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.

![Utility Clamp](image)
![Iron Ring](image)
![Buret Clamp](image)
![Ring Stand](image)
![Burner](image)

![Clay Triangle](image)
![Wire Gauze](image)
![Wing Tip](image)

![Electronic Balance](image)
![Beam Balance](image)

Figure 1 Laboratory equipment.
Figure 1, continued
<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>APPARATUS</th>
<th>USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>iron ring with screw fastener several sizes</td>
<td>IRON RING</td>
<td>to fasten to the ring stand as a support for apparatus</td>
</tr>
<tr>
<td>metal clamp with 1. screw fastener 2. swivel and lock nut 3. adjusting screw 4. curved clamp</td>
<td>BURET CLAMP TEST TUBE CLAMP</td>
<td>to hold apparatus may be fastened to the ring stand</td>
</tr>
<tr>
<td>heavy porcelain dish with grinder</td>
<td>MORTAR AND PESTLE</td>
<td>to grind chemicals to a powder</td>
</tr>
<tr>
<td>may be of metal or porcelain</td>
<td>SPATULA</td>
<td>to transfer solid chemicals in weighing</td>
</tr>
<tr>
<td>metal file with three cutting edges</td>
<td>TRIANGULAR FILE</td>
<td>to scratch glass to file</td>
</tr>
<tr>
<td>short length of rubber tubing</td>
<td>RUBBER CONNECTOR</td>
<td>to connect parts of apparatus</td>
</tr>
<tr>
<td>metal clamp with finger grips</td>
<td>PINCH CLAMP</td>
<td>to clamp a rubber connector</td>
</tr>
<tr>
<td>rack: may be wood, metal or plastic</td>
<td>TEST TUBE RACK</td>
<td>to hold test tubes in an upright position</td>
</tr>
<tr>
<td>squeezable plastic bottle with angular tip</td>
<td>PLASTIC WASH BOTTLE</td>
<td>to dispense distilled water</td>
</tr>
<tr>
<td>galvanized iron container with rolled edge, overflow tube, and bottle shelf</td>
<td>PNEUMATIC TROUGH</td>
<td>to hold water, gas collecting bottles, and delivery tube from gas generator</td>
</tr>
<tr>
<td>glass or plastic</td>
<td>FUNNEL</td>
<td>to transfer small amounts of liquid</td>
</tr>
<tr>
<td>wood</td>
<td>MEDICINE DROPPER</td>
<td>to pick up or hold small objects</td>
</tr>
<tr>
<td>glass</td>
<td>FUNNEL SUPPORT</td>
<td>to support funnels</td>
</tr>
<tr>
<td>many uses as a container</td>
<td>WIDE-MOUTH BOTTLE</td>
<td>plastic used in micro experiment to transfer small amounts of liquid</td>
</tr>
<tr>
<td>to hold a filter paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>may be used as a beaker cover</td>
<td></td>
<td></td>
</tr>
<tr>
<td>may be used in evaporating very small amounts of liquid</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to stir combinations of materials to use in pouring liquids</td>
<td></td>
<td></td>
</tr>
<tr>
<td>as a container for small amounts of liquid being evaporated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>many uses (should not be heated)</td>
<td>GLASS PLATE</td>
<td></td>
</tr>
<tr>
<td>to scrub glass apparatus</td>
<td>TEST TUBE BRUSH</td>
<td></td>
</tr>
<tr>
<td>glass rod</td>
<td>STIRRING ROD</td>
<td></td>
</tr>
<tr>
<td>porcelain dish</td>
<td>EVAPORATING DISH</td>
<td></td>
</tr>
<tr>
<td>thick glass</td>
<td>WATCH GLASS</td>
<td></td>
</tr>
<tr>
<td>curved glass</td>
<td></td>
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</tbody>
</table>

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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.](image)

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.
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.
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.

![Figure 5 Sample readings of a four-beam balance.](image)
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
   ? 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.](image)

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.](image)
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](image)

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](image)

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.](image)

**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.](image)

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.
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).
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.](image)

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.](image)

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.