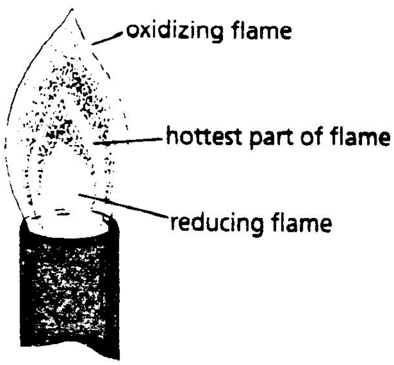


Figure 3 A properly adjusted burner flame.

Using the Balance

Beam balances are the most common type used in high school laboratories. The two balances shown in Figure 4 are (**a**) a triple-beam platform balance and (**b**) a four-beam pan balance.

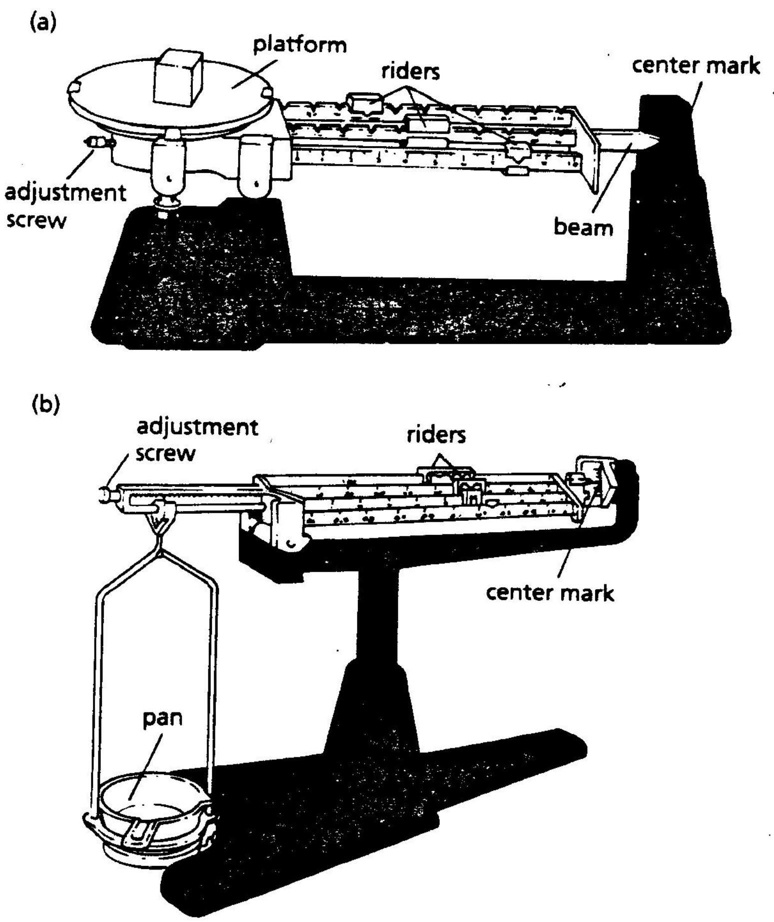


Figure 4 Two types of beam balances.

The proper use of the balance is described in the following steps:

1. Check to see that the balance is properly adjusted, or "zeroed." To do this, set all of the riders at zero and remove all objects from the pan or platform. The pointer should swing an equal distance on each side of the zero point on the scale. If it does not, use the adjustment screw to obtain an equal swing of the pointer.

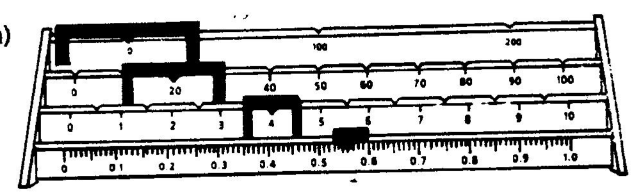
2. *Never place chemicals directly on the balance pan or platform.* Samples to be measured should be placed on a piece of pre-measured paper or in a pre-measured container. Clean up any spills immediately. Never place hot objects on the balance. Allow samples to cool before measuring their mass.

3. Once the object whose mass is to be determined is on the pan or platform, move the rider of greatest mass along this beam, one notch at a time, until it causes the pointer to drop. Then move the rider *back* one notch. Repeat this procedure with each succeeding rider of smaller mass. If the beams are notched, make sure each rider is securely in its notch. The front beam, which is marked off in the smallest increments, is not notched. Slide the rider on this beam until the pointer swings an equal distance on each side of the zero on the scale.

4. When the pointer is zeroed, sum up the masses shown on the beams. The mass of the object is equal to the sum of the masses shown on the beams *minus the pre-measured mass of the paper or container.*

The precision of a balance depends on the size of the smallest increments on the scale of the front beam. On some triple-beam balances, this scale is divided into 10 1-gram increments. This scale can be read to the nearest ±0.1 gram. On a four-beam balance (and some triple-beam balances), the scale on the front beam is divided into 10 0.1-gram increments. This scale can be read to the nearest ±0.01 gram. Some sample readings of this type of balance are illustrated in Figure 5. The reading on balance (**a**) is 24.56 grams. The reading on balance (**b**) is 107.08 grams.

(a)



(b)

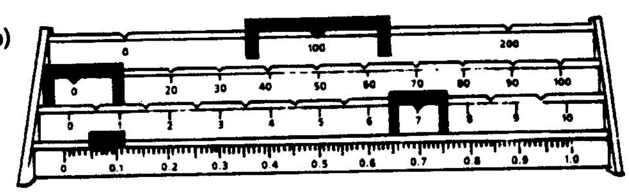
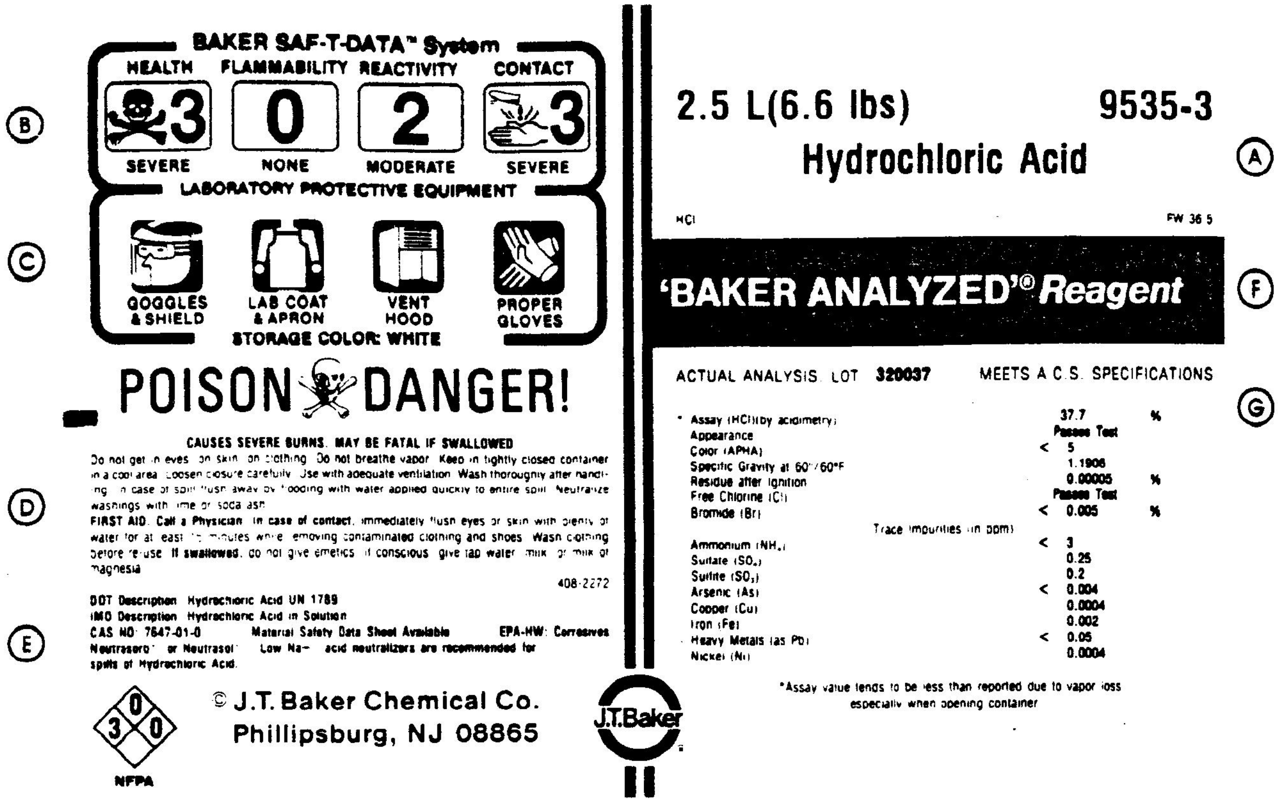


Figure 5 Sample readings of a four-beam balance.



Label: Courtesy J.T. Baker Chemical Company

books, purses, etc., out of the way in designated storage areas.

Reading Reagent Labels

Before working with any chemical, you should familiarize yourself with any hazards associated with the use of the chemical. Chemicals currently being shipped from chemical manufacturers contain a wealth of important information on the reagent labels. Though labeling systems can vary, most contain the following common features:

(A) Name of Reagent

(B) Hazard Category/Rating

1. Health hazards – Poisons, Carcinogens, Life, Radioactive
2. Flammability hazards
3. Contact hazards – Corrosives, Life
4. Reactivity hazards – Explosive, Oxidizers, Water Reactive, Air Reactive

? Insufficient data available to rate

0	1	2	3	4
None		Moderate		Extreme

(C) Safety Equipment to be worn when handling this reagent

(D) Caution/First Aid Instructions – Always read this information BEFORE you use a reagent

(E) Clean-up Instructions for Spills

(F) Color Coding for Storage of the Reagent (color not shown)
One supplier uses: blue – health hazard; red – flammability hazard; yellow – reactivity hazard; white – contact hazard; orange – general storage; striped – incompatible materials

(G) Physical Data for the Reagent

Handling Chemical Reagents

When conducting an experiment, it will be necessary for you to obtain chemical reagents, both liquid and solid, from some central supply area. The chemicals in this supply area have a degree of purity that must be maintained. In order to avoid contaminating these chemicals, the following rules should be strictly adhered to:

1. Take only as much reagent as you need.
2. If a scoop (or spatula) is used to remove a solid reagent from its container, use *only* that scoop for that reagent. Do *not* use your own scoop. Do *not* use the same scoop to remove reagents from two different containers.
3. Once a reagent has been removed from its container, *never return any portion of it to its container*. All excess materials should be discarded as instructed by your teacher.

Solids. Whenever possible, solid reagents should be poured, rather than scooped, from their containers. Figure 6 illustrates the most satisfactory method for pouring solid reagents.

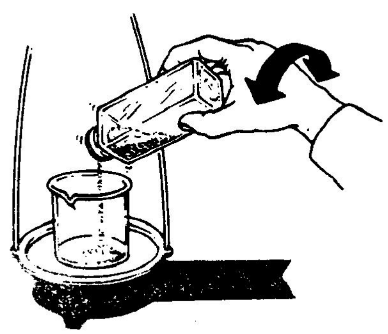


Figure 6 Pouring solid reagent.

By gently rotating the bottle back and forth and tapping the side of the bottle with your finger, you can make the reagent come out in a controlled, steady flow.

When transferring a solid reagent to a test tube or other small-mouth container, it is best to use a piece of paper. Using the method shown in Figure 6, the desired quantity of reagent is first poured from its container onto a piece of paper. The paper is then used to pour the reagent into the test tube, as shown in Figure 7.

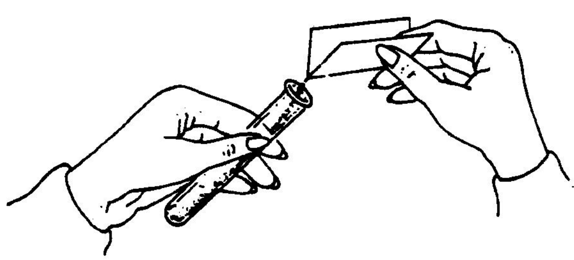


Figure 7 Using a creased paper to transfer a solid.

Liquids. When transferring liquids from a reagent bottle, remove the stopper from the bottle by grasping it between the forefinger and middle finger, as shown in Figure 8.

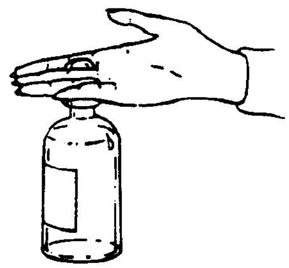


Figure 8 Removing the stopper from a liquid reagent bottle.

Do not set the stopper down. While still grasping the stopper, pour from the side of the reagent bottle away from the label, as illustrated in Figure 9.

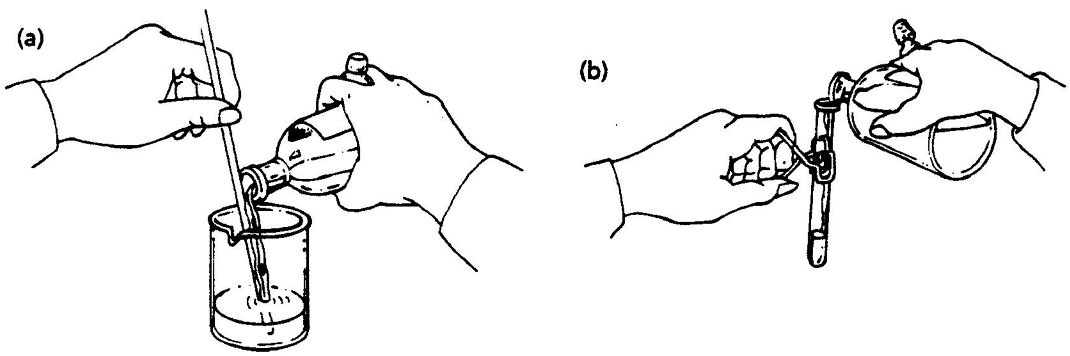


Figure 9 Proper methods of pouring liquid reagents

When pouring a liquid into a large-mouth container, pour the liquid down a glass stirring rod [Figure 9(a)] to avoid spattering. If pouring into a test tube, stand the tube in a test-tube rack, or use a test-tube holder [Figure 9(b)].

Measuring Liquids

The most commonly used instruments for measuring liquids in the laboratory are graduated cylinders, burets, and measuring pipets. Each of these instruments has a scale marked on its side. In most cases, the larger the measuring device, the less precise the scale. Graduated cylinders are designed to measure the volume of liquid they are *holding*. Thus, the 0-mL mark is at the bottom of the scale. Burets and pipets are designed to measure the volume of liquid they *deliver*. On the scales of these instruments, the 0-mL mark is at the top. This permits the user to read the amount of liquid that has been delivered from the zero mark.

In all of these instruments, the surface of the liquid will be slightly curved. This curved surface is called a *meniscus*. The curvature is caused by the combined effects of the pull of gravity on the liquid and the attraction (or nonattraction) of the liquid for the glass of the instrument. Most liquids are attracted to the glass and are said to "wet" the glass. The meniscus formed by such a liquid is concave (curved downward). Such liquids as mercury, that do not wet the glass, form a convex meniscus.

When reading the scale of an instrument containing a liquid, you read to the *bottom* of a concave meniscus and to the *top* of a convex meniscus. Figure 10 shows the correct and incorrect lines of sight in reading a concave meniscus.

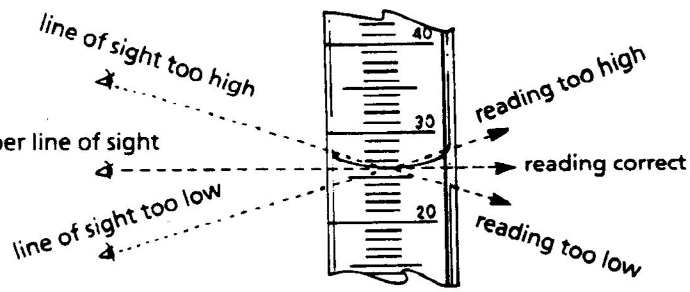


Figure 10 Reading a concave meniscus.

Filtering a Mixture

Filtration is a procedure commonly used to separate liquids from insoluble solids. In this procedure, the solid-liquid mixture is poured into a funnel in which a paper filter has been fitted. The filter traps the solid particles and allows the liquid to pass through, where it is collected in a container.

The paper filter is formed by folding a piece of filter paper as illustrated in Figure 11. Tearing off a corner of the filter paper, as shown in step (3) of the figure, prevents air from leaking down the fold of the filter. Once the filter is formed, place it in the funnel and "tack" it into position by wetting it slightly with distilled water and pressing it against the walls of the funnel until all air bubbles are removed.

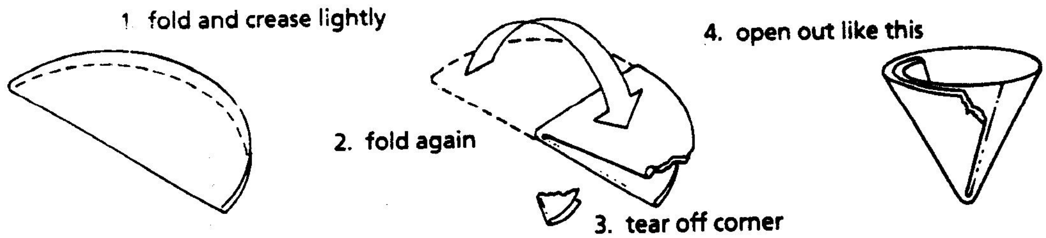


Figure 11 Folding a filter paper.

Figure 12 shows the proper setup for carrying out a filtration. Slowly pour the mixture down a glass stirring rod into the filter, making sure that none of the mixture rises above the edge of the filter in the funnel. After all the liquid has been poured from the container, use a wash bottle to rinse out any solid that remains in the container. Then wash the solid trapped in the filter with small amounts of water from the wash bottle.

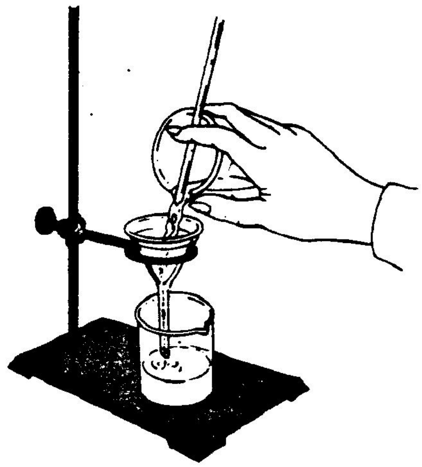


Figure 12 Filtration setup.

Working with Glass Tubing

The glass tubing most commonly used in the laboratory is made of a "soft" type of glass that is easily cut and shaped. To cut a piece of tubing, place it on a flat surface. Place one edge of a triangular file on the tubing at the spot where you wish to make your cut. While holding the tubing with one hand, press down firmly with the file and make one firm stroke away from you. Before trying to break the tubing at the cut mark, protect your hands by wearing gloves or wrapping a piece of cloth around the tubing. Pick up the tubing and place your thumbs on opposite sides of the scratch, as shown in Figure 13(a). Holding your thumbs firmly against the glass, snap the tubing at the scratch, as shown in Figure 13(b).

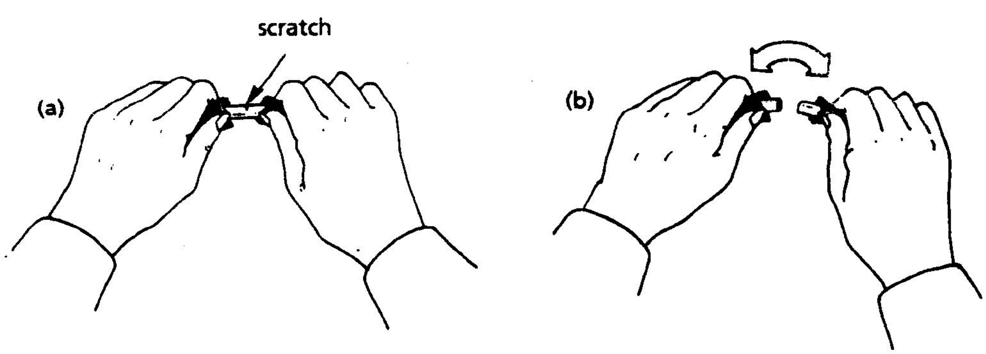


Figure 13 Cutting glass tubing.

After a piece of tubing has been cut, the cut edges are very sharp and should be polished. To do this, place the cut end of the tubing into the hottest part of a burner flame. Rotate the glass as you heat it (Figure 14), and continue heating it until the flame becomes a bright yellow. If you examine the cut end, you will see that the sharp edges have become smooth.

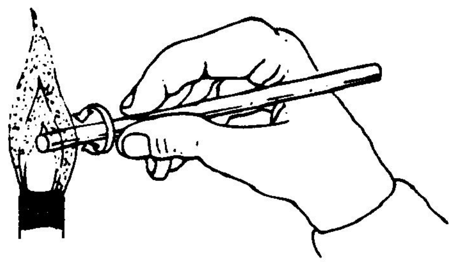


Figure 14 Fire-polishing glass tubing.

Place the tubing on an insulated pad to cool. DO NOT TOUCH THE HOT GLASS.

If you wish to bend a piece of glass tubing, first place a flame spreader, or "wing tip," on the burner. Light the burner and rotate the glass in the flame, as shown in Figure 15.

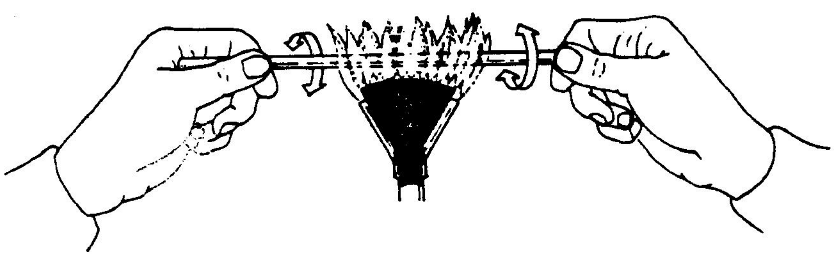


Figure 15 Heating glass tubing prior to bending.

As the glass heats, the flame will become yellow and the glass will soften. Remove the glass from the flame and lift the ends of the tubing with a smooth, even motion. When the glass has been bent to the desired angle, place it on an insulated pad to cool.

Preparing Laboratory Reports

A laboratory report is a written record of an investigation. Such a report is an integral part of any laboratory experiment. The names and brief descriptions of the sections of a laboratory report are given below.

Purpose. The purpose is a brief statement of the goals to be achieved by conducting the experiment. This statement is always given at the beginning of the experiment.

Procedure. In the lab manual, the procedure is a step-by-step description of the activities to be done in order to gather the information needed to achieve the purpose of the experiment. In your lab reports, you might be asked to summarize the most important of these steps.

Observations and Data. This section is a running account of what takes place during the course of an investigation. All of your observations, qualitative and quantitative, must be recorded in this section *at the time the observation is made.* Entries in the final two sections of the lab report will be based on the information recorded here. Thus, it is vital that this information be complete, well-organized, accurate, and properly labeled.

Calculations. In many cases, the "raw" data collected during the course of an experiment must be "processed" before valid conclusions can be reached. Processing data can include making mathematical calculations. the results of these calculations then are used as a basis on which to draw conclusions.

In some experiments, the raw data are all that is needed for the purpose of drawing conclusions. In such cases, the calculations section is omitted from the laboratory report.

Conclusions and Questions. Basically, this section is where you answer the question: "Was the purpose of this experiment achieved?" In answering this question, you must provide evidence to support your answer.

The pages of this laboratory manual are designed to be used as a laboratory report. The purpose is stated, and space is provided for recording observations and data and for making calculations. In cases where data are to be graphed, grids are provided. The "Conclusions and Questions" section consists of a series of questions and/or problems related to the experiment. However, your teacher might prefer that you prepare your own laboratory reports on separate sheets of paper.