Introduction to the Chemistry Laboratory

PRELAB ASSINGMENT

Read the entire laboratory write up. Write an objective, briefly describe any hazards associated with this lab, and answer the following questions in your laboratory notebook before coming to the lab. Read the entire laboratory write up before answering these questions.

1. When reporting measurements the last digit recorded should be the first digit estimated. In general this means the first digit for which there is not a mark on the measurement devise. For each piece of lab equipment listed below, state to what accuracy you should record your observations. (e.g, 1 g, 1 mL, 0.1 g, 1 cm, etc.)

   Buret __________________________ Graduated Cylinder ________________________
   Analytical Balance ________________ Top loading Balance _______________________
   Thermometer ___________________

2. Briefly summarize the 6 rules for using a balance.

3. A student is attempting to determine the density of an unknown metal by using the displacement method.
   (a) If the sample weighs 12.46 g and displaces 1.4 mL of water, what is the density of the metal? Report your answer using the correct number of significant figures.
   (b) Use the densities listed below to identify the metal.

Table 1

Density of the metallic materials	
Metallic material	Density (g/cc)
Aluminum and aluminum alloy	2.70
Titanium and titanium alloy	4.54
Nickel and nickel alloy	8.90
Copper and copper alloy	8.96
Steel	7.87
Austenitic stainless steel	7.8 - 8.0
Ferritic stainless steel	7.7 - 7.8
Martensitic stainless steel	7.8 - 8.0

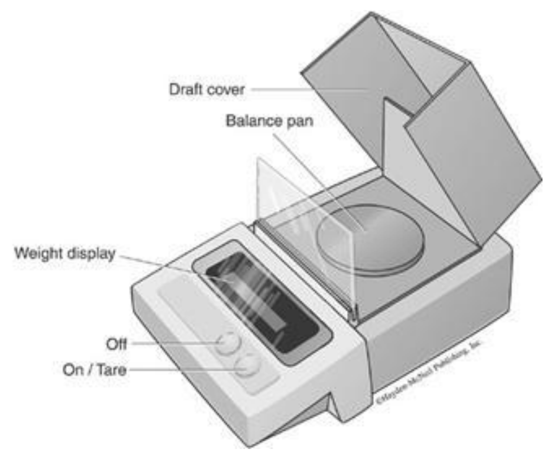
4. Which type of water (tap water or distilled water) is most appropriate for the following activities?
   (a) Cleaning the lab bench
   (b) Preparing a solution to use in carrying out a chemical reaction
   (c) Making an ice bath into which a test tube will be placed
   (d) Rinsing out a beaker
   (e) Washing your hands after lab

5. Why should you not return unused solid reagents to the original container when you are done with an experiment?

INTRODUCTION

Balances

One of the most important pieces of equipment that you will use in the lab is the balance. In a typical lab there are two types of balances, an electronic top-loading balance and an electronic analytical balance. The top-loading balance is generally used when a rough measurement is adequate and can weigh objects to 0.1 or 0.001 gram precision. The analytical balance is necessary when greater accuracy and precision are needed and can weigh to 0.0001 gram precision. Note that whenever you use an analytical balance you should record all four decimal places even if there are zeros.

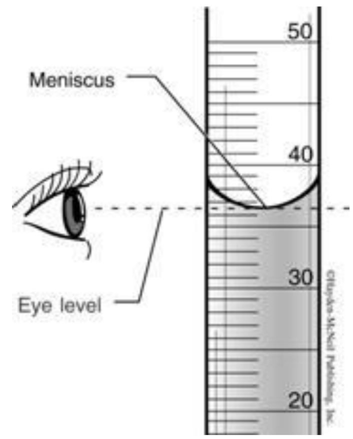


To use the balance, first turn it on. The balance should be zeroed by pressing the TARE or ZERO button. Place the object to be weighed on the center of the balance pan and record the mass when the balance stabilizes. If you are weighing chemicals, you should place an empty weighing boat or small beaker on the balance and press tare or zero to subtract out the mass of the container. Then slowly and carefully add the chemical to the weigh boat or beaker and record the mass. The observed mass will be the mass of the chemical alone.

Always follow the general rules for the proper use of a balance listed below.

1. Never place chemicals directly onto the balance pan. Use a beaker or weighing boat to hold the chemicals.

2. Objects to be weighed should be at room temperature, not hot or cold.
3. If the balance has doors they should be closed when zeroing the balance and when actually weighing something.
4. Do not lean on the lab benches when you or others are using the balance.
5. Always use the same balance for weighing an item before and after an experiment when determining if a change in mass has occurred.
6. Always clean up the balance pan before and after you use the balance. You will find a brush for cleaning the balance near the balance. If the balance pan is dirty your measurement will not be correct.



Graduated Cylinders

The graduated cylinder is essentially the measuring cup for a chemistry laboratory. It is used to measure the volumes of liquids or solutions with reasonable accuracy. When a liquid is placed in a graduated cylinder the surface of the liquid forms a **meniscus** (or a concave surface) inside the cylinder. You should read the bottom of the meniscus to record the volume of the liquid, and all readings should be made at eye level.

All volumes should be recorded to 0.1 mL precision, which means that you will have to estimate the last decimal place.

Buret

A Buret is the most accurate way of measuring volumes that you will use in the introductory laboratory. Volumes measured with a buret should be recorded to 0.01 mL precision. When using a buret to deliver a volume of liquid you should accurately read and record the volume of the liquid in the buret both before and after delivery. The volume of the liquid delivered is then calculated by subtraction of the final volume reading from the initial volume reading. For this reason you should never start the measurement when the volume is above the graduations on the buret and you should be sure that the liquid level does not drop below the markings at the bottom of the buret. As with the graduated cylinder you should always read the lowest point on the meniscus and all readings should be taken at eye level.

Thermometer

An alcohol thermometer will be made available when needed for an experiment. When using the thermometer to measure the temperature of a liquid you should be sure that the thermometer does not touch the inside of the container and all temperature readings should be recorded to 0.1 ^{o}C. You will need to estimate the last decimal place. Care should be taken at all times handling the thermometer, since it is fragile and can break.

Bunsen Burner

The Bunsen burner is a convenient heat source for laboratory use when a hot plate is not adequate and when you are sure there are NO FLAMMABLE LIQUIDS nearby. With proper adjustment, an extremely hot flame can be produced with the Bunsen burner. Make sure long hair and loose clothing is secured before using a Bunsen burner.

Distilled or Deionized Water

In the laboratory there are three types of water, distilled water, deionized water, and tap water. Tap water (normal drinking water) contains dissolved minerals, chlorine to kill germs, and fluoride for tooth hardening. Tap water should be used when the water will <u>not</u> come into contact with a chemical reaction of interest. This includes contact with chemicals or glassware used in carrying out a chemical reaction. Distilled water has been purified by boiling and condensing to remove most dissolved minerals. Deionized water has been purified by passing it through columns that adsorb dissolved minerals. Distilled or deionzed water should always be used for preparing solutions and for thoroughly rinsing glassware before use. Distilled or deionized water will be available in labeled plastic carboys on the lab bench. Fill the squeeze bottles on the lab benches marked distilled or deionized water from the carboys.

Hot Plates and Stir Plates

A hot plate is useful for heating solutions or water baths. A hot plate rather than a Bunsen burner should be used when a liquid (other than water) needs to be heated. The surface of a hot plate can get quite hot, and you should never place your hand or fingers on the surface. To stir solutions using a stir plate, a small magnet encased in Teflon is placed into the solution. After placing the beaker or flask containing the solution on the center of the stir plate, the stirring control is slowly turned on and the solution is allowed to stir gently. Care must be taken not to stir any solution too rapidly or spilling and breaking of glassware may occur. Also, remember to turn off the stir and hot plate when you are finished using it. The hot plate surface will take some time to cool. Please do not allow electrical cords to touch the hot plate surface while it is hot.

Cleaning Glassware

The glassware on the shelves in this laboratory is far from clean. To clean glassware you should use hot soapy water. You will find squeeze bottles near the sinks labeled detergent or soap.

Once the glassware has been washed with soap and a brush, it should be rinsed thoroughly with tap water and then rinsed 2 to 3 times with small volumes of distilled or deionized water.

Do not dry the glassware with a paper towel. Distilled or deionized water will not contaminate your experiment and a paper towel might introduce contamination.

Lab Etiquette
When measuring both solid and liquid reagents (chemicals):

1. Do not return unused reagents to the original container. This can contaminate the entire reagent bottle.
2. Do not put extra liquids or solutions back in the original container. This can contaminate the original liquid or solution.

When you finish your lab, thoroughly clean all glassware and wipe your lab bench work area and the sink areas with a damp paper towel. Return all glassware, chemicals, or supplies to the original position in which you found them before you leave the lab.

Stay near your experiment and alert at all times.

Do not place lab equipment near the edge of the lab bench.

Properly dispose of all waste.
1. Never put a chemical down the drain or in the trash without asking your instructor how the chemical should be disposed of.
2. Broken glass should be carefully placed into the marked boxes.
3. If spills or breakage occurs, notify you lab instructor immediately.

Wash your hands thoroughly before leaving the laboratory.

LABORATORY PROCEDURE

A. Distilled versus tap water

You will evaporate a sample of distilled and tap water and record your observations.

Procedure
1. Thoroughly wash and rinse two 250 mL beakers. Use a 25 mL graduated cylinder to measure and transfer 100 mL of tap water (measure and transfer 25 mL 4 times) to one beaker and 100 mL of distilled water to the other beaker. Clearly label each beaker so that you can identify the contents of each beaker during and after the experiment.
2. Place the beakers on a hot plate and turn the hot plate to a setting of 5-6.
3. Record the time when each of the two water samples begin to boil. Once the water in the beakers has begun to boil measure and record the temperature of each sample. Remember the bulb or tip of the thermometer should be submersed in the water but should never touch the beaker walls.

4. When the volume in each beaker has been reduced to about 50 mL, turn off the hot plate and record the time. Allow the water samples to cool to room temperature, and record any observations in your laboratory notebook.

B. Determination of Densities

Density is the relationship between the mass of an object and the volume the object occupies. The fact that aluminum is less dense than iron is what makes a piece of aluminum feel lighter than an identically sized piece of iron. Generally, density is expressed in units of g/cm^3 or g/mL ($1\ cm^3 = 1$ mL).

The density of an object is determined by measuring the mass of the object and the volume occupied by that object. The volume of a solid can be determined by two different methods. With regularly shaped objects (such as a rectangular block or a sphere) the dimensions of the object can be measured directly using a ruler and the volume calculated. With more oddly shaped objects this is not as simple and the displacement method must be used. Here an object is placed in a graduated cylinder containing water and the volume of the water is recorded before and after adding the object. The difference in volume is due to the displaced volume occupied by the object.

Volumes of liquids can be determined by direct measurement using a graduated cylinder, pipet, or buret.

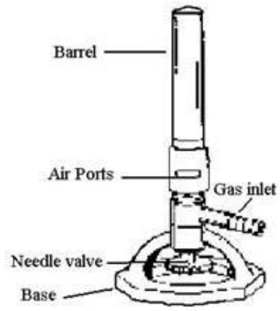
Procedure

1. Weigh a metal cylinder using a top loading balance and record the mass in your lab notebook.
2. Measure the length and diameter of the metal cylinder to 0.01 cm precision using a ruler.
3. Add approximately 10 mL of water to a 25 mL graduated cylinder and as precisely and and as accurately as possible record the volume added to the nearest 0.1 mL.
4. Gently place the same metal cylinder weighed and measured in steps 1 and 2 above into the graduated cylinder containing water.
5. Precisely and accurately record the new volume of the water level (with the metal cylinder displacing some of the water) to the nearest 0.1 mL.

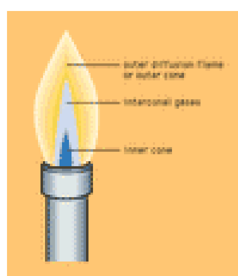
C. Investigating the Bunsen burner

This experiment examines how a Bunsen burner works and how it can be adjusted. Then, using the difference in melting points of three metals, the temperature range of various regions of the burner flame will be estimated.

Procedure:



1. Compare your Bunsen burner to the figure above and make sure you can locate all of the parts that are indicated in the figure.
2. Close the air vents and gas control and connect the burner to the gas source on your lab bench.
3. Turn on the gas source. Open the gas control (the needle valve in the figure above) on the burner a small amount, about two turns. Bring the flint striker over the top of the burner. Squeeze the striker so the flint produces sparks. Repeat as necessary until the flame ignites. If the flame has not ignited after two to three attempts. Turn off the gas source. Wait a minute or so to allow the gas to diffuse away from the area, and try again.
4. Gradually open the air vents at the bottom of the burner. While adjusting the air vents, you should be able to identify three regions of slightly different color in the burner flame as shown in the figure below.



5. With tongs, hold the end of a strip of aluminum wire in the outermost region of the flame, C. Does it melt? Record the result in your notebook. Now hold the end of the aluminum wire in the central region of the flame, B. Does it melt in this region? Record the result. Move the wire to the inner most region of the flame, A. Record whether or not the wire melts in this region. Repeat this procedure with copper and steel wire.
   Melting point of aluminum (Al) = 660 ^{o}C
   Melting point of copper (Cu) = 1080 ^{o}C
   Melting point of steel = 1425-1540^{o}C

OBSERVATIONS AND DATA

Record all data and observations collected or made in your laboratory notebook and not on this lab write up. You may find the following format a useful example of how to organize your data in your laboratory notebook.

A. Distilled water Tap water

Temperature while boiling

Time required for evaporation
from 100 mL to 50 mL

Observations during and after
Evaporation from 100 mL to 50 mL

B. Density of a solid

Direct measurement method

Mass of the metal cylinder (g) ___________g

Length of the metal cylinder (cm) ___________cm

Diameter of the metal cylinder (cm) ___________cm

Calculated volume of the metal cylinder ___________cm^3

Recall that the volume of a right circular cylinder = $\pi(\text{radius})^2\text{length}$,
and that the radius is ½ the diameter.

Calculated density of the metal cylinder (g/cm^3) ___________g/cm^3

Displacement method

Mass of the metal cylinder (g) ___________g

Volume of water before adding the metal cylinder (mL) ___________mL

Volume of water after adding the metal cylinder (mL) ___________mL

Calculated volume of the metal cylinder due to displacement of water (mL)
___________mL

Calculated density of the metal cylinder (g/mL) ___________g/mL

C. Investigating the Bunsen burner

Wire (melting point)	A	B	C
Al (660°C)			
Cu (1080°C)			
Steel (1425-1540°C)			

Which region(s) of the flame are hottest?

Which region(s) of the flame are coolest?

Record all observations. What did you see, hear, smell or otherwise sense when you inserted the metal wires into the flame? Consider both the wires and the flame.

QUESTIONS

Answer all questions in your laboratory notebook.

1. From what you observed in the lab, why is it so important that you use distilled water to make up any solutions that you need for chemical reactions?

2. The reported value for the density of brass ranges from approximately 7.4 to 8.6 g/cm^3. Were your determinations within this range?

3. (a) Calculate the percent relative difference between the density values you determined using the direct measurement method and the displacement method.

$$\%\,\text{difference} = \left(\frac{\text{value 1} - \text{value 2}}{\left(\frac{\text{value 1} + \text{value 2}}{2} \right)} \right) \text{x } 100$$

   (b) Which method do you think gave the more accurate density determination?
   (c) Why do you think this is so? Consider the measurements and calculations involved in each method. Is it possible to make a measurement without error?

4. From your observations with the Bunsen burner, would it be possible to use the Bunsen burner to melt an ordinary penny and why do you think so?